Aerial view of a water-spreading diversion weir (Heinz Bender)

Water-spreading weirs for the development of degraded dry river valleys (Chad)

Seuils d'épandage pour la valorisation des vallées d'oued dégradées

DESCRIPTION

Water-spreading weirs are structures that span the entire width of a valley to spread floodwater over the adjacent land area.

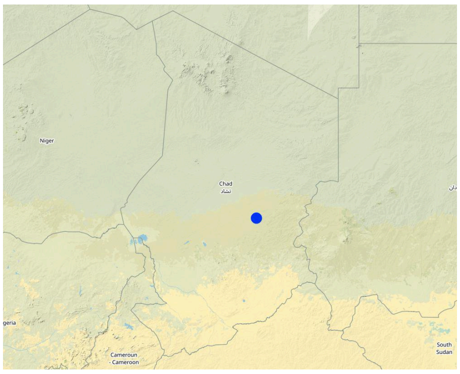
Over the last 12 years water-spreading weirs have been introduced and improved as a new rehabilitation technique for degraded dry valleys in Burkina Faso, Niger and Chad. In Chad 104 water-spreading weirs were constructed in the scope of the two development projects, initiated by the German Technical Cooperation (GIZ) and the Swiss Development Cooperation (SDC) in the 1990s. Water-spreading weirs are made of natural stones and cement, and consist of a spillway in the actual riverbed and lateral abutments and wings. Floodwaters are spread over the adjacent land area above the structure, where they eventually overflow the lateral wings and then slowly flow back towards the riverbed below the structure. As a result the land area below the weir is flooded. The lateral spreading of the water causes the land area above and below the structure to be flooded and supplies it with sediment. Water infiltrates, gullies in the valley are filled and the riverbed is raised. Thanks to the infiltration, the groundwater table also rises in a few years.

Purpose of the Technology: In dry valleys in which water flows in the rivers for only a few days a year, the weirs serve to distribute the incoming runoff over the valley floor and allow as much water as possible to infiltrate the soil. The aquifer is thus replenished and is then available for agricultural use. In contrast to the various types of dams, the goal of water-spreading weirs is not to create reservoirs for later use. What water-spreading weirs do is cause a temporary flooding of the adjacent land area above and below the weir. Depending on user preferences, the primary goal may be 1) agricultural use, 2) sylvo-pastoral use or 3) the replenishment and rising of the water table.

Establishment / maintenance activities and inputs: Water-spreading weirs require detailed technical planning and experienced engineering and construction firms. The bulk of the work is performed using local materials and by village craftsmen and helpers.

Natural / human environment: Compared to small impoundment dams, retention basins and microweirs, water-spreading weirs are especially well-suited for shallow, wide valleys that, due to severe gully erosion, are no longer inundated by small and medium volume floodwaters. The flooding no longer takes place because the actual riverbed has been deeply eroded and enlarged. However, water-spreading weirs are also suitable for improving agricultural productivity in more or less intact valley floors. Water-spreading weirs are successful in regions where precipitation during the growing season is erratic and where the weirs ensure a more evenly distributed water supply for crops, as well as in zones in which water enrichment makes one or two additional growing seasons possible. At the present time they are in use in a broad area where annual rainfall ranges from 50 to 1,200 mm/year.

LOCATION



Location: Eastern Chad, Chad

No. of Technology sites analysed:

Geo-reference of selected sites
- 20.0, 14.0

Spread of the Technology: evenly spread over an area (approx. 10-100 km2)

In a permanently protected area?:

Date of implementation: 10-50 years ago

Type of introduction
- [ ] through land users' innovation
- [ ] as part of a traditional system (> 50 years)
- [ ] during experiments/ research
- [x] through projects/ external interventions

Water-spreading diversion weir during the rainy season (Heinz Bender)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose
- [x] improve production
- [x] reduce, prevent, restore land degradation
- [ ] conserve ecosystem
- [ ] protect a watershed/ downstream areas – in combination with other Technologies
- [ ] preserve/ improve biodiversity
- [ ] reduce risk of disasters
- [ ] adapt to climate change/ extremes and its impacts
- [ ] mitigate climate change and its impacts
- [ ] create beneficial economic impact
- [ ] create beneficial social impact

Land use
Cropland
- Annual cropping

Grazing land
- Semi-nomadic pastoralism

Water supply
- [ ] rainfed
- [ ] mixed rainfed-irrigated
- [ ] full irrigation
- [x] Post-flooding

Purpose related to land degradation
- [ ] prevent land degradation
- [x] reduce land degradation
- [x] restore/ rehabilitate severely degraded land
- [ ] adapt to land degradation
- [ ] not applicable

Degradation addressed
soil erosion by water - Wt: loss of topsoil/ surface erosion, Wg: gully erosion/ gullying

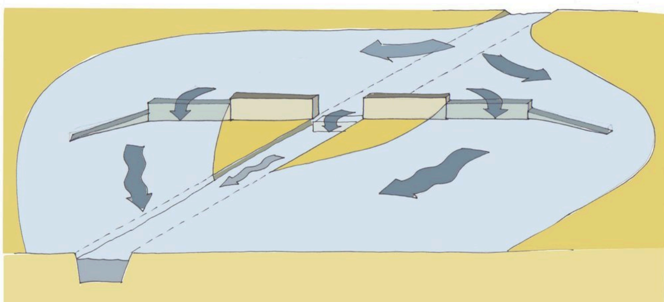
water degradation - Hg: change in groundwater/aquifer level

SLM group
- cross-slope measure
- irrigation management (incl. water supply, drainage)
- water diversion and drainage

SLM measures
structural measures - S6: Walls, barriers, palisades, fences

TECHNICAL DRAWING

Technical specifications
None



Author: Heinz Bender

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs
- Costs are calculated:
- Currency used for cost calculation: **n.a.**
- Exchange rate (to USD): 1 USD = n.a
- Average wage cost of hired labour per day: n.a

Most important factors affecting the costs
n.a.

Establishment activities
1. Excavating the steps (Timing/ frequency: None)
2. Excavating the wall foundations (Timing/ frequency: None)
3. Pouring the foundations (Timing/ frequency: None)
4. Building the walls (Timing/ frequency: None)
5. Finishing the walls and filling the stilling basin (Timing/ frequency: None)

Establishment inputs and costs

Specify input	Unit	Quantity	Costs per Unit (n.a.)	Total costs per input (n.a.)	% of costs borne by land users
Labour					
Labour	ha	1.0	750.0	750.0	100.0
Equipment					
Total costs for equipment	ha	1.0	750.0	750.0	
Construction material					
Stone	ha	1.0	750.0	750.0	
Total costs for establishment of the Technology				**2'250.0**	

Maintenance activities
n.a.

Maintenance inputs and costs

Specify input	Unit	Quantity	Costs per Unit (n.a.)	Total costs per input (n.a.)	% of costs borne by land users
Labour					
Labour	ha	1.0	50.0	50.0	100.0
Equipment					
Total costs for equipment	ha	1.0	50.0	50.0	
Construction material					
Stone	ha	1.0	50.0	50.0	
Total costs for maintenance of the Technology				**150.0**	

NATURAL ENVIRONMENT

Average annual rainfall
- [x] < 250 mm
- [x] 251-500 mm
- [ ] 501-750 mm
- [ ] 751-1,000 mm
- [ ] 1,001-1,500 mm
- [ ] 1,501-2,000 mm
- [ ] 2,001-3,000 mm
- [ ] 3,001-4,000 mm
- [ ] > 4,000 mm

Agro-climatic zone
- [ ] humid
- [ ] sub-humid
- [x] semi-arid
- [ ] arid

Specifications on climate
251-500 mm Ranked 1
<250 mm Ranked 2
150-400 mm / year
Thermal climate class: tropics

Slope
- [x] flat (0-2%)
- [x] gentle (3-5%)
- [ ] moderate (6-10%)
- [ ] rolling (11-15%)
- [ ] hilly (16-30%)
- [ ] steep (31-60%)
- [ ] very steep (>60%)

Landforms
- [ ] plateau/plains
- [ ] ridges
- [ ] mountain slopes
- [ ] hill slopes
- [ ] footslopes
- [x] valley floors

Altitude
- [ ] 0-100 m a.s.l.
- [x] 101-500 m a.s.l.
- [x] 501-1,000 m a.s.l.
- [ ] 1,001-1,500 m a.s.l.
- [ ] 1,501-2,000 m a.s.l.
- [ ] 2,001-2,500 m a.s.l.
- [ ] 2,501-3,000 m a.s.l.
- [ ] 3,001-4,000 m a.s.l.
- [ ] > 4,000 m a.s.l.

Technology is applied in
- [ ] convex situations
- [ ] concave situations
- [ ] not relevant

Soil depth
- [ ] very shallow (0-20 cm)
- [ ] shallow (21-50 cm)
- [x] moderately deep (51-80 cm)
- [x] deep (81-120 cm)
- [ ] very deep (> 120 cm)

Soil texture (topsoil)
- [ ] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [x] fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- [ ] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Topsoil organic matter content
- [x] high (>3%)
- [x] medium (1-3%)
- [ ] low (<1%)

Groundwater table

Availability of surface water

Water quality (untreated)

Is salinity a problem?

- [ ] on surface
- [ ] < 5 m
- [x] 5-50 m
- [ ] > 50 m

- [ ] excess
- [ ] good
- [ ] medium
- [x] poor/ none

- [x] good drinking water
- [ ] poor drinking water (treatment required)
- [ ] for agricultural use only (irrigation)
- [ ] unusable

Water quality refers to:

- [ ] Ja
- [ ] Nee

Occurrence of flooding
- [ ] Ja
- [ ] Nee

Species diversity
- [ ] high
- [x] medium
- [ ] low

Habitat diversity
- [ ] high
- [ ] medium
- [ ] low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [ ] subsistence (self-supply)
- [x] mixed (subsistence/ commercial)
- [ ] commercial/ market

Off-farm income
- [x] less than 10% of all income
- [ ] 10-50% of all income
- [ ] > 50% of all income

Relative level of wealth
- [ ] very poor
- [x] poor
- [ ] average
- [ ] rich
- [ ] very rich

Level of mechanization
- [ ] manual work
- [ ] animal traction
- [ ] mechanized/ motorized

Sedentary or nomadic
- [ ] Sedentary
- [ ] Semi-nomadic
- [ ] Nomadic

Individuals or groups
- [ ] individual/ household
- [x] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [ ] women
- [ ] men

Age
- [ ] children
- [ ] youth
- [ ] middle-aged
- [ ] elderly

Area used per household
- [x] < 0.5 ha
- [ ] 0.5-1 ha
- [ ] 1-2 ha
- [x] 2-5 ha
- [ ] 5-15 ha
- [ ] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [ ] > 10,000 ha

Scale
- [ ] small-scale
- [ ] medium-scale
- [ ] large-scale

Land ownership
- [ ] state
- [ ] company
- [x] communal/ village
- [ ] group
- [ ] individual, not titled
- [ ] individual, titled

Land use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [x] leased
- [ ] individual

Water use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [ ] individual

Access to services and infrastructure

IMPACTS

Socio-economic impacts

Crop production
decreased ☐☐☐☐☐☐✓ increased
Quantity before SLM: 158 kg/ha
Quantity after SLM: 653 kg/ha
Increase of millet yield in Chad

fodder production
decreased ☐☐☐☐☐☐✓ increased

fodder quality
decreased ☐☐☐☐☐☐✓ increased

animal production
decreased ☐☐☐☐☐☐✓ increased
Quantity before SLM: 6,000 cattle head
Quantity after SLM: 16,000 cattle heads
The increase in groundwater level has led to a significant increase in the number of cattle heads that can be watered

risk of production failure
increased ☐☐☐☐☐☐✓ decreased

product diversity
decreased ☐☐☐☐✓☐☐ increased

production area (new land under cultivation/ use)
decreased ☐☐☐☐☐☐✓ increased
Quantity before SLM: 2.85 ha
Quantity after SLM: 5.29 ha
The numbers are from a study on water-spreading weirs in Niger, but for Chad the situation is comparable

farm income
decreased ☐☐☐☐☐☐✓ increased
Users of water-spreading weirs had 112% higher incomes compared to farmers outside the impact zone from sales of vegetables and surplus grain

workload
increased ☐☐☐☐☐☐✓ decreased
The workload of women is eased thanks to the availability of and easier access to water due to the shallower water table

Income for the community
None ☐☐☐☐☐✓☐ None
Temporary income was generated for the local workers during the weir construction. About 231 Euros per user family.

Socio-cultural impacts

food security/ self-sufficiency	reduced	improved	Food security assured through crop and livestock farming
health situation	worsened	improved	Children have a healthier, more diverse diet due to the vegetable production and the introduction of new crops
community institutions	weakened	strengthened	The weirs are becoming an element of interaction and social integration for the inhabitants of surrounding villages
SLM/ land degradation knowledge	reduced	improved	Through training
conflict mitigation	worsened	improved	Decline in conflicts between farmers and livestock raisers over water rights owing to the fact that sufficient water is now available
situation of socially and economically disadvantaged groups (gender, age, status, ehtnicity etc.)	worsened	improved	Temporary emigration to Sudan and Lybia has declined and in some villages people who had long since emigrated returned home
Diversification and creation of activities	decreased	Increased	In the vicinity of the weirs activities such as trading of agricultural products, fishing, watering livestock and making clay tiles have emerged
Training for weir construction	None	None	Numerous local masons were trained
Improved planning skills	None	None	Village people, service providers, communal representatives, government technical sectors have improved their skills in organisation, planning and implementation
Poverty	increased	decreased	

Ecological impacts

water quantity	decreased	increased	
harvesting/ collection of water (runoff, dew, snow, etc)	reduced	improved	More and longer-lasting bodies of surface water
surface runoff	increased	decreased	
groundwater table/ aquifer	lowered	recharge	In some communities groundwater has risen to a depth of 6m below surface
soil moisture	decreased	increased	
soil loss	increased	decreased	Gullies are filled in
nutrient cycling/ recharge	decreased	increased	Deposition of nutrients
soil organic matter/ below ground C	decreased	increased	Deposition of organic matter
biomass/ above ground C	decreased	increased	Spread of natural vegetation around the rehabilitated valley plains
plant diversity	decreased	increased	Vanished plant species return
animal diversity	decreased	increased	Vanished animal species return
habitat diversity	decreased	increased	

Off-site impacts

water availability (groundwater, springs)	decreased	increased	
downstream flooding (undesired)	increased	reduced	
downstream siltation	increased	decreased	
buffering/ filtering capacity (by soil, vegetation, wetlands)	reduced	improved	

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns: very negative [ ][✓][ ][ ][ ][ ][ ] very positive
Long-term returns: very negative [ ][ ][ ][ ][ ][ ][✓] very positive

Benefits compared with maintenance costs

Short-term returns: very negative [ ][ ][ ][ ][✓][ ][ ] very positive
Long-term returns: very negative [ ][ ][ ][ ][ ][ ][✓] very positive

Depending upon the users' experience and the availability of labour, it may take anywhere from 2 to 10 years before the rehabilitated land area reaches its optimum use potential.

CLIMATE CHANGE

Gradual climate change

annual temperature increase: not well at all [ ][ ][ ][✓][ ] very well

Climate-related extremes (disasters)

local rainstorm: not well at all [ ][ ][ ][✓][ ] very well
local windstorm: not well at all [ ][ ][ ][✓][ ] very well
general (river) flood: not well at all [ ][ ][ ][✓][ ] very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

☐ single cases/ experimental
☐ 1-10%
☐ 11-50%
☐ > 50%

Of all those who have adopted the Technology, how many have done so without receiving material incentives?

☑ 0-10%
☐ 11-50%
☐ 51-90%
☐ 91-100%

Has the Technology been modified recently to adapt to changing conditions?

☐ Ja
☐ Nee

To which changing conditions?

☐ climatic change/ extremes
☐ changing markets
☐ labour availability (e.g. due to migration)

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

Strengths: compiler's or other key resource person's view

- Through the construction of water-spreading weirs, soils are regularly flooded and supplied with water and sediment. Thus, the arable land area and the yields of the rainy season crops serving as staple food increase.

  How can they be sustained / enhanced? Ensure proper maintenance of the system.
- The more frequent flooding of the soils results in increased infiltration, and the groundwater level rises substantially.
- Prior to rehabilitation, in most of the sites, it was only possible to grow a rainfed crop and perhaps an irrigated crop on some small areas of land. After, in addition to the rainfed crop grown on larger areas of land, it became possible to grow a post-rainy season crop (culture de contresaison) and, once the water table had risen, an irrigated crop (culture de décrue) as well.

  How can they be sustained / enhanced? Upscale water-spreading weirs to increase the number of people benefitting.
- Post-rainy season crops and irrigated crops diversify agricultural production. They are used as a means of earning cash income.

  How can they be sustained / enhanced? Improve access to markets.
- With their capacity to regulate annual floodwaters and harness them to stabilise production, water-spreading weirs are an effective measure for adapting to climate change in regions experiencing increasing variability in rainfall.

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome

- It can be assumed that one third of the weirs will require complete renovation every 20 years The renovation of these weirs can be done for approximately 10% of the initial construction costs
- Maintenance of the weirs by the management committees is still a weak area. Funds expected from user fees for the plots are often inadequately collected and too low to cover costs. Some management committees lose their drive and neglect their duties. New fundings sources have to be found and tapped.
- In spite of the great potential for the use of water-spreading weirs and the very promising results, implementation will continue to depend in the medium term on outside funding, as it is unlikely that the communal budgets will be able to fund investments of this size. The existing knowledge hast to be spread.
- Know-how and experience for the construction of water-spreading weirs are still concentrated among a few countries.

REFERENCES

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Resource persons
Heinz Bender - SLM specialist

Full description in the WOCAT database
https://qcat.wocat.net/af/wocat/technologies/view/technologies_1536/

Linked SLM data
n.a.

Documentation was faciliated by

Institution
- n.a.

Project
- Book project: Water Harvesting – Guidelines to Good Practice (Water Harvesting)

Key references

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