Water Source Conservation and Protection

Nepal – खानेपानीका श्रोतहरूको सुरक्षा तथा संरक्षण

Drinking water source conservation and protection in the rural mid-hills of Nepal.

To conserve the yield of spring water sources over the long-term and safeguard them from contamination, vegetative and structural measures are applied at the source location, its immediate vicinity, and in the wider catchment area. The primary targeted group of the technology described here is financially and socially deprived communities, living mostly from subsistence farming in water-scarce areas of the Nepal mid-hills. In these regions, source yield is often not adequate, i.e., sources are often remote or intermittent and households spend on average two hours per day on fetching water, with a significant portion spent on queuing up at the water source. Likewise, spring water quality can be compromised during flood or landslide events or due to the deposition of human or animal waste in the catchment area.

Depending on local circumstances, a suite of interrelated measures is deployed to protect drinking water sources. We distinguish between two types of safeguards: Strict protection measures shield the source from potential contamination and protect the intake structure. Conservation measures are implemented in the wider catchment with the aim of sustainably preserving source water quantity and quality in the mid- to long-term.

Source protection measures include:

- **Source protection chamber:** includes a masonry and concrete chamber to protect the source from contamination from its immediate surroundings and a concrete tap platform to provide clean and convenient water access.
- **Barbed wire fencing around intake:** to prevent humans and livestock from accessing and potentially damaging the intake structure.

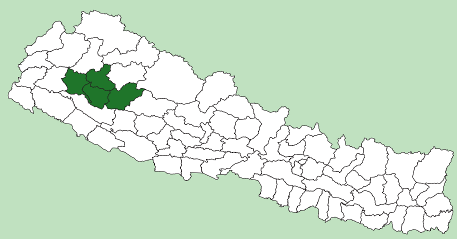
  Note that the above two protection measures in the vicinity of the source are also an integral part of every intake design of gravity flow systems (QT NEP 40).
- **Live fencing:** plantation of shrubs, bushes, and trees (preferably thorny plants) with spacings of about 30 cm to demarcate boundaries of protected spring catchment areas and to prevent access of free-grazing animals. At the same time, the vegetative barrier reduces surface runoff velocity and favours sedimentation of eroded soil. Size of protected areas is subject to local conditions; however, it should encompass at least 0.25 ha.
- **Dead fencing:** needed to prevent intrusion of animals and – to a lesser extent – humans into the source protection area while the life fence is still too small. Depending upon the availability of local materials, the dead fencing can consist of barbed wire fencing, wooden or bamboo fencing, or a masonry wall. Dead fencing may encircle the whole area, but is often limited to animal entry-prone sections.

Source conservation and catchment area treatment measures may include:

- **Plantation:** plantation of shrubs and trees in the catchment area increases soil stability and infiltration and soil-moisture retaining capabilities of the soil, thereby leading to reduced surface runoff, erosion, and landslide potential and higher water source recharge rates. Shrub species, plantation technique, and blending with other measures are the subject of due consideration of local conditions.
- **Contour and eyebrow trenches:** to reduce surface flow velocity, promote infiltration, and increase local soil moisture levels (QT NEP 43)
- **Gully plugging and check dams:** to prevent channels from deepening further by reducing flow velocity, thus minimizing erosion and promoting deposition
- **Drainage ditches:** to divert storm surface water runoff
- **Recharge ponds:** to increase infiltration and water source recharge rates (QT NEP 45)

Left: Masonry wall around the source area keeps cattle from entering (WARM-P)

Right: This masonry and concrete source protection chamber, with attached tap platform, shields the spring from contamination (WARM-P)



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

Technology area: per source 1–10 km^2

Conservation measure(s): Structural, Vegetative

Land use type: Extensive grazing land

Climate: Humid subtropical

WOCAT database reference: QT NEP 48

Related approach: QA NEP 36

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Comments: The water source conservation and protection technology described here complements gravity flow water supply schemes and is part of the water supply measures 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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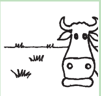
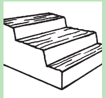
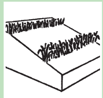
Classification

Water use problems

- Growing water demand for both domestic and agricultural use and diminishing or fluctuating water supply due to climate change
- Water sources can be compromised by floods and landslides, spring water quality can deteriorate as a result of animal or human waste in the catchment area or due to increased turbidity during floods
- Loss of vegetative cover due to open grazing and human interventions

Land use		Climate		Degradation				Conservation measure(s)			
											
Extensive grazing land		Humid subtropics		Physical degradation: Decline of water quality and quantity		Water erosion: loss of topsoil by water; gully erosion		Structural: masonry box. walls, check dams, dead fencing		Vegetative: plantation of tree and shrub species	

Stage of intervention		Origin		Level of technical knowledge	
high	Prevention	insignificant	Land users' initiative:	high	Field staff
high	Mitigation/reduction	insignificant	Experiments/research	low	User
insignificant	Rehabilitation	high	Externally introduced: 10-50 yrs ago	insignificant	

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; lack of infrastructure; increase in water demand due to progressively higher living standards and augmented agricultural production

Main technical functions

- improve infiltration/spring recharge rates
- reduce surface runoff and its erosive power

Secondary technical functions

- increase local soil moisture level

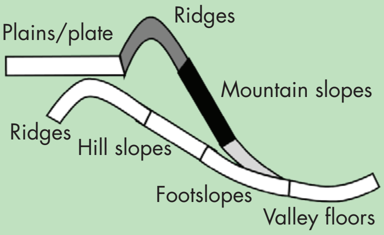
Legend	
black	high
dark grey	moderate
light grey	low
white	insignificant

Environment

Natural environment

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

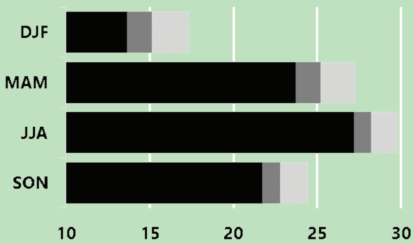
Landform



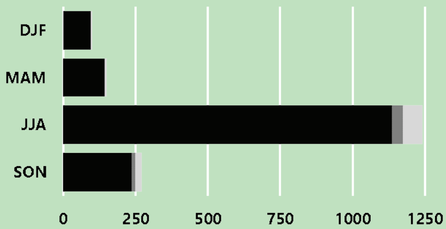
Slope (%)

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:	1976 - 2005
Future climate:	2020 - 2039
Future climate:	2040 - 2059

Tolerant of climatic extremes: wind storms/dust storms; decreasing length of growing period

Sensitive to climatic extremes: temperature increase; seasonal rainfall increase/decrease; heavy rainfall events; droughts/dry spells; floods

If sensitive, what modifications were made/are possible: consider deployment of more extensive vegetative and agronomic measures to further promote water recharge and soil conservation (e.g., plantation, contour trenches)

[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

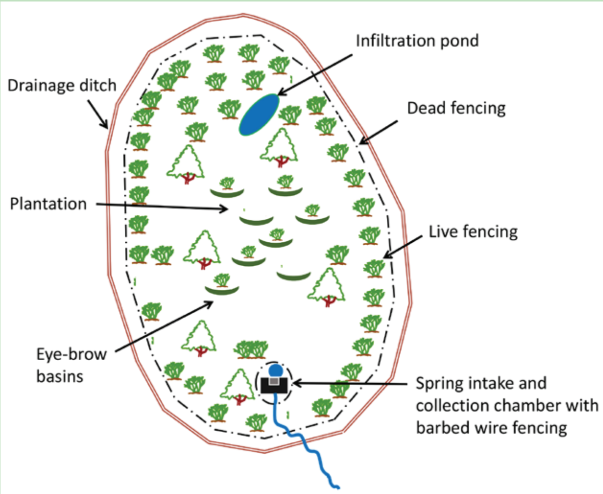
Human environment

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

Structural and vegetative measures applied to sustain or improve water quality of springs

Implementation Activities, Inputs, and Costs

Establishment activities

Establishment is carried out under the supervision of field staff using construction tools, which include shovel, stone cutting hammer, stone chisel, measuring tape, knife, tape, pipe wrench, crowbar, and a hack saw. Establishment steps of recharge ponds, as well as contour and eyebrow trenches, are described in QT NEP 45 and QT NEP 43. The following are general implementation procedures for source protection and conservation schemes:

1. Delineate the spring catchment area. Make note of any land use and erosion problems in the catchment area.
2. Measure the source discharge during the dry season. Design storage tank and outlet capacity accordingly.
3. Identify possible contamination sources. Assess geological conditions and infer likely subsurface flow patterns – using thumb rules or – if possible – more thorough methods.
4. Identify source protection and conservation measurements to be employed, as well as their respective locations.
5. Develop the plantation zones in the catchment area. Plant tree, shrub, and grass seedlings on the open and degraded land areas with intermitting conservation trenches.
6. Implement source protection measures with collection chamber, live fencing and – in critical sections – dead fencing. Dig drainage ditches to divert surface runoff.

Total establishment costs and inputs for an extensive source conservation and protection system for an area of 3.5 ha, which includes a source protection chamber (3 m^3), two recharge ponds, 25 contour trenches, 50 eyebrow basins, gully plugging with five masonry walls, as well as live fencing for 1,250 m and dead fencing of about 40 m for critical parts. The improved water source caters to 60 households.

Inputs	Costs (US$)[1]	% met by users
Skilled Labour, mainly for source protection chamber (13 person days)	70	0
Unskilled Labour (485 person days)	1,700	70
Construction Materials		
• HDPE and GI pipes, fittings and valves	60	0
• Cement (5,600 kg)	210	0
• Barbed wire (50 kg)	45	0
• Other construction materials	130	0
• Tools	40	0
Local Materials (costs reflect unskilled labour effort for collection and portering)		
• Stone (18 m^3)	90	100
• Sand (3.5 m^3)	255	20
• Aggregate 5-40 mm (0.85 m^3)	55	50
• Wood (0.6 m^3)	30	100
• Bamboo for live fencing (500 pieces)	15	100
• Local seedlings for trees and shrubs (1,000 seedlings, mainly Uttish and Dudhilo)	35	100
Total	**2,735**	**53**

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

Maintenance/recurrent activities

1. Fostering of seedlings and young plants, especially in the first few years.
2. Repair and maintenance works for dead fencing and source protection chamber (once a year)
3. Periodically remove sediment from drainage ditches and trenches.

Maintenance/recurrent inputs and costs per pond per year

Inputs	Costs (US$)	% met by users
Labour (30-40 person days)	120	100%
Total	**7**	**100%**

Remarks: The above cost breakdown is based on the analysis of one extensive source conservation and protection system implemented in 2015. Costs for portering and road transportation of non-local materials, which depend on the remoteness of the project site, were omitted. Community contribution to source conservation schemes usually ranges between 30% and 55%.

Costs for source protection chambers depend on their storage capacity (1 to 3 m^3) and range from USD 400 to 900. Community contribution to the protection chamber costs typically amount to about 20%.

Assessment

Impacts of the technology			
Production and socioeconomic benefits		**Production and socioeconomic disadvantages**	
+ + +	Improved drinking/household water availability and quality	–	Loss of land for livestock grazing
+ +	Reduced time for queueing up at the water source, resulting in decreased workload for women		
Sociocultural benefits		**Sociocultural disadvantages**	
+	Reduced incidence of water-borne diseases due to more reliable water access		None
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
Source conservation schemes were first introduced two to three years ago. As such, the cost benefit analysis is not covering a long-term timeframe yet. Over the first few years, the labor-intensive establishment activities usually still outweigh the benefits of surplus discharge. Clearly, source conservation measures are implemented with a mid- to long-term perspective in mind.	Establishment	negative	as yet unknown
	Maintenance/recurrent	neutral	as yet unknown

Acceptance/adoption

The implemented water schemes are identified and prioritized based on inclusively planned WUMPs (QA NEP 36). Moreover, representatives of the community take a lead role in the detailed planning and implementation process, resulting in a high acceptance rate of the technology; virtually all households are making use of the protected source. On the other hand, water conservation systems and even source protection chambers are often too costly for communities to adopt without substantial external material support, either by the government (VDC/DDC) or other donors.

Concluding Statements

Strengths and ➔ how to sustain/improve	Weaknesses and ➔ how to overcome
Source conservation and protection measures secure a more reliable domestic water supply with improvements in both water quantity and quality ➔ ensure that improved household water supply leads to improved health outcomes by raising HWTS and hygiene awareness and conducting behavior change campaigns	Source protection chambers offer a low-cost alternative to a full-fledged gravity flow distribution system with substantial reductions in material and labour input (less than USD 30 per household for protection chambers compared to USD ~250 per household for the piped water systems). However, in general, costs are still too high for independent adoption ➔ (i) consider how to further reduce costs and simplify construction for source protection chambers to increase adoption rate, (ii) WUMP serves as an instrument for dissemination and marketing with potential resource organizations to secure additional funding; (iii) look into microfinance schemes/governmental subsidies as additional funding sources
The resilient physical structure of the source protection chamber makes it quite interference-free with a long potential lifespan ➔ strengthen institutional mechanisms to also maintain vegetative components (live fencing, plantation) in the mid- and long-term. Consider combining source conservation with Multiple Use Schemes to raise household incomes and incentivize the community to guard their natural sources and maintain the conservation measures.	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.
As women are predominantly responsible for water fetching, a higher spring source yield reduces the need for queueing and/or accessing more remote water sources and thus frees up time for other activities ➔ consider how additional (income) opportunities could be seized (e.g., cultivation of vegetables in kitchen garden).	Spring water quality may not meet drinking water standards at all times and can be particularly impaired after heavy rainfall events; water quality may further deteriorate during transportation and storage ➔ raise HWTS awareness and promote treatment methods such as SODIS, filtering, or boiling of water.
The source conservation measures double as soil stabilization and erosion control ➔ inform users of importance of proper and regular maintenance to avoid premature failure of the schemes	Spring source yield may not be adequate to fulfill the needs of all catered households, in particular during the dry season. Some households may still need to spend a lot of time on water fetching if the protected source is located far off ➔ complement spring source with roof rainwater harvesting technologies to bridge the dry season, meet irrigational water demands, and/or shorten the time spent on water fetching

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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