Contour and Eyebrow Trenches

Nepal – समोच्च रेखामा बनाइने लाइन तथा आइब्रो खाडलहरू

Spring water source recharge with contour and eyebrow trenches in the rural mid-hills of Nepal.

In the rural areas of the Nepal mid-hills, yield of water sources is often not adequate to meet all domestic and agricultural demands of the local population year-round. Water sources are frequently remote and/or intermittent, making water fetching a time-consuming affair. As a measure to increase the yield of spring water sources, trenches are dug out along contour lines of equal elevation in the uphill area to promote local water infiltration and hence source recharge. Primary targeted beneficiaries of the intervention are financially and socially deprived communities, living mostly from subsistence farming in water-scarce areas. The application of contour and eyebrow trenches in the project area follows the principles below:

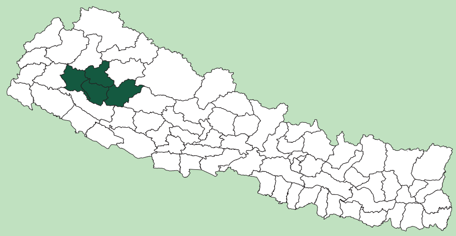
- **Location:** As ditches in the ground can cause inconveniences for the daily life of the community, they are dug wide of residential areas on grassland or in forests within the catchment area of the targeted spring water source. The positioning of the contour and eyebrow trenches is further guided by an analysis of the runoff characteristics and subsurface flow patterns within the catchment area.
- **Aspect:** Contour eyebrow trenches are particularly suited for south-facing slopes, which are exposed to higher amounts of solar radiation and thus feature increased levels of evapotranspiration. These characteristics make southern slopes less favourable for traditional ponds, whereas the additional percolation through the trenches and basins can help to replenish the local soil moisture and ground water level.
- **Slope:** Contour trenches are applied in areas with slopes up to 30%. Above this threshold, the programme makes use of the smaller eyebrow trenches for stability reasons.
- Size: As long continuous trenches may pose a risk in heavy rainfall events, the programme opts for interrupted trenches, i.e., several shorter rectangular ditches of about 5 m length, with a width of 0.5–1 m and a depth of 0.5–0.75 m. The eyebrow-shaped trenches are of smaller size, with a length of about 3 m and a width and depth of roughly 0.5 m.
- **Spacing:** Horizontal intervals between the micro-basins range from 4 m to 10 m (subject to local slope).
- **Plantation:** The excavated soil is placed on the downslope-edge of the trench to form a small bund. To reinforce the soil and trap sediment during rainfall events, stripes of local grass varieties like napier (pennisetum purpureum) or amlisso (thysanolaena maxima), as well as local shrub species (asparagus racemosus, persian lilac) are planted on these bunds. Seedlings of local tree species (diploknema butyracea, alnus nepalnesis) are placed in the space between the trenches to further stabilize the soil and increase its water-retaining ability.

Besides the primary aim of recharging spring water sources, the cross-slope basins also bring about other benefits. By breaking the slope, they reduce surface flow velocity and its erosive power and thus may help to stabilize landslide-prone terrain. The increased soil moisture levels also create more favourable conditions for plant growth between the trenches. In this way, the trenches enable the re-establishment of vegetative cover on bare land and allow for land utilization such as cattle grazing or crop cultivation. By increasing the soil's moisture-holding and recharge capacity, contour trenches hedge against an anticipated increase in seasonal rainfall variability and more frequent dry spells in the future due to climate change.

The community digs out the ditches with manual labour while the programme contributes with technical support, the necessary tools, and seedlings for plantation. Maintenance is vital to keep the intervention effective in later years: the trenches and bunds should be regularly cleared of sediment, which can be re-applied in the uphill fields. The vegetation on the bunds may need special care and protection (e.g., from cattle), particularly in the early stages.

Left: Plantation of shrubs in the space between the trenches to stabilize the soil and increase its water retaining ability (WARM-P)

Right: Trench dug out along a contour line to promote local water infiltration (WARM-P)



Location: Four districts in the Western, Mid-Western, and Far-Western Development Regions of Nepal

Technology area: per source 1 – 10 km²

Conservation measure(s): Structural, Vegetative

Land use type: Extensive grazing land

Climate: Humid subtropical

WOCAT database reference: QT NEP 43

Related approach: QA NEP 36

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Comments: The contour and eyebrow trenches described here are often part of water source conservation and protection measures (QT NEP 48). They are planned and implemented within the Water Use Master Plan (WUMP) framework for poor communities in the rural mid-hills of Nepal.

The technology was documented using the WOCAT (www.wocat.org) tool.

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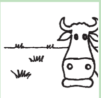
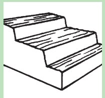
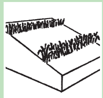
Classification

Water and land use problems

- Growing water demand for both domestic and agricultural use and diminishing or fluctuating water supply due to climate change
- Loss of vegetative cover due to open grazing and human interventions

Land use		Climate		Degradation				Conservation measure(s)			
											
Extensive grazing land Natural forests		Humid subtropics		Physical degradation: Decline of water quality and quantity		Water erosion: loss of topsoil by water; gully erosion		Structural: trenches, basins, bunds		Vegetative: plantation of grass, shrub and tree species	

Stage of intervention	Origin	Level of technical knowledge
Prevention Mitigation/reduction Rehabilitation	Land users' initiative: Experiments/research Externally introduced: 0-0 years ago	Field staff User

Main causes of local water scarcity

- **Natural causes:** temporary water scarcity during dry season; deterioration of water quality during monsoon period; higher fluctuations in supply due to change in seasonal rainfall patterns; diminishing supply and increasing water demand due to increase in temperature
- **Human-induced causes:** poor water governance; lacking infrastructure; increase in water demand due to progressively higher living standards and augmented agricultural production

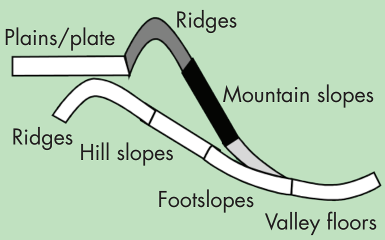
Main technical functions	Secondary technical functions	Legend
• improve access to irrigation water	• increase local soil moisture level	high moderate low insignificant

Environment

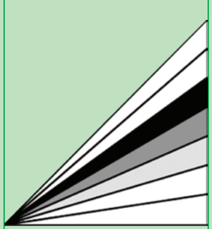
Natural environment

Average annual rainfall (mm)	Altitude (masl)
>4000	>4000
3000-4000	3000-4000
2000-3000	2500-3000
1500-2000	2000-2500
1000-1500	1500-2000
750-1000	1000-1500
500-750	500-1000
250-500	100-500
<250	<100

Landform

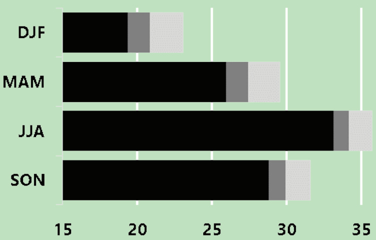


Slope (%)

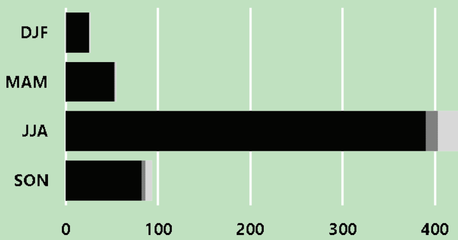


Climate change[1]

Temperature (T) in °C



Precipitation (P) in mm



– Future **T** increase projected to be most pronounced in dry season

– **P** projections still with large uncertainty; **P** predicted to stay constant or slightly decrease in winter (DJF) and increase during the monsoon period (JJA)

→ Possibility of more frequent winter droughts and summer floods

Historical climate: 2001 - 2010
Future climate: 2020 - 2039
Future climate: 2040 - 2059

Tolerant of climatic extremes: wind storms/dust storms; decreasing length of growing period; temperature increase; seasonal rainfall increase/decrease; heavy rainfall events; moderate dry spells

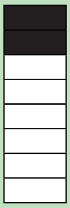
Sensitive to climatic extremes: extreme droughts and floods

If sensitive, what modifications were made/are possible:

[1] Historical climate is drawn from local observational records. Future **T** and **P** anomalies are based on the ensemble median of 15 climate models employed in IPCC AR4 representing the SRES B1 emission scenario. Source: World Bank Climate Change Knowledge Portal

Human environment

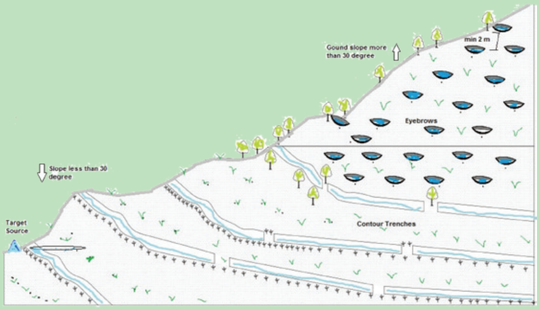
Cropland per household (ha)



<0.5
0.5-1
1-2
2-5
5-15
15-50
50-100
100-500

Land user: individual/household, small-scale land users, disadvantaged land users, men and women
Population density: 120 persons/km^2
Annual population growth: 1-2%
Land ownership: individually owned/titled
Land use rights: individual
Water use rights: communal (organised)

Relative level of wealth: very poor and poor, which represent 39% and 27% of population in the area, respectively.
Importance of off-farm income: less than 10% of all income
Access to service and infrastructure: low: health, technical assistance, employment, market, energy, financial services; moderate: education; roads and transport; drinking water supply and sanitation
Market orientation: mainly subsistence (self-supply)



Technical drawing

Schematic overview of application of eyebrow (slope > 30%) and contour trenches for a sample water source.

Implementation Activities, Inputs, and Costs

Establishment activities
Trenches are preferably dug in the dry season to give the vegetation time to stabilize the downslope bunds before heavy rainfall can wash them away.

1. Mark the position of the trench along the contours. Dig trenches in a staggered sequence; i.e., downhill trenches catch the surface runoff, which flows between trenches in the adjacent line above (see above figure). For eyebrow trenches: mark an arc on the ground with the convex part facing downhill.
2. Clear the trench surroundings of all undesired vegetation.
3. Excavate the trench to about 50-75 cm depth and 50–100 cm width.
4. Deposit the excavated soil on the downslope-edge of the trench.
5. Compact the excavated soil and form a small bund.
6. Plant native grasses or shrubs on the bund.
7. Optionally, plant tree seedlings in the space between trenches.

Establishment costs and inputs for 1,600 eyebrow trenches and associated plantation in the catchment area of one spring source. Total treated area amounts to 50 ha (i.e. ~30 trenches per ha).

Inputs	Costs (US$)[1]	% met by users
Unskilled Labour (950 person days)	3,325	60
Local seedlings for trees, shrubs, and grass		
1,200 Bakaino (persian lilac)	45	50
900 Timur (*zanthoxylum armatum*)	30	50
1,400 Lapsi	50	50
1,500 Napier (*pennisetum purpureum*)	55	50
Construction Materials		
Tools (Shovels)	60	100
Total	**3,565**	**60**

[1] Exchange rate as per June 2015 USD 1 = NRs 100

Maintenance/recurrent activities

1. Periodically remove sediment from trenches and re-apply either to uphill fields or on downslope bunds. Preferably, dig out trenches before cropping season, to re-apply sediments before tilling of the fields.
2. Vegetation on the bunds may need special care and protection (e.g., from cattle), particularly in the early stages.

Maintenance/recurrent inputs and costs per year for the above case of a 50 ha field

Inputs	Costs (US$)	% met by users
Labour (50 person day)	175	100%
Total	**175**	**100%**

Remarks: The above cost breakdown is based on the analysis of one extensive plantation project implemented in 2015. Costs for portering and road transportation of non-local materials –subject to the remoteness of the project site – were omitted.

Assessment

Impacts of the technology			
Production and socioeconomic benefits		**Production and socioeconomic disadvantages**	
+ + +	Improved drinking/household water availability; mitigates risk of supply shortages	– –	Potential loss of land for crop cultivation
+ +	(Potentially) enhanced crop, fodder, and tree growth		Loss of grazing area when the trenches are filled with water
+ +	Reduced time for queueing up at the water source, resulting in decreased workload for women		
Sociocultural benefits		**Sociocultural disadvantages**	
+	Reduced incidents of water-borne diseases due to more reliable water access		
Ecological benefits		**Ecological disadvantages**	
+ + +	Increased water infiltration and source recharge rates		
+ + +	Reduced soil erosion and landslides		
Off-site benefits		**Off-site disadvantages**	
+	Reduced risk of downstream flooding		
Contribution to human well-being/livelihoods			
+	Decreased workload due to reduced time for water fetching/queueing at source. The saved time is reported to be spent on livestock raising, vegetable cultivation, and household chores.		
+++: high / ++: medium / +: low			

Analysis of benefits and costs	Benefits compared with costs	short-term	long-term
Contour trenches were first applied two to three years ago. As such, the cost benefit analysis does not cover a long-term timeframe yet. Over the first few years, the labor-intensive establishment activities usually still outweigh the benefits of surplus discharge.	Establishment	negative	as yet unknown
	Maintenance/recurrent	neutral	as yet unknown

Acceptance/adoption
Contour and eyebrow trenches were only recently introduced. Hence, there is still little experience regarding acceptance and adoption. So far, high acceptance rates are observed. This was expected, as the trenches are identified and prioritized based on inclusively planned WUMPs (QA NEP 36). Furthermore, representatives of the community take a lead role in the detailed planning and implementation process. Due to the considerable labour input. adoption and replication rates are expected to be significantly lower.

Concluding Statements

Strengths and ➔ how to sustain/improve	Weaknesses and ➔ how to overcome
The trenches are easy to design and straightforward to implement, requiring little material input and only basic construction tools. Hence, they are – in theory – easily replicable ➔ to increase replication likelihood, scrutinize boundary conditions (tenure security; labour availability; market access) in a prior feasibility assessment to identify favorable environments.	Users are often unwilling to implement source conservation and recharge measures on their own land, as the catchment area occupies potentially arable land. Similarly, if land tenure is not secured, users are hesitant to put effort into rehabilitating the area ➔ select implementation areas with due diligence regarding land ownership and land rights. If possible, favor communal land areas.
Besides spring water recharge, the trenches also markedly improve conditions for crop cultivation. Surplus cash crops and vegetables may offer additional incentives for implementation ➔ coordinate with other programs to help establish market access in remote regions	Contour trenches have a high manual labour requirement for construction and maintenance and are thus dependent on labour availability. (Seasonal) migration of the youth in rural areas may diminish the likelihood of adoption and proper maintenance ➔ confirm availability and motivation of labor force in a prior feasibility assessment
The trenches double as soil stabilization and erosion control measures ➔ inform users of importance of proper and regular maintenance to avoid premature failure of the schemes	In dense soils with poor drainage properties, the increased infiltration rates may create temporary waterlogging issues ➔ analyze soil properties and subsurface flow conditions ahead of time
Increased infiltration rates and a higher moisture-holding capacity of the soil reduce the risk of downstream flooding ➔ analyze surface runoff flow patterns before implementation and place trenches accordingly	

Key references: SWISS Water & Sanitation NGO Consortium (2013) Beneficiary Assessment of WARM-P, Nepal. Lalitpur, Nepal: WARM-P/HELVETAS;
HELVETAS (2013) The Effectiveness and Outcomes of Approaches to Functionality of Drinking Water and Sanitation Schemes. Lalitpur, Nepal: WARM-P/HELVETAS

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