Left: Public water tap stand with soil cement pond to store overflow and excess water for irrigation purposes. (WARM-P))

Right: Construction works of a reservoir tank which is combined with technical training activities. (WARM-P)

Multiple-use Water Systems

Nepal – बहु उपयोग पानी प्रणाली

Multiple-use water systems catering to domestic and agricultural demands of smallholder farmers in the rural mid-hills of Nepal.

Multiple Use Systems – often referred to as MUS – are usually developed in gravity flow water supply and rainwater harvesting schemes (QT NEP 40 and QT NEP 46) that have abundant water sources. They provide water for domestic and agricultural use for smallholder farmers in the mid-hills of Nepal. Conventional gravity flow systems may also cater to multiple purposes and do not have to be limited to domestic use. However, such a de-facto MUS can often only partly accommodate the different demands, which commonly exceed the design capacity of the system. On the contrary, systems that are planned with a multi-purpose use of water in mind offer more holistic solutions by balancing the different needs and optimizing the use of available resources.

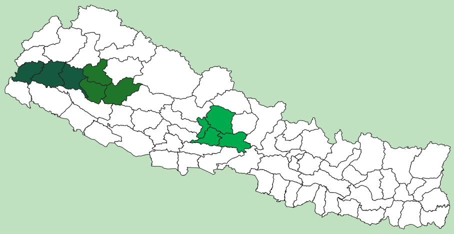
In addition to delivering better access to drinking water, MUS promote the productive use of water (i.e., small-scale irrigation and cattle rearing) so that users may attain economic benefits. The designs of the physical structures of the system (pipelines, storage tanks, soil cement and plastic-lined ponds, irrigation canals, rainwater harvesting jars) are aligned with regard to these productive uses. The following general principles guide the MUS design:

- In first priority, the system ensures adequate domestic water supply. Systems, which are limited to drinking water supply, are designed to provide at least 45 litres (l) per capita (cap) and day (d) for domestic uses at community taps. MUS are developed in schemes where a minimum supply of at least 70 l/cap/day is guaranteed.
- With the program's standardized MUS design, the minimum water supply should allow a household of five to cultivate an area of ¼ Ropani or 125 m^2 (a Ropani is a Nepalese customary unit of area measurement and is equivalent to 509 m^2). Hence, the average water demand for irrigation is presumed to be 500 litres per Ropani per day, equivalent to ~1 $l/m^2/d$. Actual irrigation water demand is subject to cropping patterns and employed irrigation methods.

According to circumstances and the community's needs, MUS designs may assume the following elements:

- **"Oversized" gravity flow systems:** The capacity of (parts of) the pipeline network are increased to accommodate for the additional agricultural water demand.
- **Additional storage facilities, pipelines, and outlets:** Surplus water from storage tanks and tapstands, catering to domestic demands, is directed to overflow collection chambers as well as to soil-cement and plastic-lined ponds. The surplus domestic water is then channelled through a separate distribution line network to irrigation outlets.
- **Rainwater harvesting package:** Rainwater harvesting jars (QT NEP 46) are complemented with downstream soil-cement ponds (QT NEP 47 to capture surplus water for agricultural use.

The benefits of productive water use are manifold. Augmented agricultural production increases food security, creates new local employment opportunities, and raises household incomes of smallholders. This helps to alleviate the pressure of (seasonal) labour migration. Productive usage more clearly realises the economic value of water and endows users with the financial means and additional motivation to look after their water supply schemes. Measures, which create monetary benefits that go beyond the health and hygiene outcomes of the domestic realm, may thus enhance the sustainability of the whole water supply system.



Location: 10 districts in the Western, Mid-Western, and Far-Western Development Regions of Nepal

Technology area: per scheme: 1–10 km^2

Conservation measure(s): Structural

Land use type: Settlements

Climate: Humid subtropical

WOCAT database reference: QT NEP 44

Related approach: QA NEP 36

Related technologies:

Compiled by: Lukas Egloff, Madan Bhatta, Mohan Bhatta, Rubika Shrestha, HELVETAS Swiss Intercooperation

Date: July 2015

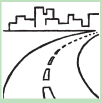
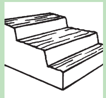
Comments: Multiple use water systems are a variation of gravity flow water supply and rainwater harvesting schemes which are planned and implemented within the Water Use Master Plan (WUMP) framework for poor communities in the rural mid-hills of Nepal.

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

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 are intermittent and/or far away; households spend upwards of two hours per day on water fetching
- Lack of irrigation water and agricultural inputs result in poor agricultural productivity and food insecurity

Land use	Climate	Degradation	Conservation measure(s)
			
Settlements, infrastructure networks	Humid subtropics	Physical degradation: Local water scarcity; Water erosion: loss of topsoil by water; gully erosion	Structural: pipeline network with intake, storage tanks, tap stands, and ponds

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

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 temperature increase
- **Human-induced causes:** poor water governance; lack of adequate infrastructure; increasing water demand due to progressively higher living standards and augmented agricultural production

Main technical functions

- improve water service level (accessibility, quantity, quality, reliability, continuity)

Secondary technical functions

- improve household income and food security

Legend

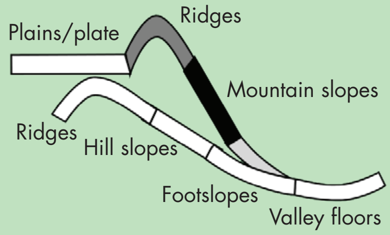
black	high
dark grey	moderate
light grey	low
white	insignificant

Environment

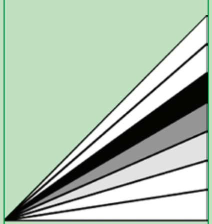
Natural environment

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

Landform

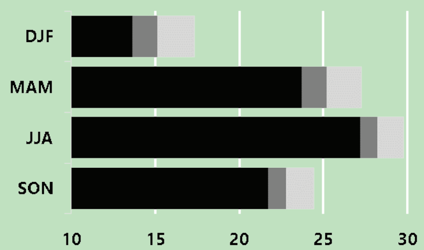


Slope (%)

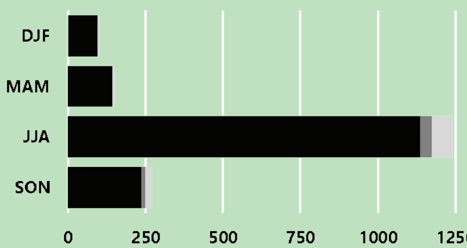


Climate change[1]

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

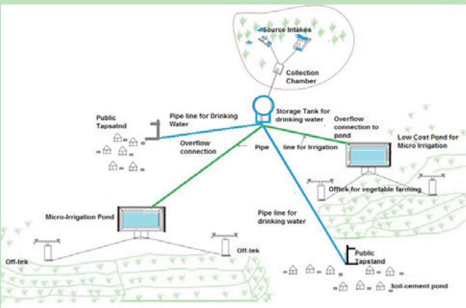
black	Historical climate: 1976 - 2005
dark grey	Future climate: 2020 - 2039
light grey	Future climate: 2040 - 2059

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

Sensitive to climatic extremes: seasonal rainfall increase/decrease; heavy rainfall events (intensities and amount); droughts/dry spells

If sensitive, what modifications were made/are possible: consider water source recharge and conservation measures

[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)	**Land user:** individual/household, small-scale land users, disadvantaged land users, men and women **Population density:** 120 persons/km² **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)
<0.5 0.5-1 1-2 2-5 5-15 15-50 50-100		**Technical drawing** Components of a typical multiple-flow water supply system with public tap stands.

Implementation Activities, Inputs, and Costs

Establishment activities

Establishment of the whole system is generally spread out over about six to eight months (this excludes the planning and preparation phase). Main establishment activities include:

1. Detailed survey and feasibility check of MUS with discharge and demand supply assessment (Preparation phase)
2. Identify potential irrigable land in the vicinity of the settlement
3. Prepare detailed design cost estimate based on survey report
4. Collection and transportation of local and external materials
5. Lay transmission pipelines, followed by the distribution pipelines. Pipelines are buried at least 90 cm below the ground, except in rock sections. Pipe width varies between 40–60 cm. Develop structures on main lines.
6. Construction of drinking water storage tanks followed by ponds and regulating overflow chambers.
7. Construction of distribution system with outlet structures in settlements and irrigated fields.

Establishment costs and inputs for a typical MUS system catering to a community of 50 households.

The system allows irrigating an area of 0.5 Ropani or 250 m² per household. It consists of a conventional gravity supply system (10 public tap stands), which is complemented by: additional distribution pipelines of ~1,000 m length; two overflow chambers; three 3 m³ community ponds; one 10 m³ pond; five additional outlets for irrigation. The below breakdown only accounts for components which are additional to the domestic water supply system.

Inputs	Costs (US$)[1]	% met by users
Skilled labour (40 person days)	220	0
Unskilled Labour (550 person days)	1,925	72
Construction Materials		
HDPE, PVC, and GI pipes	280	0
Fittings and valves	65	0
Cement (1,900 kg)	320	0
Other construction materials	55	0
Local Materials (costs reflect unskilled labour effort for collection and portering)		
Stone (53 m³)	330	100
Stand (3 m³)	25	100
Aggregate 5-40 mm (2.7 m³)	250	100
Wood (2.4 m³)	40	100
Total	**3,510**	**58**

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

Maintenance/recurrent activities

1. Monitoring of structures by walking along the pipeline network
2. Minor repair and maintenance works

Maintenance/recurrent inputs and costs for the above-mentioned typical GWS system per household and year

Inputs	Costs (US$)	% met by users
Labour and equipment	240	100%
Total	**240**	**100%**

Remarks: The above cost breakdown is based on the analysis of 15 schemes implemented in the period from 2010 to 2014. Costs for portering and road transportation of non-local materials – very much subject to the remoteness of the project site – were omitted. In the mid-hills of Nepal, the average transportation costs amount to about 5-10% of the total construction cost. Village Development Committees (VDC) contribute on average about 5% to the overall costs (2.5% is the minimum contribution). Community contribution to the overall costs (including all transportation costs for non-local materials) ranges between 40% and 60% and is thus substantially higher than for domestic water supply systems. Community contribution includes collection and portering of local materials, half of the unskilled labour works for the irrigation ponds, and all unskilled labour required for the distribution line network and the outlets. The programme reimburses the unskilled labour required for the construction of the intake structures and half of the unskilled labour works for the ponds.

Average costs for non-MUS schemes (i.e., meeting only domestic water supply) with public taps amount to USD 40–45 per capita. The additional MUS-related costs vary according to the implemented structures. In general, construction costs for MUS schemes are 10-30% higher than for comparable gravity supply systems without MUS components.

Operation and maintenance activities are carried out by Village Maintenance Workers and are financed out of the scheme's O&M fund. The latter is managed by the scheme's User Committee. Connection charges and user fees are similar to domestic gravity supply systems). Note that, while the collected user fees suffice to pay the wage of the local maintenance worker and finance minor repair works (replacement of small fittings and parts (i.e., taps, valves, washers, etc.), they are not adequate to deal with major system failures, such as the reconstruction or replacement of larger structures (i.e., the reservoir tank, intake, or the main pipeline).

Assessment

Impacts of the technology			
Production and socioeconomic benefits		**Production and socioeconomic disadvantages**	
+ + +	Improved drinking/household water availability and quality	–	Regular payments to O&M fund
+ +	Increased irrigation water availability. Given established market access, irrigation of vegetables and cash crops can raise household income	–	Loss of land (to accommodate ponds)
Sociocultural benefits		**Sociocultural disadvantages**	
+ +	Improved food security, more nutritious diet.		None
+ +	Significant reduction of reported incidents of water-borne diseases due to improved water access		
Off-site benefits		**Off-site disadvantages**	
+	Reduced risk of downstream flooding	–	Reduced water availability further downstream
Contribution to human well-being/livelihoods			
+ + +	Increased production and greater variety of crops help people to increase food sufficiency. Vegetables contribute to a healthier diet and may be sold to increase household incomes		

+++: high / ++: medium / +: low

Benefits and costs	Benefits compared with costs	short-term	long-term
Most of the users utilize the stored water in the MUS facilities for kitchen gardening. The additional vegetable production is valued highly and can add substantially to the household income. In most cases, the establishment of soil-cement structures is too costly for most communities without any outside assistance.	Establishment	negative	positive
	Maintenance/recurrent	neutral	positive

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 multiple use scheme. There is a high motivation in communities to get access to additional irrigation water and thus the ability to improve their livelihoods. On the other hand, MUS are often too costly for communities to adopt without substantial external material support, provided by either the government (VDC/DDC) or other donors.

Concluding Statements

Strengths and ➔ how to sustain/improve	Weaknesses and ➔ how to overcome
The excess water can be used to raise cash crops and vegetables, thereby increasing food security, creating new local employment opportunities, and raising household incomes of smallholders ➔ support partial shift from cereals to high-value but low water-demanding crops by linking farmers to agricultural service providers and developing their capacity to devise suitable post-construction cropping patterns and irrigation schedules	Management, operation, and maintenance of multiple use schemes is challenging and requires appropriate knowledge and skills of the managing user community and the responsible maintenance workers ➔ include capacity-building activitiesas an integral part of the technology implementation process
Given established market access, the agricultural usage realises the economic value of water and endows users with the financial means and additional motivation to look after their water supply schemes ➔ coordinate with other programs to help establish market access in remote regions; support collection and storing centers or processing facilities for vegetables	MUS, which are add-ons to gravity systems or rainwater harvesting jars, are costly. Poor communities have difficulty adopting them or financing major repairs without substantial external material support ➔ (i) WUMP serve as an instrument for dissemination and marketing with potential resource organizations to secure additional funding; (ii) promote the cultivation of high-value crops to increase household incomes; (iii) microfinance or governmental subsidy schemes may represent an additional funding source
Strong physical foundation of schemes: 98% of the schemes are functional five to ten years after construction, with the potential to function up to a designated lifespan of 20 years ➔ strengthen institutional mechanisms related to O&M and ensure that they remain active throughout the projected lifetime of each scheme.	Follow-up visits in some schemes showed that after some time, the community made little to no use of the irrigation facilities ➔ reaffirm the community's willingness to expand agricultural production before implementation; a high community contribution to the construction process can strengthen its commitment

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

Contact person: Country Office, HELVETAS Swiss Intercooperation Nepal, GPO Box 688, Kathmandu/Nepal, co.np@helvetas.org, +977 1 5524925;
Madan R. Bhatta, Programme Manager, Tel: +977 1 5524926; 9858051902 (M), HELVETAS Swiss Intercooperation Nepal, madan.bhatta@helvetas.org