Implementation of Water Supply and Sanitation Systems

Nepal – खानेपानी र सरसफाई आयोजनाहरुको कार्यान्वयन

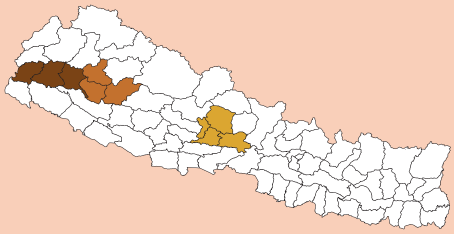
Implementation of water supply and sanitation systems in the rural mid-hills of Nepal.

The approach documented here for implementing water supply and sanitation systems in the rural mid-hills of Nepal balances a blend of hardware and software support. Hardware support comes in the form of standard construction materials and technology, whereas software support focuses mainly on enhancing the capacity of User Committees (UCs) and local service providers to better plan, implement, and take proper care of their schemes. The 20 steps of the implementation process with clearly defined activities synergize hardware and software support with long-term impacts on the functionality of the water and sanitation schemes. The approach enhances feelings of ownership, ensures a sense of entitlement to use the scheme equitably, and instils a feeling of responsibility to effectively operate and maintain it. The following key elements are central to the implementation approach:

- Participatory Planning and Implementation: Through a participatory approach, gender and ethnically balanced UCs are formed, which are responsible for leading the scheme's implementation process. The community contributes time, labour, and local construction materials. Public hearings/audits before, during, and after implementation are mandatory.
- Capacitated Local Service Providers: Appropriate local people are provided with social and technical training to become skilled service providers (village maintenance workers, tap-stand caretakers, latrine builders, and rainwater harvesting maintenance workers).
- Capacitated User Committees: All members of the UCs are provided with two trainings on management issues during pre-construction, construction, and post-construction phases, enabling them to effectively manage implementation, operation, and maintenance of water and sanitation schemes on their own.
- Operation and Maintenance Funds: For every scheme, an O&M fund is established and managed by the respective UC. The UC prepares collection and spending regulations in consultation with the community.
- One Scheme, One Tool Box: Tools and spare parts are not easily available in remote areas and hardly affordable by economically poor users. The project provides one trunk with tools for minor repair and maintenance works to each supported scheme.
- Standardized Procurement, Norms, and Practices: Procurement and construction follow standardized norms and practices. High quality design of schemes is ensured by the application of a standardized design package.
- Proficient Workmanship: For each scheme, a social and a technical expert ensure a high level of workmanship by supervising the implementation process and backstopping the UC.
- Use of Perennial Source, Protection, and Conservation: Reliability, continuity, and safety of water sources is ensured by chiefly focusing on perennial sources, protecting them from contamination, and supporting their conservation (see QT48).
- Multiple Use System (MUS) and Waste Water Use: Productive use of water (e.g., irrigation) may provide economic benefits to the community. MUS are usually developed in schemes with abundant sources and include promotion of measures to reuse waste water.
- Follow-up Monitoring and Post-Construction Support: Two follow-up surveys occur within two years after construction to monitor the status of physical structures and institutional mechanisms. Social and technical field staff provide post-construction support and mentoring to UC.

Left: Public hearing for a water supply system in Dailekh (WARM-P)

Right: Community members laying pipelines for a water supply system (WARM-P)



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

Approach area: >3,000 km^2

Type of Approach: Project/programme-based

Focus: Usage, conservation, and protection of water sources

WOCAT database reference: QA NEP 40

Related technologies: QT NEP 40

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

Date: June 2015

Comments: The documented implementation approach is part of the Water Use Master Plan (WUMP) approach (QA NEP 36). Key features of the WUMP are its particular focus on "planned and agreed use" of water resources and its holistic approach to managing drinking water schemes. The preparation of a WUMP serves as an entry point for interventions in the water sector and sets priorities in terms of using available water sources and the implementation of related water supply schemes in Village Development Committee areas (VDC), the lowest administrative units in the country. The approach documented here describes the implementation of water projects identified during the WUMP preparation.

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

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Problem, Objectives, and Constraints

Problems

- Issues of access to water are often contentious; communities often quarrel over water rights.
- A growing water demand for both domestic and agricultural use and diminishing water sources due to climate change may aggravate water conflicts.
- Dubious sustainability of water supply systems: a significant portion of existing schemes in Nepal are not fully functional, indicating a lack of ownership, proper management, and maintenance

Aims/objectives

- Establish inclusive implementation of water and sanitation schemes to increase sustainable access to water and sanitation
- Ensure an equitable and efficient use of water resources
- Improve functionality and operational life span of implemented water supply schemes by enhancing local ownership and capacitating local service providers and User Committees to operate, repair, and maintain the schemes

Constraints Addressed

Major	**Constraint**	**Treatment**
Institutional/Social	Lacking sense of ownership and entitlement by communities to equitably use drinking water facilities and to share the responsibility for effective operation and maintenance	Apply a participatory planning and implementation approach; gender and ethnically balanced UCs are responsible for implementation process as well as operation and maintenance; regular public audits; in-kind contribution by community
Technical	Lack of skills to manage and maintain water supply schemes	Capacity development of UC and local service providers
Financial	Challenge to secure long-term funding for sustainable O&M	Introduce community O&M fund managed by the UC
Minor	Constraint	Treatment
Environmental	Depletion of water sources may aggravate water scarcity	Apply a holistic planning and implementation approach by considering several technologies (e.g., rainwater harvesting or source conservation)

Participation and Decision Making

Stakeholders/target groups				
				
Users, individual/ group	Local service providers, NGOs, consultants	Village development committees (VDCs)		

Contribution to costs:	**Construction**	**Approach**
Local Government (Village Development Committee)	5 - 15%	0%
Local Community	15 - 25%	0%
International non-governmental organisation (HELVETAS)	65 - 75%	100%
Total	**100%**	**100%**

For gravity flow schemes (QT NEP 40), approach costs (i.e., training, social mobilisation, and technical support for implementation) make up about 15-20% of the total scheme costs. For a typical scheme of 50 households, total costs amount to USD16,0001, which include approach-related expenses of roughly USD2,500 (corresponding to 2 times 120–150 person days).

Decisions on choice of the Technologies: Made by local community based on proposal of technical and social experts, taking into account the suitability and availability of local water sources.

Decisions on method of implementing the Technologies: Made by local community based on proposal of technical and social experts.

Approach designed by: The Water Resources Management Programme (WARM-P) of HELVETAS Swiss Intercooperation

Implementing bodies: The VDCs in partnership with WARM-P/HELVETAS Swiss Intercooperation and local NGO

Land User Involvement

Phase	**Involvement**	**Activities**
Initiation/motivation	Interactive	During community meetings, a joint decision to go forward with the implementation of a specific scheme is taken. After recommendation by the VDC, the community selects/elects a UC, which is responsible for the whole implementation process.
Planning	Interactive	Members of the Village Water, Sanitation, and Hygiene Coordination Committee (V-WASH-CC) take a lead role in preparing a WUMP for a VDC; similarly, the UC is in charge of the detailed planning and implementation process of particular scheme. Public hearings during the preparation phase disseminate information on the implementation plan and respective roles and responsibilities; they also act as forums to gain approval of the entire community.
Implementation	Interactive/external support	The community contributes to construction with labour and local construction materials. Public reviews during the construction phase assess progress and ongoing works.
Monitoring/evaluation	Interactive/passive	Public audits are conducted after completion: all members of the community assess the quality of the completed work, review expenditures/contributions by the programme and the community, and evaluate whether the scheme meets the set standards and serves the targeted households. Two follow-up reviews are conducted by project staff within two years after construction.

Involvement of women and disadvantaged groups: Quotas are used as one means of ensuring the participation of women (minimum 40%) and disadvantaged groups (proportional to their local population), backed by pro-active measures such as the engaging of local women as social mobilizers, small group discussions to bring out sensitive issues, and training women in non-stereotypical roles such as tap and tank maintenance, and water distribution.

Involvement of disadvantaged groups: Disadvantaged groups (Dalit and Janajati, among others) participate in all activities and committees in numbers proportional to their share of the overall population.

STEP-WISE DRINKING WATER AND SANITATION SCHEME IMPLEMENTATION PROCESS

Phase	Step	Activity
Post-construction phase Steps 18 - 20	20	Second follow-up (after 2 years)
	19	First follow-up (after 6 months)
	18	UC Management Training II and WSP Training
Construction phase Steps 6 - 17	17	Public Audit
	16	Final Commissioning
	15	Construction Completion Information
	14	Construction Supervision & Public Review
	13	VMW Training
	12	Women Tapstand Care Taker Training and Sanitation Trigger*
	11	Construction Implementation
	10	Non Local Material Transporation
	9	Local Material Collection
	8	Triggering on Sanitation and Hygiene Behaviour Change
	7	Selection of VMW and Initial O&M fund collection
	6	UC Management Training I
Preparation Phase Steps 1 - 5	5	Public Hearing and Agreement for Implementation
	4	Detail survey and Preperation of Design Cost Estimate
	3	Social and Resource Mapping
	2	UC formation
	1	Approval from Village Development Committee

20 steps of implementation process

UC = Users Committee
O&M = Operation and Maintenance
VMW = Village Maintenance Workers
WSP = Water Safety Plan

*Sanitation Trigger: Women tapstand caretakers also act as change agents for open defecation free (ODF) and total sanitation campaigns.

Technical Support

Training/awareness raising: Social mobilization and awareness-raising orientations are key components of the approach: public hearings and audits are held to gain the communities' approval but also to build transparency, shared commitment, and ownership to use and maintain schemes responsibly. Sanitation motivation events are organized to raise awareness on safe household water treatment and sanitation practices.

On-site training sessions are organized for the members of the User Committee (training on management issues during pre-construction/construction/post-construction phases of the scheme), for local village maintenance workers (training on construction, operation, monitoring, and maintenance of the schemes), tap stand caretakers (training on maintenance of community tap stands), and local latrine builders (training on construction of latrines and awareness promotion on sanitation).

Advisory service: Programme staff regularly backstops the UCs in all matters related to scheme implementation. A social and a technical field staff are assigned to each scheme during construction. These field staff members are stationed in the assigned scheme areas until construction is completed and the scheme is finally commissioned.

Research: Research is not a major focus of the approach. However, two follow-up surveys are conducted within two years after construction, focussing on the functional status of physical structures, institutional mechanisms (activity of UC, collection and utilization of O&M Fund, activity of trained service providers, and availability of maintenance tools), and sanitation and hygiene practices. Intermittently, more comprehensive functionality studies are conducted, which cover older schemes as well. Findings of these studies inform general updates of the approach, as well as specific adjustments to different local contexts and needs.

External Material Support/Subsidies

Labour: The majority of unskilled labour works is provided by the community (structural works for tap stands, distribution lines, part of portering of materials from road to village), while all skilled labour and selected unskilled labour works (intake and reservoir tank construction, transmission lines) are provided and paid for by the implementing organization.

Inputs: Locally available materials (stone, sand, aggregate, wood, bamboo) are contributed by the community. Procurement and road transportation of other construction materials (HDPE pipes, GI pipes, fittings and valves, cement, wire) and tools are covered by the implementing organization.

Credit: No credit is provided.

Support to local institutions: Support is provided to VDCs, especially to the Village Water, Sanitation, and Hygiene Coordination Committee (V-WASH-CC) during preparation of the WUMP through capacity-building workshops. Training workshops are organized for UCs during the implementation phase.

Monitoring and Evaluation

Monitored aspects	Methods and indicators
Biophysical	Two surveys (after six months and two years) after construction conducted by project staff to follow up on changes in source runoff (measured) and source protection and conservation measures (observed).
Technical	Final commissioning after completion of construction and two follow-up surveys on status of physical structures (observed), hydraulic flow in the scheme (measured), and water availability at point of supply (measured).
Institutional	Two follow-up surveys on institutional mechanisms: activity of UC, collection and utilization of O&M Fund, activity of trained service providers, and availability of maintenance tools.
Sociocultural	Detailed socioeconomic assessment during WUMP preparation. No dedicated follow-up monitoring. Public hearings/audits before, during, and after implementation ensure transparency and community participation. Ad hoc observations of attitude during follow-up visits of project staff.
Economic/production	Detailed socioeconomic assessment during WUMP preparation. No dedicated follow-up monitoring. Ad hoc observations of status/income during follow-up visits of project staff.
No. of land users involved	During public review and final commissioning, community contribution and participation is assessed.
Management of Approach	Final reports of every implemented scheme and annual reports of the programme conclude on allocation of resources.

Changes as result of monitoring and evaluation: Functionality surveys revealed that in some cases users are reluctant to use and properly maintain community taps and that they would rather connect separate pipes from a community tap to bring water directly to their homes. Moreover, users are less inclined to pay O&M fees for community tap stands. Hence, the programme now supports private taps on a case-by-case basis, subject to technical feasibility and a socioeconomic assessment whether users are willing to pay for improved services. On another note, as trained village maintenance workers were often absent due to (seasonal) migration, the programme now organizes training workshops for new maintenance workers in old schemes.

Impacts of the Approach

Improved water resources management: The approach instils feelings of shared responsibility to use water resources in an equitable and sustainable manner. On average, schemes implemented with this approach have a better functional status compared to schemes implemented with other approaches in Nepal (see cited literature below).

Adoption by other users/projects: The approach represents an influential guideline and has been adopted by other organizations for implementation projects. Nepal's Ministry of Local Development, Department of Local Infrastructure and Roads, has expressed an interest to upscale the approach for all the VDCs in Nepal.

Improved livelihoods/human well-being: Improved water access and hygiene practices lead to a significant reduction of reported incidents of water-borne diseases. Additionally, the daily workload for water fetching is reduced on average by two hours per household. The saved time is reported to be spent on livestock raising, vegetable cultivation, and household chores.

Improved situation of disadvantaged groups: Socially and economically disadvantaged groups are the primary target group of the programme. They participate in all parts of the process on equal terms.

Poverty alleviation: If water supply is ample and market access is established, surplus supply can be used for irrigating vegetables and cash crops to raise household income (see QT NEP 41, 42 and 44). Trained local service providers gained an additional source of income, earning on average from USD120 (village maintenance workers) to USD250 (local latrine builders, rainwater harvesting workers) per annum.

Training, advisory service, and research: The offered training and advisory services effectively capacitate UCs and local service providers to manage, monitor, and maintain the water supply schemes. However, this increased capacity does not always result in well-managed and -maintained schemes, as retention of trained service providers, continuing activity and renewal of the UC, and mobilisation and apposite use of the O&M funds are challenging aspects in the post-construction phase.

Land/water use rights: Used water sources are registered with the District Water Resources Committee, which gives users legal ownership of the sources.

Long-term impact of subsidies: No subsidies are part of the approach. UCs are expected to finance maintenance works with the O&M fund established during implementation. The community is asked to ascertain each household's contribution to the O&M fund based on a wealth ranking exercise. While most of the schemes have adequate funds for minor repairs and maintenance, regular collection of O&M funds is not practiced in all communities, which poses a concern for long-term functionality.

Concluding Statements

Main motivation of land users to implement SLM: Sustainable access to water resources to meet domestic and agricultural needs, as well as a reduced workload for water fetching.

Sustainability of activities: Proper functioning of drinking water and sanitation schemes is determined by both the quality of physical structures and the effectiveness of the institutional mechanisms to properly operate, monitor, and maintain the schemes. While the schemes have a robust physical foundation, a key issue toward true sustainability is the establishment of institutional mechanisms related to operation and maintenance (UC, O&M fund, skilled service providers) which remain active throughout the designated lifespan of each scheme.

Strengths and ➔ how to sustain/improve	Weaknesses and ➔ how to overcome
Approach capacitates user committee and local service providers to manage, monitor, and maintain the water supply schemes themselves ➔ secure long-term post-construction support so that UC and service providers remain active for scheme's whole service life. Post-construction support is of particular importance to facilitate repair works, which are beyond the technical and financial capabilities of the communities. As these issues are of long-term nature, the related support should be institutionalized at the governmental level.	Institutional mechanisms related to operation and maintenance (UC, O&M fund, skilled service providers) at the local level are less active during post-construction as during preparation and construction phases(e.g., 40% of the UCs are inactive 5 to 10 years after construction). This can adversely affect the long-term functionality of schemes ➔ UCs control or mobilize other institutional components; therefore, measures to further activate the UCs are crucial to keep the entire mechanism active in the long run. Measures to make UCs more effective include: (i) reform UC every two years and provide training to new members; (ii) build UC capacity by strengthening linkages with local bodies and other resource organizations; (iii) become member of the Federation of Drinking Water and Sanitation Users Nepal (FEDWASUN) and other networks in the sector; and (iv) increase UC income by better mobilizing the Operation and Maintenance fund.
Community owns process by participating in planning and contributing to implementation. Approach enhances feelings of ownership and instils a sense of shared responsibility to utilize the resources in an equitable and sustainable manner. ➔ Investigate how process can be simplified and made more cost-effective to facilitate replication.	Retention (migration) and remuneration of trained service providers is not always satisfactory: about one-third of the trained service providers are absent or inactive after 5 to 10 years ➔ engage and retain trained service providers in scheme area by creating opportunities to offer their skills in other programmes. Additionally, consider training a greater number of service providers per scheme.
Inclusive implementation process managed by the whole community ➔ further capacity-building of disadvantaged groups may enable them to participate more actively.	In some schemes, monitoring activities are carried out rather casually, as opposed to in regular intervals ➔ establish an institutional mechanism at the local level to monitor schemes. Schemes should prepare and implement a water safety plan (as prescribed in Nepal's Drinking Water Quality Ordinance), while local and national governmental bodies can and should assume more responsibility in the monitoring process.
Approach is appreciated by both the government and national and international NGOs. The approach represents an influential guideline and has been adopted by other organizations for implementation projects ➔ increase collaboration to further develop and disseminate approach.	In some cases, users are reluctant to maintain community taps or to pay for repair services ➔ support private taps on a case-by-case basis (subject to technical feasibility and willingness to pay). Make sure that services still serve lower income households adequately.

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

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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Implementation of Small-Scale Farmer-Managed Irrigation Systems

Nepal – कृषक ब्यवस्थित साना सिंचाई योजना

Implementation of small-scale farmer-managed canal and pond irrigation systems in rural Nepal.

The approach documented here aims to increase agricultural productivity by providing better access to water for irrigation to poor farmers with predominantly marginal landholding (~0.5 ha on average). It focuses on the construction and rehabilitation of farmer-managed irrigation schemes (FMIS) to improve the income and food sufficiency of rural communities and in particular of disadvantaged groups.

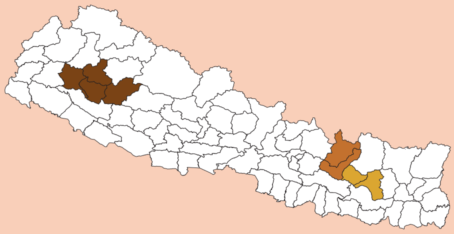
The programme provides technical assistance and funds for two types of irrigation technologies. Support of traditional canal-fed irrigation systems (QT NEP 40, 41) focuses on the rehabilitation of damaged or malfunctioning existing schemes. Irrigation canals are prevalent in lower elevated areas subject to subtropical climatic conditions. Newly constructed pond irrigation systems (QT NEP 43, 42), on the other hand, are situated in the higher, colder, and more water-scarce hill areas.

Implementation modalities are guided by a systematic eight-step approach led by the District Technical Offices (DTO) of the District Development Committees (DDC), supported by community-based organizations and specialized Nepali service providers. The following key elements are central to the implementation approach:

- Demand Driven: The initiative and willingness of the local communities concerned are key prerequisites for the programme's support.
- Participatory Planning and Implementation: Through a participatory approach, gender and ethnically balanced UCs are formed, which are responsible for leading the scheme's implementation process. The community contributes time, labour, and local construction materials. Public hearings, reviews, and audits before, during, and after implementation are mandatory.
- Capacitated User Committees (UC): All members of the UCs are provided with trainings on management and water rights issues during pre-construction, construction, and post-construction phases, enabling them to effectively manage implementation, operation, and maintenance of irrigation schemes on their own.
- Capacitated Local Service Providers: Training events enhance the capacities of local NGOs, which supervise the construction process and provide social mobilization services related to the scheme implementation. For each scheme, two appropriate local people are provided with technical training to become skilled caretakers in charge of operation and maintenance.
- Funding through governmental channels: Some of the programme funds are channelled through the District Development Funds (DDF) of the District Development Committees.
- Operation and Maintenance Funds: For every scheme, an O&M fund is established and managed by the respective UC. The UC prepares collection and spending regulations in consultation with the community. Most communities adopt equitable contribution systems.
- Equitable water-sharing mechanisms: Tailor-made policies developed by the users provide equitable distribution and utilization of irrigation water.
- Community procurement: To increase ownership, accountability, and commitment, the community procures locally available materials itself.
- Agricultural extension: Farmers are linked to agricultural service providers (seed, fertilizer, and input suppliers) and receive information on available agricultural inputs, as well as support in developing their post-implementation cropping patterns.
- Post-Construction Monitoring and Support: Follow-up support in the form of coaching and mentoring is provided to the user community at least twice a year in the first three years after construction. Annual functionality inspections are conducted in the same period.

Left: Public review in Budhekhola pond irrigation, Birpath VDC, Achham. (LILI)

Right: Canal construction in rocky area. (LILI)



Location: Eight districts in the Central, Eastern, and Mid-Western Development Regions of Nepal

Approach area: >3,000 km²

Type of Approach: Project/programme-based

Focus: Usage of water sources for irrigation

WOCAT database reference: QA NEP 41

Related technology (ies): QT NEP 40

Compiled by: Lukas Egloff, Bhagat B. Bista, Susan Shakya

Date: June 2015

Comments: The documented implementation approach is part of the Water Use Master Plan (WUMP) approach (QA NEP 36). Key features of the WUMP are its particular focus on "planned and agreed use" of water resources and its holistic approach to managing drinking water schemes. The preparation of a WUMP serves as an entry point for interventions in the water sector and sets priorities in terms of using available water sources and the implementation of related water supply schemes in Village Development Committee areas (VDC), the lowest administrative units in the country. The approach documented here describes the implementation of irrigation projects identified during WUMP preparation.

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

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Problem, Objectives and Constraints

Problems

- Issues of access to water are often contentious; communities often quarrel over water rights.
- A lack of irrigation water and agricultural inputs results in poor agricultural productivity and food insecurity.
- A weak economy, along with the decreasing appeal of subsistence agriculture, leads to high migration (especially young men).
- Growing water demands for domestic and agricultural use and diminishing water sources (climate change) may aggravate water conflicts.
- Dubious sustainability of irrigation systems: a significant part of the existing schemes in Nepal are not fully functional, indicating a lack of proper management and maintenance.

Aims/objectives

- Establish inclusive implementation of irrigation schemes at the community level; ensure an equitable and efficient use of water resources.
- Improve access to water for irrigation to increase agricultural productivity, improve livelihoods, and reduce dependencies onexternal support and migration.
- Improve functionality and operational lifespan of implemented irrigation schemes by enhancing local ownership and capacitating local service providers and User Committees to operate, repair, and maintain the schemes.

Constraints Addressed

Major	Constraint	Treatment
Institutional/Social	Lacking sense of ownership and entitlement by communities to equitably use irrigation facilities and to share the responsibility for effective operation and maintenance	Apply a participatory planning and implementation approach; gender and ethnically balanced UCs are responsible for implementation process as well as operation and maintenance; regular public audits; in-kind contribution by community; advocate equitable water sharing policies
Technical	Lack of skills to manage and maintain irrigation schemes	Capacity development of UC and local service providers
Financial	Challenge to secure long-term funding for sustainable O&M	Introduce community O&M fund managed by the UC
Minor	Constraint	Treatment
Environmental	Depletion of water sources may aggravate water scarcity	Source conservation schemes to improve natural recharge rates; consider rainwater harvesting

Participation and Decision Making

Stakeholders/target groups				
				
Users, individual/ group	Local service providers, NGOs, consultants	Village/ district development committees (VDCs/ DDCs)		

Contribution to costs:	Construction	Approach
Local Government (Village/District Development Committee)	2 - 5%	0%
Local Community	10 - 15%	0%
International non-governmental organisation	80 - 90%	100%
Total	**100%**	**100%**
For canal and pond irrigation schemes (QT NEP 40, 41 and QT NEP 43, 42), approach costs (i.e., training, social mobilisation, and technical support for implementation) make up about 10-15% of the total scheme costs. Total average scheme costs amount to USD 15,000 (canals) and USD 11,000 (ponds), which includes approach-related expenses of roughly USD 1,500.		

Decisions on choice of the Technologies: Initial proposal made by local community to VDCs. Local service providers then compile detailed technical and social surveys, design and cost estimates, which form the basis for project evaluation.

Decisions on method of implementing the Technologies: Made by local community based on proposal of technical and social experts.

Approach designed by: The Local Infrastructure for Livelihood Improvement (LILI) project of HELVETAS Swiss Intercooperation

Implementing bodies: The User Committee (UC) in partnership with local service providers and backstopping by VDC/DDCs and LILI/HELVETAS Swiss Intercooperation.

Land User Involvement

Phase	Involvement	Activities
Initiation/motivation	Interactive	During community meetings, a joint decision to go forward with the implementation of a specific scheme is taken. After recommendation by the VDC, the community selects/elects a UC, which is responsible for the whole implementation process.
Planning	Interactive	The UC is in charge of the detailed planning and implementation process of a particular scheme. Public hearings during the preparation phase disseminate information on the implementation plan and respective roles and responsibilities; they also act as forums to gain approval of the entire community.
Implementation	Interactive/external support	The community contributes to construction with labour and local construction materials. Public reviews during the construction phase assess progress and ongoing works.
Monitoring/evaluation	Interactive/passive	Public audits are conducted after completion: all members of the community assess the quality of the completed work, review expenditures/contributions by the programme and the community, and evaluate whether the scheme meets the set standards. Follow-up visits with functionality inspections are conducted by project staff during the first three years after construction.

Involvement of women and disadvantaged groups: Quotas are used as one means of ensuring the participation of women (minimum 40%) and disadvantaged groups (proportional to their local population), backed by pro-active measures such as the engaging of local women as social mobilizers, small group discussions to bring out sensitive issues, and training women in non-stereotypical roles such as tap and tank maintenance, and water distribution.

Involvement of disadvantaged groups: Disadvantaged groups (Dalit and Janajati among others) participate in all activities and committees in numbers proportional to their share of the overall population.

The eight steps of the implementation process

Phase	Steps		Responsibility
Preparation	1	Demand submission by communities to VDCs directly or by service providers, line agencies or others through DDC, first screening.	Community, LSP, LILI, DDC
	2	First socio-economic and technical survey of screened demands and prioritization of projects	Local Service Provider (LSP) and LILI/DDC
Survey, Design & Formalisation of the Project	3	Social and technical Detail Survey, Design, Cost Estimate including agricultural cropping areas. ▪ Evaluation of prioritized projects. ▪ Linkage to Agricultural Service Providers	External Service Provider (ESP) and / or LSP LILI/DDC through DTO Agricultural Service Providers
	4	▪ Public Hearing for Communicating Results of Detail Survey to the Community and VDC concerned - Publication of Design of Irrigation Scheme, Agricultural Plan, Contributions & Cost Sharing - Formation of User Committee (UC) - Preparation of Operation & Maintenance Fund System (OMF/S) - Signing of Community Agreement ▪ Construction Management Training	Local Service Provider (LSP) / LILI and / or External Service Provider (ESP) DDC/VDC/LILI/Agriculture Service Providers
Construction & Finalization	5	Collection of local materials and start of excavation of trenches, ponds or foundations (depends upon the nature of the project). Monitoring and Verification of required community contribution.	Community DDC / LILI / LSP
	6	Supply of non-local materials to agreed road-head and subsequent transportation of the site Simultaneous completion of excavation	DDC / LILI / LSP / Community
	7	Project construction, site supervision and public review	DDC through DTO / LILI / LSP / Community
	8	Project completion commissioning and reporting including public audit	DDC through DTO / VDC / LILI / LSP / Community

It is assumed that each project can be completed within 1½ years including preparation. Detailed surveys of irrigation projects need to be done in the driest periods – i.e. in the pre-monsoon months of mid-February to mid-May

Technical Support

Training/awareness raising: Social mobilization and awareness-raising orientations are key components of the approach: public hearings and audits are held to gain the community people approval, but also to build shared commitment and ownership to use and maintain schemes responsibly.

On-site training sessions are organized for the members of the User Committee (training on management issues during preconstruction/construction/post-construction phases of the scheme) and caretakers (training operation, monitoring, and maintenance of the schemes). The two selected caretakers also become of part of the construction crew, preparing them to identify and execute repair and maintenance works later on. Local service providers (NGOs and private organizations) are capacitated with training events on social mobilization, facilitation of participatory processes, basic conflict mediation techniques, and technical expertise.

Advisory service: Local service providers and resource persons provide FMIS users agricultural, technical, and social advisory services and regularly backstop the UCs in all matters related to scheme implementation. The local service providers are jointly selected and hired through an open bidding process run by the DDC and the programme.

Research: Research is not a major focus of the approach. However, functionality and quality inspections are conducted annually in the first three years after construction, focussing on the functional status of physical structures and institutional mechanisms (activity of UC and scheme caretakers, collection and utilization of O&M Fund, established water sharing practices). In specific schemes, cost-benefit analyses are carried out. Findings of these inspections inform general updates of the approach, as well as specific adjustments to different local contexts and needs.

External Material Support/Subsidies

Labour: The majority of unskilled labour works is carried out by the community (trench digging, pond excavation, collection and portering of local materials), while all skilled labour and selected unskilled labour works (intake construction, idle length of main canal/pipe) are organized and managed by the community and paid for by the programme. To this end, the programme funds are channelled through the District Development Funds (DDF) of the District Development Committees.

Inputs: Local materials (stone, sand, aggregate, wood, bamboo) are contributed by the community. The programme bears the road transportation costs for sand and provides other required construction materials (cement, reinforcement bars, pipe fittings, and tools) up to the nearest motorable road-head. This, if applicable, is done through community procurement.

Credit: No credit is provided.

Support to local institutions: The programme extends technical assistance to DDCs and VDCs for the evaluation of community project proposals and the procurement of local service providers and backstops the whole implementation process. As mentioned above, training workshops are organized for UCs and local service providers.

Monitored aspects	Methods and indicators
Biophysical	None
Technical	Final commissioning after completion of construction and annual function and quality inspections during the first three years after construction monitor the status of physical structures and the hydraulic flow in the scheme.
Institutional	Function and quality inspections include institutional mechanisms: activity of UC, collection and utilization of O&M Fund, activity of trained service providers, as well as established and complied water sharing policies.
Sociocultural	Detailed socioeconomic assessment during preparation phase. No dedicated follow-up monitoring. Public hearings/ audits before, during, and after implementation ensure transparency and community participation. Ad hoc observations of attitude during follow-up visits of project staff.
Economic/production	Detailed socioeconomic assessment during preparation phase. Post-implementation production–income and cost–benefit analyses are conducted once within the first three years after construction.
No. of land users involved	During public review and final commissioning, community contribution and participation is assessed.
Management of Approach	Final reports of every implemented scheme and annual reports of the programme conclude on allocation of resources.

Monitoring and Evaluation

Changes as result of monitoring and evaluation: Functionality surveys revealed that a common problem with pond schemes was rupturing of the silpaulin sheets and reluctance of the user committee to replace them. As a simple cost-effective protection measure, jute bags were filled with a mixture of soil and cement to cover the plastic membrane sheets. Moreover, larger ponds (>150 m^3) were found to have a higher failure rate. Hence, in later project stages, the programme stepped away from large ponds and turned toward implementing batteries of smaller ponds (30 m^3 – 60 m^3) instead.

Impacts of the Approach

Improved water resources management: The approach instils feelings of shared responsibility to use water resources in an equitable and sustainable manner.

Adoption by other users/projects: DDCs and Central Government agencies consider the approach as relevant since it provides a viable model for addressing the priorities of marginalized farmers. It is in line with the District Development Plans and with policy options being discussed for the new Agriculture Development Strategy. ADB-funded Community Irrigation Project adopted the pond technology.

Improved livelihoods/human well-being: The irrigation schemes helped to increase food security, health, and household income through increased and diversified production. This makes farmers less dependent on migration. Most farmers mention that the increase in income also allows for better schooling of the children. The availability of water (for irrigation) is of outstanding importance for improving livelihoods of farmers. For other inputs to agricultural production, they are less dependent on external support.

Improved situation of disadvantaged groups: Socially and economically disadvantaged groups are the primary target group of the programme. They participate in all parts of the process on equal terms.

Poverty alleviation: The additional irrigation water supply is often used to grow vegetables and cash crops. If market access is established, the latter may contribute to considerable increments in income. Net annual incremental benefits for an average household range between USD 60 and 80 against a baseline of USD 25. Scheme caretakers also gain an additional source of income.

Training, advisory service, and research: The offered training and advisory services effectively capacitate UCs and local service providers to implement, monitor, and maintain the irrigation schemes. However, this increased capacity does not always result in well-managed and -maintained schemes, as retention of caretakers, continuing activity and renewal of the UC, and mobilisation and apposite use of the O&M funds are challenging aspects in the post-construction phase.

Land/water use rights: UCs are introduced to handling water rights issues and conflicts during construction management, operation, and maintenance trainings. As a result, most of the UCs have registered their schemes and water sources with either the District Water Resource Committee (DWRC) and/or the Irrigation Division office. The schemes' tailor-made water distribution and maintenance policies are governed by equitable principles, i.e., water is allocated to households either equally or proportionately (proportionate to cultivated land).

Long-term impact of subsidies: No subsidies are part of the approach. UCs are expected to finance maintenance works with the O&M fund established during implementation. Households contribute to the O&M fund either equally or proportionally (to allocated water). While most of the schemes have adequate funds for minor repairs and maintenance, regular collection of O&M funds is not practiced in all communities, which poses a concern for long-term functionality.

Concluding Statements

Main motivation of land users to implement SLM: The irrigation schemes help to increase food sufficiency. Increased and diversified production improves the diet, and through marketing of surplus, farmers can increase income.

Sustainability of activities: Proper functioning of irrigation schemes is determined by both the quality of physical structures and the effectiveness of the institutional mechanisms to properly operate, monitor, and maintain the schemes. While the schemes have a robust physical foundation, a key issue toward true sustainability is the establishment of institutional mechanisms related to operation and maintenance (UC, O&M fund, caretakers), which remain active throughout the designated lifespan of each scheme.

Strengths and ➔ how to sustain/improve	**Weaknesses and ➔ how to overcome**
The approach improves food sufficiency, household income, and health. The improvements are tangible enough for villagers to reduce migration, in particular among the more marginalized groups who, for financial reasons, usually depend on the more "precarious" migration options. The improvements of livelihoods are so substantial that farmers have a genuine interest in maintaining them ➔ institutionalize the approach by developing a FMIS-subsector, which requires focused action by the government to coordinate the FMIS subsector, combined with coordinated donor support to build capacity at the central and district level. Broaden the funding of FMIS by integrating related governmental funds and attracting new donors to subscribe to the approach.	Institutional mechanisms related to operation and maintenance (UC, O&M fund, caretakers) at the local level are less active during post-construction phases. This could adversely affect the long-term functionality of schemes. ➔ UCs control or mobilize other institutional components; therefore, measures to further activate the UCs are crucial to keep the entire mechanism active in the long run. Measures to make UCs more effective include: (i) reform UC every two years and provide training to new members; (ii) build UC capacity by strengthening linkages with local bodies and other resource organizations; (iii) become member of the National Federation of Irrigation Water Users' Association Nepal (NFIWUAN) and other networks in the sector; and (iv) increase UC income by better mobilizing the O&M fund.
Community owns process by participating in planning and contributing to implementation. Approach enhances feelings of ownership and instils a sense of shared responsibility to utilize the resources in an equitable and sustainable manner. ➔ investigate how the process can be simplified and made more cost-effective to facilitate replication. Further capacitybuilding of disadvantaged groups may enable them to participate more actively.	Migration of key UC members, ineffective retention and remuneration of caretakers, as well as major repair works, which are beyond the resource mobilization capacity of the community, may result in quiescent O&M mechanisms and functionality failures ➔ retain caretakers in scheme area by offering refresher courses and creating opportunities to offer their skills in other programmes. Secure long-term post-construction support so that UC and service providers remain active for the scheme's whole service life. As these issues are of a long-term nature, the related support should be institutionalized at the governmental level.
Approach is economically viable; the implemented schemes exhibit a positive return on investment ➔ to maximize the benefits, review the needs of farmers in terms of backward and forward linkages within the agriculture value chain.	Conflicts may emerge when tail-end users receive less water than originally allotted due to diminishing water sources ➔ capacitate local service providers to help review and adapt water sharing policies during follow-up visits.

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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Sanitation and Hygiene Promotion Approach

Nepal – सरसफाई र स्वच्छता प्रवर्धन पद्धति

Sanitation and hygiene promotion activities in the rural mid-hills of Nepal.

The approach documented here describes sanitation and hygiene promotion activities in the rural mid-hills of Nepal. These promotion activities are usually carried out in the course of establishing Water Use Master Plans (QA NEP 36) and the implementation of drinking water and sanitation schemes (QT NEP 40). They combine awareness-raising activities with the construction of sanitary facilities. There are two types of intervention levels:

1. Activities which are tied to the construction of drinking water and sanitation schemes. An average scheme caters to about 50 households.
2. Activities related to the establishment of open defecation free zones (ODF). Usually, ODF is declared for village development committee (VDC) areas (the lowest administrative unit, with about 700 households on average).

Water users and sanitation committee (WUSC) and village water and sanitation coordination committee (V-WASH-CC), as local institutions, lead the process at scheme level and VDC level, respectively. In both cases, the approach consists of two main components:

1. **Awareness-raising and capacity building:** This includes village activities (door-to-door campaigns, orientation, interaction, hand washing demonstration), school-level activities (quiz, debates at local schools) using IEC (Information, Education, and Communication) material such as pamphlets, posters, hoarding boards, etc. Hygiene and sanitation trigger trainings are held for the WUSC and the V-WASH-CC. In ODF schemes, a training for local latrine builders is also included, as well as additional activities such as street dramas or feature programmes on the local FM radio. Sanitation and hygiene education activities vary from community to community, depending upon the local situation, but they usually focus on the 5 + 1 indicators of "total sanitation", introduced by the Department of Water Supply and Sewerage (DWSS) in 2012:

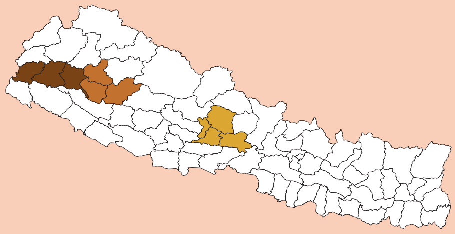
   i. Use of toilets (awareness of transmission routes of water-borne diseases)
   ii. Use of safe water (household water treatment and storage)
   iii. Use of safe food
   iv. Practice of hand washing with soap
   v. Practice of cleaning the household and surroundings
   vi. Environmental sanitation/keeping the environment clean

To achieve total sanitation, the programme employs the hygiene and sanitation ladder approach (see Hygiene and Sanitation Software by Andy Peal, Barbara Evans, & Carolien van der Voorden (2010)).

2. **Construction:** toilets, changs (rack for drying of kitchen utensils), and garbage pits (see above photo) are constructed at every household. Generally, the construction costs are borne by the users themselves. Only poor households receive support for external materials (about 25% of total costs) for the construction of toilets in coordination with V-WASH-CC. In ODF schemes, the programme also foresees the construction of institutional toilets (schools, health posts).

Left: Awareness raising event to promote an open defecation free community in Dailekh (WARM-P)

Right: A household in Dailekh, which fulfils all indicators of total sanitation, i.e. hand washing station, chang (dish drying rack), toilet and waste disposal pit



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

Approach area: >3,000 km^2

Type of Approach: Project/programme-based

Focus: Usage, conservation, and protection of water sources

WOCAT database reference: QA NEP 42

Related technology (ies): QT NEP 40

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

Date: June 2015

Comments: The approach documented here describes the promotion of sanitation and hygiene related to the construction of drinking water schemes and/or the establishment of open defecation free zones (ODF) in rural Nepal. It is closely related to, and sometimes part of, the Water Use Master Plan approach.

Problem, Objectives and Constraints

Problems/challenges

- The government of Nepal launched a sanitation and hygiene master plan aiming for universal sanitation coverage by 2017.
- Despite good progress in the declaration of open defecation free VDCs, keeping VDCs ODF over the mid- to long-term proves to be challenging. This raises the need for post-ODF interventions.
- Because of bad maintenance, some latrines are abandoned after more than one year of use. A lack of understanding of the importance of latrine use and/or the construction of the latrine under pressure rather than self-motivation may be underlying causes.

Aims/objectives

- Establish an inclusive implementation of sanitation schemes to increase sustainable access to sanitation.

Constraints Addressed

Major	**Constraint**	**Treatment**
Institutional/Social	Little sense of ownership by communities with regard to sanitary facilities and lacking responsibility for effective maintenance	Apply a participatory planning and implementation approach; gender and ethnically balanced User Committees (UCs) are responsible for implementation process, as well as operation and maintenance; regular public audits; in-kind contribution by community
Technical	Lack of skills to build sound sanitary facilities	Capacity development of UC and local latrine builders
Financial	Challenge to secure long-term funding for sustainable O&M	Raising awareness about importance of toilet, engagement, and lead role by local authorities
Minor	Constraint	Treatment
Environmental	Depletion of water sources may aggravate water scarcity and lead to worse hygiene practices	Raising awareness about the importance of hygiene behaviour

Participation and Decision Making

Stakeholders/target groups				
				
Users, individual/ group	Local service providers, NGOs, consultants	Village/ development committees (VDCs)		

Contribution to costs:	**Construction**	**Approach**
Local Government (Village Development Committee)	10%	0%
Local Community	75%	0%
International non-governmental organisation	15%	100%
Total	**100%**	**100%**

For activities on a water scheme level (~50 households) approach costs for awareness raising and capacity building activities (USD ~1,000) amount to slightly less than half of the construction costs for toilets, changs and garbage pits (USD ~5,000). For ODF schemes on the VDC level (~700 HH), approach costs (USD ~3,500) are significantly lower than the construction costs (USD 16,500).

Decisions on choice of the Technologies: Made by local community based on proposal of technical and social experts.

Decisions on method of implementing the Technologies: Made by local community based on proposal of technical and social experts.

Approach designed by: The Water Resources Management Programme (WARM-P) of HELVETAS Swiss Intercooperation

Implementing bodies: The VDCs or users committee in partnership with WARM-P/HELVETAS Swiss Intercooperation and local NGO

Land User Involvement

Phase	**Involvement**	**Activities**
Initiation/motivation	Interactive	During community meetings, a joint decision to go forward with the implementation of the total sanitation steps is taken (see figure on next page). The community selects/elects a UC or V-WASH-CC, which is responsible for the whole implementation process.
Planning	Interactive	Members of the V-WASH-CC and the UC lead the process at scheme level and VDC level, respectively. Public hearings during the preparation phase disseminate information on the implementation plan and respective roles and responsibilities; they also act as forums to gain approval of the entire community.
Implementation	Interactive/external support	The community contributes to construction with labour and local construction materials. Public reviews during the construction phase assess progress and ongoing works.
Monitoring/evaluation	Interactive/passive	Public audits are conducted after completion: all members of the community assess the quality of the completed work, review expenditures/contributions by the programme and the community, and evaluate whether the facilities meet the set standards and serve the targeted households.

Involvement of women and disadvantaged groups: Quotas are used as one means of ensuring the participation of women (minimum 40%) and disadvantaged groups (proportional to their local population). These are backed by pro-active measures such as:

- Women-only meetings to encourage them to speak on matters difficult to raise in a mixed audience
- Support for women's leadership in user groups
- Technical training for women in e.g. tap maintenance and water distribution - breaking gender stereotypical roles

- Engaging local women social mobilizers who can talk readily with women and speak the local language – thus facilitating contact with groups who do not use Nepali as their first language
- Engaging women technical officers as role models
- Pro-actively visiting Dalit tols to encourage them to participate, ensuring that water supplies cater to them and are not captured by elite groups
- Championing the shared use of community water sources by different groups to break down caste barriers

Step	Scheme Level	VDC Level
1	Formation of Water Users and Sanitation Committee (UC)	Rapport building and V-WASH-CC (re) formation
2	Social and Resource mapping	Situation Assessment
3	UC management/training	Orientation to V-WASH-CC (one day)
4	Triggering on sanitation and hygiene behavior: by NGO staff	Orientation to teachers one1 day)
5	Women tap stand caretaker and trigger agent training	Selection of trigger agents (two-three persons from each ward) and training (two days)
6	Promotional Activities: Sanitation and hygiene education activities, e.g., Tole-level orientation, dialogue, household visit	Formation of ward WASH-CC and orientation (one day); ward citizen forum could be ward WASH-CC
7	Construction/use of toilets and total sanitation infrastructure (hand washing station, waste disposal pit, chang, etc.)	Promotional Activities: Sanitation and hygiene education activities, e.g., Tole-level orientation, dialogue, household visit
8	Motivational activities: Incentives, rewards, etc.	Construction/use of toilets and total sanitation infrastructure (hand washing station, waste disposal pit, chang, etc.)
9	UC management II and water safety plan training	Motivational activities: Incentives, rewards, etc.
10	Monitoring and validation	Monitoring and validation
11	Declaration of ODF/Total sanitation	Declaration of ODF/Total sanitation

11 steps of total sanitation

UC = Users committee
V-WASH-CC = Village water and sanitation coordination committee
ODF = Open defecation free
VMW = Village maintenance workers
WSP = Water Safety Plan

*Sanitation Trigger: Women tap stand caretakers also act as change agents for open defecation free (ODF) and total sanitation campaigns

Technical Support

Training/awareness raising: Social mobilization and awareness-raising orientations are key components of the total sanitation approach: public hearings and audits are held to gain the community people approval, but also to build transparency, shared commitment, and ownership to use and maintain the sanitary facilities responsibly.

In the course, the 11 steps of total sanitation (see table above), on-site training sessions on sanitation and hygiene are organized for the members of the User Committee and the V-WASH-CC (training on management issues during pre-construction/construction/post-construction), women tap stand caretakers, and selected trigger agents (awareness raising) and local latrine builders (training on construction of latrines and awareness promotion on sanitation).

Advisory service: Programme staff regularly backstops the UCs and V-WASH-CC in all matters related to scheme implementation. A social and a technical field staff are assigned to each sanitation campaign area.

Research: Research is not a major focus of the approach. However, two follow-up surveys are conducted within two years after construction, focussing on the functional status of physical structures, institutional mechanisms (activity of UC, activity of trained service providers, and availability of maintenance tools), and sanitation and hygiene practices.

External Material Support/Subsidies

Labour: All labour cost related to toilet construction is covered by the household themselves.

Inputs: Locally available materials (stone, sand, aggregate, wood, bamboo) are contributed by the community. The communities also bear the costs for external construction material. The implementing agency may provide support to poor households based upon the recommendation of the V-WASH-CC. The support is equivalent to 25% of the total costs of toilet construction.

Credit: No credit is provided.

Support to local institutions: Support is provided to VDCs, especially to the Village Water, Sanitation, and Hygiene Coordination Committee (V-WASH-CC) through capacity-building workshops. Training workshops are also organized for UCs during the implementation phase.

Monitoring and Evaluation

Monitored aspects	Methods and indicators
Technical	Final commissioning after completion of construction and two follow-up surveys on status of physical structures
Institutional	Two follow-up surveys on institutional mechanisms: activity of UC, activity of trained service providers and availability of maintenance tools.
Sociocultural	No dedicated follow-up monitoring. Public hearings/audits before, during, and after implementation ensure transparency and community participation. Ad hoc observations of attitude during follow-up visits of project staff.
Economic/production	No dedicated follow-up monitoring. Ad hoc observations of status/income during follow-up visits of project staff.
No. of land users involved	During public review and final commissioning, community contribution and participation is assessed.
Management of Approach	Final reports of every implemented scheme and annual reports of the programme conclude on allocation of resources.

Changes as Result of Monitoring and Evaluation

To achieve total sanitation, the programme has adopted the hygiene and sanitation ladder approach with a focus on hygiene behaviour (see Hygiene and Sanitation Software by Andy Peal, Barbara Evans, & Carolien van der Voorden (2010)).

To increase ODF sustainability, post-ODF support is extended to the UC and the V-WASH-CC.

Impacts of the Approach

Improved sanitation practices: Villagers say that they have improved their sanitary habits (proper cleaning of hands and utensils, washing clothes, and taking regular baths) and that their village is cleaner now.

Adoption by other users/projects: In the course of implementing the sanitation and hygiene master plan 2011, most of the agencies working on sanitation and hygiene promotion followed a similar approach for achieving ODF on the VDC level. The harmonization of working approaches of all agencies is one of the key aspects of the master plan.

Improved livelihoods/human well-being: Improved access to sanitation and hygiene practices lead to a significant reduction of reported incidents of water-borne diseases.

Improved situation of disadvantaged groups: Socially and economically disadvantaged groups are the primary target group of the programme. They participate in all parts of the process on equal terms.

Poverty alleviation: Trained local service providers gain an additional source of income, earning on average from USD 120 (village maintenance workers) to USD 250 (local latrine builders, rainwater harvesting workers) per annum.

Training, advisory service, and research: The offered training and advisory services capacitate UCs and V-WASH-CC to monitor and maintain the sanitary facilities.

Long-term impact of subsidies: No subsidies are part of the approach; only poor households get partial support as a reward.

Concluding Statements

Main motivation of land users to implement SLM: Sustainable access to sanitary facilities, improved household hygiene, better environmental sanitation.

Sustainability of activities: Proper functioning of sanitation schemes is determined by the quality of physical structures and the understanding and awareness of the community to make use of and maintain the facilities. The programme observes that once people get used to improved sanitary facilities, they appreciate them, maintain them, and refrain from open defecation.

Strengths and ➔ how to sustain/improve	**Weaknesses and ➔ how to overcome**
Approach capacitates user committee, V-WASH-CC, and local service providers to maintain and - if needed – to motivate the community to rebuild sanitary facilities by themselves ➔ secure long-term post-construction support so that V-WASH-CC, UC, and service providers (latrine builders) remain active for the infrastructure's whole service life.	Keeping the UC and V-WASH-CC engaged over the long term to maintain and monitor ODF is challenging; communities may go back to open defecation ➔ provide post-ODF support with a focus on hygiene behaviour to improve ODF sustainability and also achieve total sanitation.
Community owns process by participating in planning and contributing to implementation. Approach enhances feelings of ownership and responsibility to utilize and maintain the sanitary facilities sustainably ➔ Investigate how process can be simplified and made more cost-effective to facilitate replication.	The impact of hygiene and sanitation activities is greatest when sanitary behaviour is practiced by the whole community. In heterogeneous communities, this is sometimes difficult to achieve, as underprivileged groups tend to leave the initiative to better-off and more innovative people ➔ Keep in mind that different ethnic and/or caste groups may have their own cultural and religious beliefs and habits. Tailor the awareness-raising activities accordingly.
Inclusive implementation process managed by the whole community ➔ further capacity building of disadvantaged groups may enable them to participate more actively.	Very poor people who live on a survival strategy spend all their time and energy on fulfilling their most basic daily needs. Even with material support, it remains hard to motivate them to change their habits ➔ give special consideration and support to economically weak society members to motivate them to participate in community efforts.
The government of Nepal launched a nationwide sanitation campaign. The approach is in line with the guiding principles of the government campaign and supports the implementation of the sanitation and hygiene master plan ➔ increase collaboration with other agencies to further develop and disseminate approach.	

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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Left: Women and children queuing up at a public water tap stand. (WARM-P)

Right: Construction of a storage tank by capacitated local service providers and community members. (WARM-P)

Gravity Flow Water Supply Systems

Nepal – खानेपानी प्रणाली (ग्रेभिटी फ्लो)

Gravity flow water supply systems with public and private taps in the rural mid-hills of Nepal.

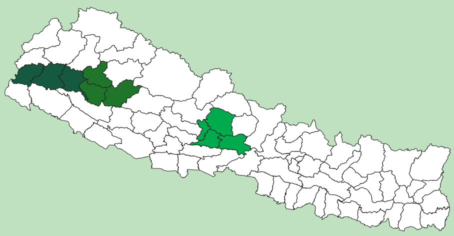
The provision of drinking water to rural communities in Nepal – adequate both in quantity and quality – continues to be a challenge for development; many rural households spend above two hours per day on fetching water from the closest water source. Gravity flow water supply systems are the most popular and widespread water supply technology in the rural mid-hills of Nepal. They form the backbone of water supply measures planned and implemented within the Water Use Master Plan (WUMP) framework for poor communities in these areas (see QA NEP 36 and QA NEP 40). When appropriately designed, constructed, and maintained, gravity schemes represent reliable and robust water supply systems with a low cost of operation. True to their name, gravity flow systems take advantage of gravity to transport water from a source to a service area located at a lower elevation. From the intake, water is transported continuously by a transmission line to one or several storage tanks. Higher capacity distribution pipelines then supply water to public and/or private tap stands.

The assessment of drinking water resources, as well as the design of aligned water supply systems, is governed by five principles:

1. **Quantity:** Systems are designed to provide at least 45 litres per capita (cap) and day (d) for domestic uses at community taps. Private taps are only considered when a safe yield of at least 60 l/cap/d is guaranteed. If the source discharge is higher than the domestic demand (>70 l/cap/d), Multiple Use Systems (MUS) may provide water for both domestic and irrigation purposes (QT NEP 44).
2. **Reliability:** Only perennial sources are tapped which provide at least the minimum safe yield for community connections, i.e., 45 l/cap/d year-round.
3. **Continuity:** Systems are designed to provide water continuously for at least six hours per day.
4. **Accessibility:** Generally, distances from households to taps should not exceed 50 m (uphill) or 150 m (horizontal). Positioning of community taps, each serving on average five households, is discussed with and agreed upon by the community.
5. **Quality:** Intakes at springs providing naturally pure water are favoured over intakes at surface water bodies like streams or ponds, as the scope for water treatment in rural water supply schemes is limited (financial barriers, absence of skilled labour needed for O&M). Source protection and conservation measures are applied while constructing intakes to guard against future pollution (QT NEP 48).

Closed continuous-supply systems are favoured over open or intermittent-supply systems. While open systems (systems with no flow-closing devices) are cheap to build, operate, and maintain, they do not allow for optimization of the available water resources. Closed systems are able to bridge potential gaps between the safe yield of a water source and the peak water demand by introducing storage tanks into the supply system. To control the water flow and minimize wastewater, faucets and valves are installed. Closed continuous systems are less prone to water contamination, as they are under pressure at all times. Accordingly, Break Pressure Chambers (BPC) are introduced at required locations to keep pressure within working limits of pipes, joints, and fittings.

If water sources are located in the vicinity of residential areas, spring protection measures (QT NEP 48) represent a less expensive alternative to a full-fledged distribution system.



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

Approach area: per scheme: 1 – 10 km²

Conservation measure(s): Structural

Land use type: Settlements

Climate: Humid subtropical

WOCAT database reference: QT NEP 40

Related approach: QA NEP 40 and QA NEP 36

Related technologies:

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

Date: June 2015

Comments: Gravity flow water supply schemes form the backbone of water supply measures planned and implemented within the Water Use Master Plan (WUMP) framework for poor communities in the rural mid-hills of Nepal.

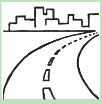
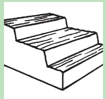
The technology was documented using the WOCAT (www.wocat.org) tool.

HELVETAS Swiss Intercooperation NEPAL   ICIMOD   WOCAT

Classification

Water use problems

- More than half of the population in Nepal lacks sustainable access to safe drinking water supply.
- Water sources are intermittent and/or far away; households spend upwards of two hours per day on water fetching.
- Growing water demand for both domestic and agricultural use and diminishing or fluctuating water supply due to climate change
- Dubious sustainability of water supply systems: a significant part of existing schemes in Nepal is not fully functional, indicating a lack of proper management and maintenance.

Land use	Climate	Degradation	Conservation measure(s)
			
Settlements, infrastructure networks	Humid subtropics	Physical degradation: local water scarcity	Structural: pipeline network with intake, storage tanks, and tap-stands

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

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

- potential to improve sanitation level (given adequate water supply)

Legend

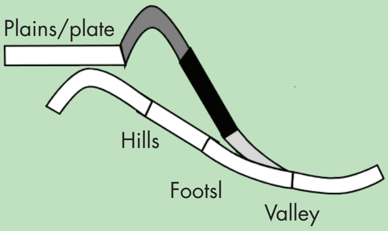
- high
- moderate
- low
- insignificant

Environment

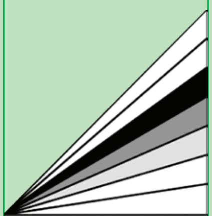
Natural environment

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

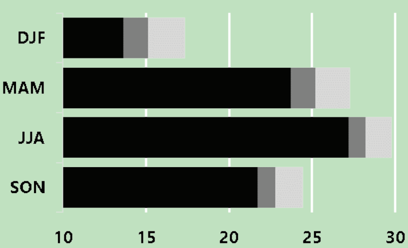


Slope (%)

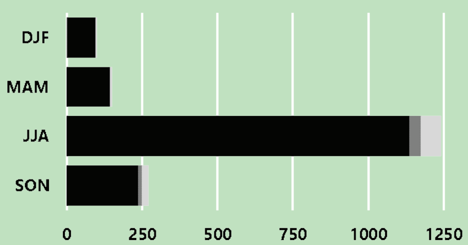


Climate change[1]

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 ly decrease slightly 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: temperature increase; wind storms/dust storms; floods; decreasing length of growing period

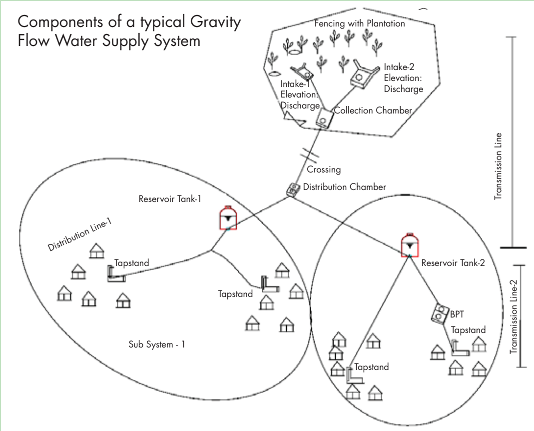
Sensitive to climatic extremes: seasonal rainfall increase/decrease; heavy rainfall events (intensities and amount); droughts/dry spells

If sensitive, what modifications were made/are possible: consider rainwater harvesting (e.g., QT NEP 46) or 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)		
<0.5 (■) 0.5-1 (■) 1-2 2-5 5-15 15-50 50-100	**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 & transport, drinking water supply and sanitation **Market orientation:** mainly subsistence (self-supply)



Technical drawing
Components of a typical gravity flow water supply system with public tap stands

BPT = Break Pressure Tank

Implementation Activities, Inputs, and Costs

Establishment activities
The establishment of the whole system could be completed within three months. However, the construction phase is generally spread out over a period of about six to eight months, which allows for several social mobilization and awareness raising orientations, as well as hands-on training workshops. Main establishment activities include:

1. Detailed survey (Preparation phase)
2. Discharge and demand supply assessment (Preparation phase)
3. Collection and transportation of local and external materials
4. Excavation of main pipe lines and development of structures on main lines
5. Construction of water storage and regulating chambers
6. Construction of distribution system and tapping structures
7. Final commissioning

Establishment costs and inputs for a typical GWS system catering to a community of 50 households with two intakes, one distribution chamber, two reservoir tanks (5 m^3) and 10 public tap stands.

Inputs	Costs (US$)[1]	% met by users
Skilled Labour (140 person days)	700	0%
Unskilled Labour (1,500 person days)	5,250	43%
Construction Materials		
HDPE and GI pipes	1,450	0%
Fittings and valves	540	0%
Cement (5,600 kg)	880	0%
Other construction materials	1,310	0%
Tools	**180**	**0%**
Local Materials (costs reflect unskilled labour effort for collection and portering)		
Stone (43 m^3)	300	100%
Sand (21 m^3)	1,160	37%
Aggregate 5-40 mm (8.5 m^3)	730	100%
Wood (1.6 m^3)	25	100%
Bamboo (10 pieces)	10	100%
Total	**12,550**	**29%**

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

Maintenance/recurrent activities
Monitoring of structures by walking along the pipeline network

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 66 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 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) typically ranges between 20 and 25%, which includes collection and portering of local materials, as well as unskilled labour work for the distribution line network and all tapstands. The programme reimburses the unskilled labour required for the construction of the intake structure, storage tanks, and the transmission line.

Establishment costs and O&M fees also depend on whether the schemes include public or private connections: average cost for schemes with public taps amount to USD 40–45 per capita compared to USD 55–65 per household in schemes with only private tap stands. 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 Users Committee

Connection charges, which also serve as initial contributions to the O&M fund during the construction phase, amount to USD 10 per public tap stand (catering on average to five households) and USD 10 per private connection. Users with private connections also pay a higher regular water tariff: public tap stands users pay a monthly fee of USD 0.2 into the O&M fund; in contrast, monthly user fees for private connections range from USD 0.6 to 0.8.

Note that, while the collected user fees suffice to pay the wages of the local maintenance worker and finance minor repair works (replacement of small fittings and parts, e.g., taps, valves, washers, etc.), they are not adequate to deal with major system failures such as the reconstruction or replacement of larger structures, e.g., 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 if source discharge is higher than domestic water demand. Given established market access, surplus supply can be used for irrigating vegetables and cash crops to raise household income		
++	Income opportunities for village maintenance workers		
Sociocultural benefits		**Sociocultural disadvantages**	
++	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			
+++	Decreased workload due to reduced time for water fetching: on average two hours per day per household. The saved time is reported to be spent on livestock raising, vegetable cultivation, and household chores.		
+++: high / ++: medium / +: low			

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 their public/private tap stands. On the other hand, gravity water flow schemes 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

Economic costs and benefits per household (USD) for a typical GWS (50 households; 10 public tap stands)	Assumptions
	▪ **Saved time:** two hours per day per household, assume that half of the saved time is spent on productive activities ▪ **Local rate for one person day (eight hours) of unskilled labour:** USD 3.5 ▪ **O&M fees/costs:** USD 0.6 per HH and month (~3% of total construction costs per year) ▪ **Discount rate:** 10%
Under the above assumptions, break-even point is reached after about two years. The net present value of the whole GWS system (with an assumed lifetime of 20 years) is around USD 50,000. The scheme has a Benefit/Cost Ratio of 4:1 and an Economic Internal Rate of Return (EIRR) of about 56%. While establishment costs are too high for most poor communities to bear by themselves, O&M expenses for minor repair works are generally paid by the users. Economic benefits can increase substantially if surplus water and waste water is used for irrigation of vegetables/cash crops.	

Strengths and ➔ how to sustain/improve	Weaknesses and ➔ how to overcome
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	Management, operation and maintenance of gravity flow schemes is non-trivial and requires appropriate knowledge and skills of the managing user community and the responsible maintenance workers➔ include capacity-building activities as an integral part of the technology implementation process
Schemes lead to a marked improvement of domestic water supply in the dimensions of quantity, quality, access, and reliability ➔ ensure that improved household water supply leads to improved health outcomes by raising HWTS and hygiene awareness and conducting behaviour change campaigns).	Spring water quality may not meet drinking water standards at all times and can be particularly impaired after heavy rainfall events; water quality may also deteriorate during transportation and storage ➔ raise HWTS awareness and promote treatment methods such as SODIS, filtering, or boiling of water.
Pilot schemes with private connections show very promising results in terms of increased ownership, better maintenance of the system, less conflict, more productive water use, and a higher willingness to pay for connection charges and fees for O&M fund ➔ support private taps on a case-by-case basis (subject to technical feasibility and willingness to pay). Make sure that services still serve lower income households adequately.	Gravity systems are on the upper end of the price scale of low-cost technologies, making them too expensive for poor communities to adopt or to finance 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) source protection represents a low-cost alternative if the source is in the vicinity of the community; (iii) microfinance or governmental subsidy schemes may represent an additional funding source.
As women are predominantly responsible for water fetching, improved water access reduces their workload and frees up time for other activities ➔ consider how additional (income) opportunities could be seized (e.g., cultivation of vegetables in kitchen garden).	If gravity schemes are designed with only domestic water demands in mind, opportunities for income generation via irrigation may be missed ➔ given sufficient supply, consider development of Multiple Use Systems by adding additional storage facilities, e.g., irrigation ponds ( ) to capture surplus supply and domestic wastewater.

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

Left: Intake works for the Thanichaur canal irrigation scheme, Chhinchu VDC in the Surkhet district (LILI)

Right: Canal construction in seepage area for the Ringrinkhola scheme in the Ramechhap district (LILI)

Canal Irrigation Systems

Nepal – कुलो सिंचाई योजना

Construction and rehabilitation of canal irrigation systems for smallholder farmers in the mid-hills of Nepal.

The canal-fed irrigation systems presented here are a traditional irrigation technology built and managed by local farmers in Nepal. The canals carry water from small rivers, streams, and rivulets to the cultivable area. In contrast to pond irrigation systems (QT NEP 43, 42), gravity flow canals are usually located in lower and wetter areas of the mid-hills with subtropical climate conditions where landowners with comparatively larger command areas (on average 0.18 ha irrigated area per household) are living. During the rainy summer season, paddy is cultivated for the most part, while wheat is typically grown in the temperate winter.

While the pond irrigation systems are externally introduced in the generally more poor and water-scarce areas further uphill, canal schemes are mostly concerned with the rehabilitation of malfunctioning or non-functioning existing systems in the plains and valley floors. This concerns systems where either the damage exceeds the technical or financial capacity of the community to repair (e.g., extreme topography of channel alignments, intakes on rivers) or where problems in scheme management cannot be settled internally (e.g., water not available for tail end users). Malfunctioning systems often establish a vicious circle, where diminished water availability leads to lower cropping, which in turn results in reduced income and insufficient funds for rehabilitation. Command areas are often expanded while rehabilitating the system for the benefit of more disadvantaged/small farmholders.

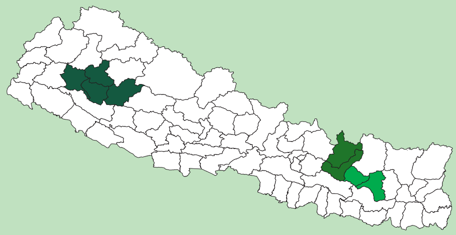
The following principles guide the construction/rehabilitation of the canal systems:

- **Minimum source yield:** The tapped water sources should guarantee at least 4,300 liters per Ropani per day (a Ropani is a Nepalese customary unit of measurement and is equivalent to 509 m^2) or roughly 85 m^3 per day per hectare. For the most part, the programme makes use of perennial water sources located uphill of the scheme. The minimum source yield is determined in the dry pre-monsoon months of April and May.
- **Mean irrigation demand:** Water demand for irrigation is subject to cropping patterns and employed irrigation methods. For the program's standardized design, the average water demand is presumed to be 500 liters per Ropani per day, equivalent to 1 $l/m^2/d$.
- **Peak demand:** Peak demand is assumed to be three times the average demand or 1,500 liters per Rop. and day.
- **Limited canal length:** Management and upkeep efforts increase considerably in systems with large canal networks. Therefore, the maximum total canal length is limited to 5 km per project.

Water sharing policy: As water availability is generally sufficient for the cultivated land in canal systems, the users often adopt policies which allocate water in proportion to the area under cultivation (see also QA NEP 41). By the same token, individual user fees for the operation and maintenance fund are set proportional to the allocated water and – by extension – also to the cultivated land.

While the rehabilitated systems show considerable variation in their salient features and specific components, the program's standardized design guidelines are reflected in the Design Manual for Small Scale Irrigation Schemes published by the Department of Local Infrastructure Development and Agricultural Roads (DoLIDAR). The standardized designs are adapted according to local needs and circumstances, namely local water availability, water requirements of the proposed crops, and agreed-upon operation rules with the farmers.

The rehabilitated irrigation schemes induce a rise in agricultural production in general and a distinct raise in cereal yields in particular, translating into a vital improvement in food sufficiency. In some places, staple cereals are partly replaced by vegetables, contributing to a healthier diet. Depending on market access, the increased production also allows farmers to sell part of the harvest and augment their income.



Location: Eight districts in the Central, Eastern, and Mid-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 40, 41

Related approach: QA NEP 41 and QA NEP 36

Compiled by: Lukas Egloff, Bhagat B. Bista, Susan Shakya

Date: June 2015

Comments: The canal irrigation systems described here are part of the irrigation measures planned and implemented within the Water Use Master Plan (WUMP) framework for poor communities in the rural mid-hills of Nepal.

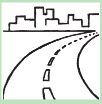
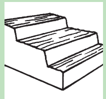
The technology was documented using the WOCAT (www.wocat.org) tool.

HELVETAS Swiss Intercooperation NEPAL ICIMOD WOCAT

Classification

Water use problems

- Growing water demand for both domestic and agricultural use and diminishing or fluctuating water supply due to climate and socioeconomic changes
- Lack of irrigation water and agricultural inputs result in poor agricultural productivity and food insecurity
- Breakdown of irrigation systems: a significant part of existing schemes in Nepal is not fully functional, indicating a lack of proper management and maintenance

Land use	Climate	Degradation	Conservation measure(s)
			
Settlements, infrastructure	Humid subtropics	Physical degradation: local water scarcity	Structural: canals

Stage of intervention	Origin	Level of technical knowledge
Prevention: insignificant Mitigation/reduction: insignificant Rehabilitation: high	Land users' initiative: 100 years ago: high Experiments/research: insignificant Externally introduced: insignificant	Field staff: high Land user: low

Main causes of local water scarcity

- **Natural causes:** temporary water scarcity during dry season; 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; lacking or malfunctioning infrastructure; increase in water demand due to progressively higher living standards and augmented agricultural production

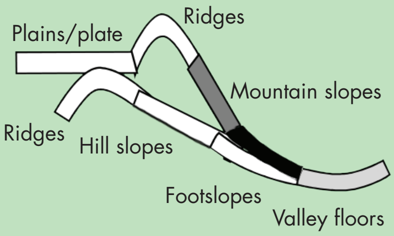
Main technical functions	Secondary technical functions	Legend
• improve access to irrigation water	• None	black: high dark grey: moderate light grey: low white: insignificant

Environment

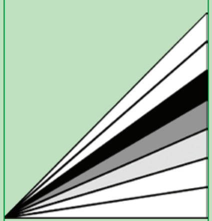
Natural environment

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

Landform

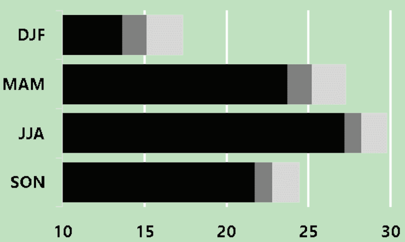


Slope (%)

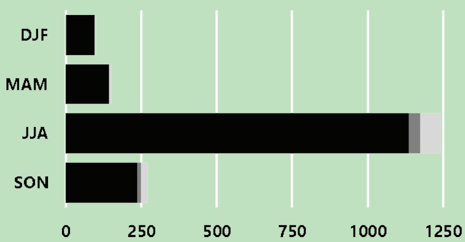


Climate change[1]

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

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

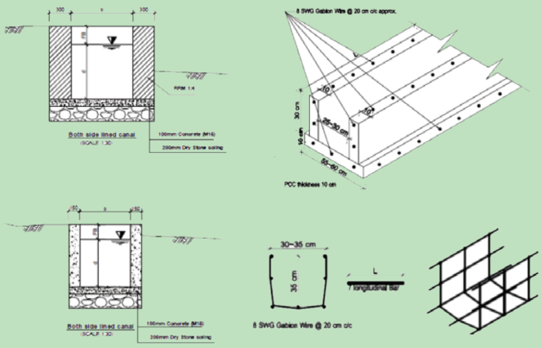
Sensitive to climatic extremes: temperature increase; seasonal rainfall increase/decrease; heavy rainfall events (intensities and amount); droughts/dry spells

If sensitive, what modifications were made/are possible: consider source conservation measures (QT NEP 48)

[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	**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 & transport, drinking water supply and sanitation **Market orientation:** mainly subsistence (self-supply)



Source: Design Manual for Small-Scale Irrigation Schemes published by DoLIDAR

Technical drawing

Canals for small-scale hill irrigation schemes.

Upper left: Typical cross-section of traditional masonry lined canals as implemented by the programme in 2006-2007. Challenges with the masonry lined systems included:

i) Thick walls (30 cm) result in a comparatively large width of whole structure (> 1m): requires more space and may create challenges for land acquisition
ii) Need for advanced professional skills, as tiling of wall requires very precise work
iii) Structure is more prone to cracks and leakage

Upper right and bottom row: Typical cross-section and sketches of concrete canals with minimal nominal reinforcement as implemented by the programme from 2008 onwards. Gabion wire is an economical and simple-to-transport reinforcement option. This canal structure features thinner walls (10-15 cm), requires less delicate construction works, and is more resilient to cracks and leakage.

Implementation Activities, Inputs, and Costs

Establishment activities

Establishment is usually carried out in the dry period under the supervision of local service providers using construction tools, which include measuring tape, spade, shovel, knife, hoe, hammer, trowel, and pan.

1. Site clearance and fixing of canal bed
2. Dry stone soiling (15 cm) of canal bed
3. 7.5 cm layer of lean plain cement concrete (1:3:6) over the stone soiling
4. 10 cm of reinforced cement concrete (1:2:4) at bed and sidewall. Eight Gauge GI wire is used as nominal reinforcement: seven bars in longitudinal direction along the canal alignment (see technical drawing above), which are tied vertically at 20 cm c/c spacing
5. Allow for canal outlets at appropriate locations
6. Fill and compact sides of canal with soil
7. Provide necessary auxiliary and protection works, e.g., retaining walls, gabion walls, cover slab, foot path along the canal alignment

Typical establishment inputs and costs for 100 m length of a concrete canal with minimal nominal reinforcement

Inputs	Costs (US$)[1]	% met by users
Skilled Labour (16 person days)	90	0
Unskilled Labour (80 person days)	280	15
Construction Materials		
Cement (4,500 kg)	700	0
8 Gauge GI wire (1,400 m)	150	0
Miscellaneous (nails, wood for form work)	100	0
Local Materials (costs reflect unskilled labour effort for collection and portering)		
Sand (7 m^3)	270	25
Aggregate (14 m^3)	350	75
Total	**1,940**	**19**

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

Maintenance/recurrent activities

1. Monitoring of structures (intakes, bridges, culverts, drop structures; regulating structures, outlets, retaining walls) by walking along the canal network
2. Minor repair and maintenance works

Maintenance/recurrent inputs and costs per household per year

Inputs	Costs (US$)	% met by users
Labour and equipment	7.5	100%
Total	**7.5**	**100%**

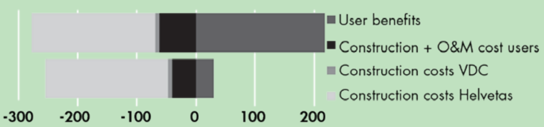
Remarks: The above cost breakdown is based on design cost estimates for the period from 2010 to 2014. Costs for portering and road transportation of non-local materials – very much subject to the remoteness of the project site – as well as project management costs were omitted. If feasible, non-local construction materials are procured by the community and paid by the programme. Village Development Committees (VDC) contribute on average about 3% to the overall costs. Community contribution to the overall costs (including project management and all transportation costs for non-local materials) is typically between 10% and 20%. This includes collection and portering of local materials (except sand), as well as unskilled labour work for trench digging, excavation, and construction supporting works. The programme reimburses the unskilled labour required for the construction of the intake structures and the idle length of the main canal. Total average investment costs per scheme amount to about USD 15,000.

In each scheme, a paid caretaker carries out the operation and maintenance activities. The O&M activities are financed out of the scheme's O&M fund, which is managed by the scheme's User Committee (see QA NEP 41). During scheme construction, cash equivalent to 3% of the scheme's total cost is raised for the O&M fund. Thereafter, users contribute with cash and food grain on a monthly basis to pay for the caretaker's salary and finance minor O&M works. Individual cash contributions range from USD 0.10 to 0.25 per Ropani per month. The individual user fees are proportional to the allocated water (and thus to the cultivated land).

Assessment

Impacts of the technology			
Production and socioeconomic benefits		**Production and socioeconomic disadvantages**	
+ + +	Increased irrigation water availability, enabling increased agricultural productivity and diversified crop patterns		Regular payments to O&M fund
+ +	Given established market access, surplus production can be sold to increase household income		
Sociocultural benefits		**Sociocultural disadvantages**	
+ +	Improved food security/self-sufficiency, more nutritious diet		None
+ +	Strengthened community spirit and fewer quarrels over water due to settled water distribution agreements		
Ecological benefits		**Ecological disadvantages**	
+ +	Increased soil moisture		None
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.		
+++: high / ++: medium / +: low			

Discounted economic costs and benefits per household (USD)



Assumptions

- **Average scheme cost per HH:** USD 250
- **Net average incremental benefit per ha and year:** USD 370. Assume benefit will be 50% in first year and 100% from second year onward
- **Average command area per HH:** 0.18 ha
- **Scheme life:** 10 years
- **O&M costs per HH:** USD 7.5 per year
- **Discount rate:** 10%

Under the above assumptions, the break-even point is reached after seven years. The net present value per HH (for an assumed lifetime of 10 years) is USD 76. The scheme has a Benefit/Cost Ratio of 1.26 and an Economic Internal Rate of Return (EIRR) of about 16%.

Acceptance/adoption

Canal-fed systems are traditional irrigation schemes built and operated by farmers, with some of the schemes being more than 100 years old. As such, acceptance of the rehabilitated systems was never an issue. More notably, the newly introduced water allocation mechanisms, which allot water in proportion to the area of cultivated land, are well adopted by most communities.

Concluding Statements

Strengths and ➔ how to sustain/improve	Weaknesses and ➔ how to overcome
The irrigation schemes can help the farmers in increasing their agricultural production and to cultivate a greater variety of crops ➔ support partial shift from cereals to high value but low water-demanding crops by linking farmers to agricultural service providers and develop their capacity to devise suitable post-construction cropping patterns and irrigation schedules	Due to failing O&M mechanisms, some schemes become partly or fully dysfunctional much ahead of their designed operational lifetime 41 ➔ ensure post-construction support and mentoring for the first couple of years 41, link canal systems to VDC/DDCs for long-term support
Concrete canals with minimal nominal reinforcement require less space (and thus ease land acquisition) and are more robust than traditional masonry-lined canals: 98% of the schemes are fully (87%) or partly (11%) functional three years after construction ➔ strengthen institutional mechanisms related to O&M and ensure that they remain active throughout the projected lifetime of each scheme 41	Maintenance and repair works may require substantial labour input, especially in delicate surroundings or complex structures (extreme topography of channel alignments, intakes on rivers) ➔ emphasize feelings of shared ownership during scheme rehabilitation; mutually establish O&M obligations in tailor-made water use policies
As crop patterns get more diverse, surplus cash crops and vegetables may be sold to increase the household income ➔ coordinate with other programs to help establish market access in remote regions; support collection and storing centers or processing facilities for vegetables	Conflicts may emerge when tails users receive less water than originally allotted due to diminishing water sources ➔ capacitate local service providers to help review and adapt water-sharing policies during follow-up visits
Gravity flow canal schemes are traditional systems. Farmers are familiar with these schemes and have experience in operation and maintenance ➔ build technical capacity of local service providers to support major repair works, which are beyond the communities' abilities	

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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Pond Irrigation System

Nepal – पोखरी सिंचाई योजना

Pond irrigation systems with plastic-lined ponds for smallholder farmers in water-scarce areas in the mid-hills of Nepal.

While traditional farmer-managed canal irrigation systems (QT NEP 41) are prevalent in the Nepal mid-hills, they tend to be located at accessible locations in the river valleys and terraced uplands. On the other hand, lacking irrigation facilities impedes the ability of farmers in higher-elevaation and water-scarce areas to enhance and diversify their agricultural production. The pond irrigation systems described here provide decentralized irrigation facilities which aim to increase agricultural productivity and create opportunities for diversification of cropping patterns for smallholder-farming households (on average 0.14 ha irrigated command area) in marginal areas of the mid-hills of Nepal.

Pond irrigation systems generally comprise the following parts: (i) intakes at one or several water sources, (ii) HDE pipes, which convey the extracted water, (iii) flow-regulating chambers, which distribute the water to one or several (iv) ponds; (v) water taps connected to the ponds serve as irrigation outlets. The system design adheres to the following principles:

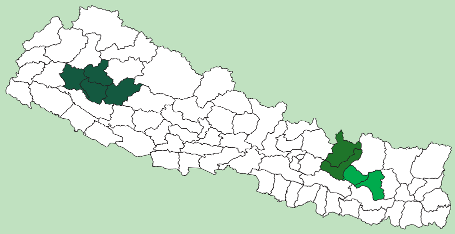
- **Minimum source yield:** The tapped water sources should guarantee at least 300 liters per Ropani per day (a Ropani is a Nepalese customary unit of measurement and is equivalent to 509 m^2). For the most part, the programme makes use of perennial spring water sources located uphill of the scheme. The minimum source yield is determined in the dry pre-monsoon months of April and May.
- **Mean irrigation demand:** Water demand for irrigation is subject to cropping patterns and employed irrigation methods. For the program's standardized pond design, the average water demand is presumed to be 500 liters per Ropani per day, equivalent to 1 $l/m^2/d$.
- **Peak demand:** Peak demand is assumed to be three times the average demand, or 1,500 liters per Rop. and day.
- **Limited pipe length:** Management and upkeep efforts increase considerably in systems with large pipe networks. Therefore, the maximum total pipe length is limited to 10 km.
- **Command Area Coverage:** Total irrigated areas connected to one pond range between 10 and 40 Ropani (0.5 – 2 ha).
- **Pond capacity:** Ponds are built in dimensions that either meet the peak demand for one day or can store two days' worth of average source yield (choosing the minimal volume of the two options). Ponds are implemented with capacities of 15 m^3, 30 m^3, 45 m^3, and 60 m^3.
- **Pond lining:** The excavated ponds are lined with Silpaulin sheets. This watertight, plastic-like material tends to become brittle when exposed to direct sunlight, i.e., when the ponds are empty. Jute bags filled with a soil-cement mixture (ratio of 10:1) cover and protect the plastic lining from direct exposure and other potentially damaging sources.
- **Pond fencing:** Barbed wire fencing prevents children and cattle from entering the pond area.
- **Water sharing policy:** Due to the water-scarce conditions, the water-sharing policies for ponds usually foresee the allocation of equal water volumes to all beneficiaries irrespective of the individual land holding (see also QA NEP 41).

The standardized designs are then adapted according to local needs and circumstances, namely local water availability, water requirements of the proposed crops, and agreed-upon pond operation rules with the farmers. A typical irrigation scheme consists of two to five ponds, each catering to three to five user households.

The irrigation schemes lead to an increase in agricultural production and a greater variety of crops, i.e., staple cereals are partly replaced by vegetables (cash crops). This contributes to both an increase in food sufficiency and a healthier diet. Depending on market access, the increased production allows farmers to sell part of the crops and augment their income.

Left: Pond construction in difficult terrain for the Mulkhola pond irrigation scheme, Sukatiya VDC, Kalikot district. (LILI)

Right: Pond excavation at Gortikhola Pond Irrigation Scheme, Kashikadh VDC, Dailekh District. (LILI)



Location: 8 districts in the Central, Eastern and Mid-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 43, 42

Related approach: QA NEP 41 and QA NEP 36

Compiled by: Lukas Egloff, Bhagat B. Bista, Susan Shakya

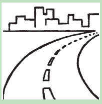
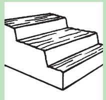
Date: June 2015

Comments: The here described pond irrigation systems are part of the irrigation measures planned and implemented within the Water Use Master Plan (WUMP) framework for poor communities in the rural mid-hills of Nepal.

Classification

Water use problems

- Growing water demand for both domestic and agricultural use and diminishing or fluctuating water supply due to climate and socioeconomic changes
- Water sources are intermittent and/or far away; households spend upward of two hours 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	Humid subtropics	Physical degradation: local water scarcity	Structural: canals

Stage of intervention	Origin	Level of technical knowledge
Prevention Mitigation/reduction Rehabilitation	Land users' initiative: 100 years ago Experiments/research Externally introduced: 10-50 years ago	Field staff Land user

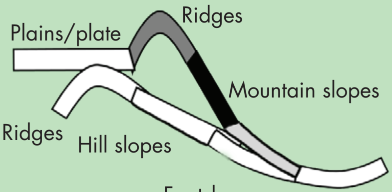
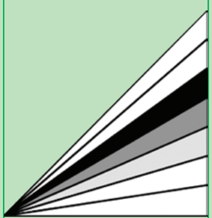
Main causes of local water scarcity

- **Natural causes:** temporary water scarcity during dry season; 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 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	• None	high moderate low insignificant

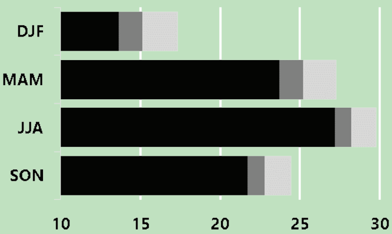
Environment

Natural environment

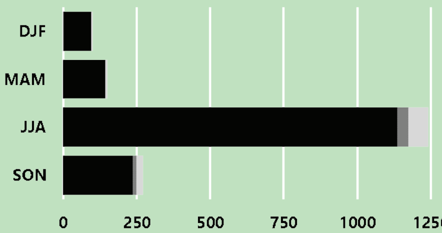
Average annual rainfall (mm)	Altitude (masl)	Landform	Slope (%)
>4000 3000-4000 2000-3000 1500-2000 1000-1500 750-1000 500-750 250-500 <250	>4000 3000-4000 2500-3000 2000-2500 1500-2000 1000-1500 500-1000 100-500 <100		 very steep (>60) steep (30-60) hilly (16-30) rolling (8-16) moderate (5-8) gentle (2-5) flat (0-2)

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; floods; decreasing length of growing period

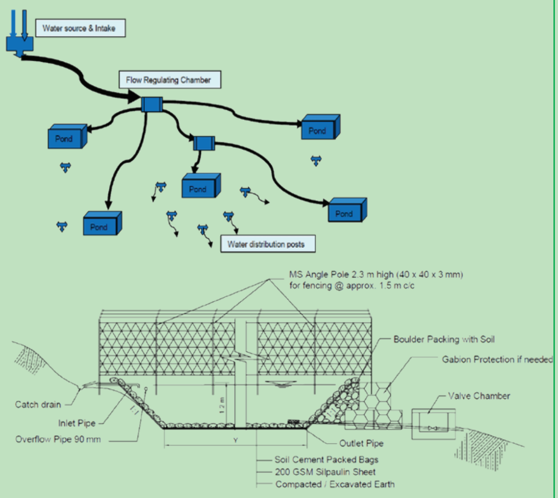
Sensitive to climatic extremes: temperature increase; seasonal rainfall increase/decrease; heavy rainfall events (intensities and amount); droughts/dry spells

If sensitive, what modifications were made/are possible: consider increasing storage volume and source 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 & transport, drinking water supply and sanitation **Market orientation:** mainly subsistence (self-supply)

Cropland per household (ha)	
■	<0.5
■	0.5-1
□	1-2
□	2-5
□	5-15
□	15-50
□	50-100



Technical drawing

Top: a typical pond irrigation system layout

Bottom: typical pond cross-section

Implementation Activities, Inputs, and Costs

Establishment activities

Establishment is carried out under the supervision of local service providers using construction tools, which include measuring tape, spade, shovel, knife, hoe, hammer, trowel, and pan. Establishment is carried out in the dry period and can be completed in five-six days.

1. Select a suitable, preferably flat, site with stable uphill slope conditions.
2. Site clearance; measure and outline pond area.
3. Excavate the pond, remove protruding stones.
4. Compact and smooth pond floor and walls.
5. Install inlet, outlet, and overflow pipes.
6. Spread clay paste on walls and floor to create a smooth surface.
7. Lay out the 200 GSM Silpaulin sheets without any folds over the pond, with overlapping at any joints.
8. Overlay fine soil on the plastic sheet.
9. Anchor the edges of the sheet at the rim of the pond with stones and soil.
10. Cover sheet with soil cement (10:1) -packed bags (jute or used cement bags).
11. Dig a catch drain on the uphill side with a two-way slope.
12. Add gabion protection on the downhill side (if needed).
13. Erect barbed wire fencing around the pond.

Typical establishment inputs and costs for a pond with 15 m³ capacity (for 5-9 households)

Inputs	Costs (US$)[1]	% met by users
Skilled Labour (4 person days)	20	0
Unskilled Labour (30 person days)	105	100
Construction Materials		
Cement (600 kg)	85	0
200 GSM Silpaulin sheet (49 m²)	60	0
MS angle poles (16 pieces)	65	0
Barbed wire (25 kg)	25	0
Jute bags (185 pieces)	85	0
Inlet, Outlet, Overflow pipe	50	0
Local Materials		
Sand and Aggregate	25	100
Excavated soil for filling of jute bags	350	100
Total	**530**	**26**

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

Maintenance/recurrent activities

1. Ensure year-round submergence of the pond.
2. Clean pond once or twice a year by removing the accumulated sediments.
3. Monitoring of structures (intake, distribution lines, flow-regulating chamber) by walking along the pipeline network.

Maintenance/recurrent inputs and costs per household per year

Inputs	Costs (US$)	% met by users
Labour and equipment	7	100%
Total	**7**	**100%**

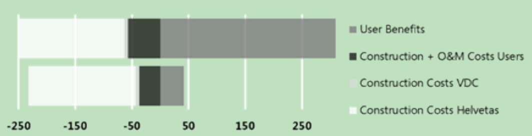
Remarks: The above cost breakdown is based on design cost estimates for the period from 2010 to 2014. Costs for portering and road transportation of non-local materials – very much subject to the remoteness of the project site – as well as project management costs were omitted. If feasible, non-local construction materials are procured by the community and paid by the programme. Village Development Committees (VDC) contribute on average about 3% to the overall costs. Community contribution to the overall costs (including project management and all transportation costs for non-local materials) is typically between 10% and 15%. This includes collection and portering of local materials, as well as unskilled labour work for trench digging, pond excavation, and supporting construction works. The programme reimburses the unskilled labour required for the construction of the intake structure and the idle length of the main pipe. Total average investment costs per scheme (including intake, transmission line, distribution chamber, and multiple ponds) amount to about USD 11,000, with costs for individual ponds ranging between USD 500 (15 m³) and USD 1,150 (60 m³). Construction of the main transmission pipe makes up about half of the total scheme costs.

In each scheme, a paid caretaker carries out the operation and maintenance activities. The O&M activities are financed out of the scheme's O&M fund, which is managed by the scheme's User Committee During scheme construction, cash equivalent to 3% of the scheme's total cost is raised for the O&M fund. Thereafter, users contribute cash and food grain on a monthly basis to pay for the caretaker's salary and finance O&M works. Individual cash contributions range from USD 0.1 to 0.25 per Ropani per month.

Assessment

Impacts of the technology			
Production and socioeconomic benefits		Production and socioeconomic disadvantages	
+ + +	Increased irrigation water availability, enabling increased agricultural productivity and diversified crop patterns	– –	Loss of land (to accommodate ponds)
+ +	Given established market access, irrigation of vegetables and cash crops can raise household income		
Sociocultural benefits		Sociocultural disadvantages	
+ +	Improved food security/self-sufficiency, more nutritious diet		None
+ +	Strengthened community spirit and fewer quarrels over water due to settled water distribution agreements		
Ecological benefits		Ecological disadvantages	
+ +	Increased soil moisture		
Off-site benefits		Off-site disadvantages	
+	Reduced risk of downstream flooding		
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.		
+++: high / ++: medium / +: low			

Discounted economic costs and benefits per household (USD)



Assumptions

- **Average scheme cost per HH:** USD 230
- **Net average incremental benefit per ha and year:** USD 675. Assume benefit will be 50% in first year and 100% from second year onward
- **Average command area per HH:** 0.14 ha
- **Scheme life:** 10 years
- **O&M costs per HH:** USD 7 per year
- **Discount rate:** 10%

Under the above assumptions, the break-even point is reached after four years. The net present value per HH (for an assumed lifetime of 10 years) is around USD 260. The scheme has a Benefit/Cost Ratio of 1.97 and an Economic Internal Rate of Return (EIRR) of about 30%.

Acceptance/adoption

Moreover, representatives of the community take a lead role in the detailed planning and implementation process and in the development of equitable water policies, resulting in a high acceptance rate of the technology; virtually all households are making use of their water ponds. In recent years, governmental agencies have started to replicate and promote pond irrigation schemes in other regions.

Concluding Statements

Strengths and ➔ how to sustain/improve	Weaknesses and ➔ how to overcome
The irrigation schemes can help the farmers increase their agricultural production and cultivate a greater variety of crops ➔ support partial shift from cereals to high-value but low water-demanding crops by linking farmers to agricultural service providers and develop their capacity to devise suitable post-construction cropping patterns and irrigation schedules	Due to failing O&M mechanisms, some schemes become partly or fully dysfunctional much ahead of their designed operational lifetime. Operation and Maintenance of pond irrigation systems differs substantially from traditional Nepalese canal irrigation systems; the user communities therefore require a lead time to get acquainted with the technology and to develop the capacity to look after the system independently ➔ ensure post-construction support and mentoring for the first couple of years; link pond systems to VDC/DDCs for long-term support
As crop patterns get more diverse, surplus cash crops and vegetables may be sold to increase the household income ➔ coordinate with other programs to help establish market access in remote regions; support collection and storing centers or processing facilities for vegetables	Big ponds (>150 m³) were noted to have higher failure rates caused by the development of cracks and faults on the pond walls and floor ➔ in later project stages, the programme stepped away from large ponds and turned toward implementing batteries of smaller ponds (30 m³ – 60 m³) in their stead
If market access and links to agricultural service providers are established, the associated economic benefits incentivize users to maintain their system ➔ consider promoting pond schemes primarily in areas with access to markets and agricultural services	In water-scarce areas and especially on ridgelines, it may prove impossible to find adequate perennial water sources in the vicinity of the community ➔ consider rainwater harvesting ponds or source conservation and recharge measures to increase source yields
Plastic-lined ponds are less costly and require less skill and workmanship to construct and maintain than masonry or concrete ponds. System defects can be corrected quickly and with comparatively low costs ➔ ensure good workmanship and system upkeep by capacitating the local service providers supporting the construction process, as well as the caretakers in charge of maintenance and repair activities	SILPAULIN sheets are often not available in local markets and are rather expensive for poor farmers, hampering repair works in case of punctured sheets ➔ consider subsidising sheets for poor communities; link pond communities to VDC/DDCs for long-term support

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

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:

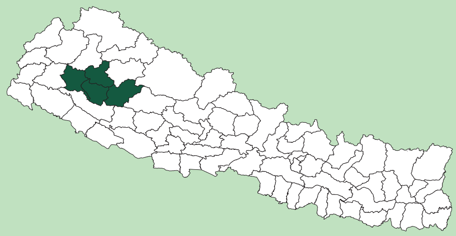
- **Location:** As ditches in the ground can cause inconveniences for the daily life of the community, they are dug wide of residential areas on grassland or in forests within the catchment area of the targeted spring water source. The positioning of the contour and eyebrow trenches is further guided 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

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

Date: June 2015

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.

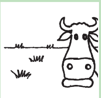
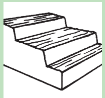
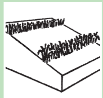
The technology was documented using the WOCAT (www.wocat.org) tool.

HELVETAS Swiss Intercooperation NEPAL   ICIMOD   WOCAT

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

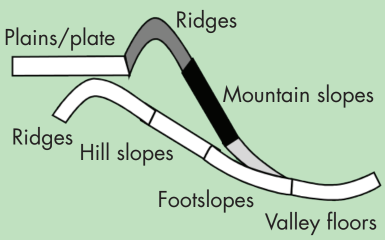
Main technical functions	**Secondary technical functions**	**Legend**
• improve access to irrigation water	• increase local soil moisture level	high moderate low insignificant

Environment

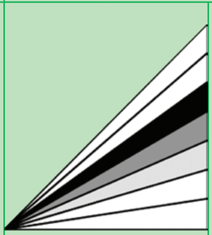
Natural environment

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

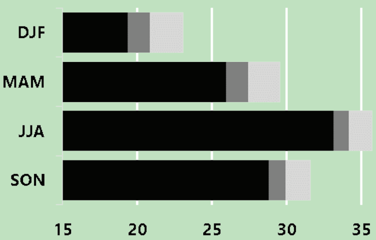


Slope (%)

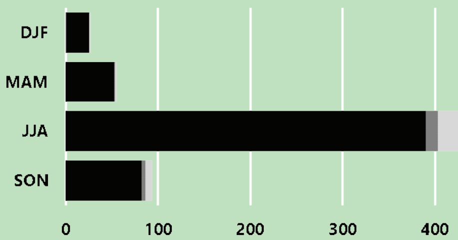


Climate change[1]

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

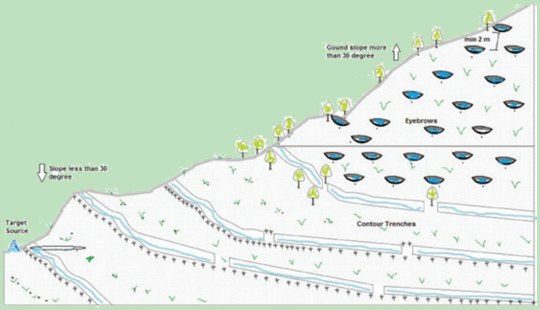
Human environment

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/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)



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

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

Multiple-use Water Sustems

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.

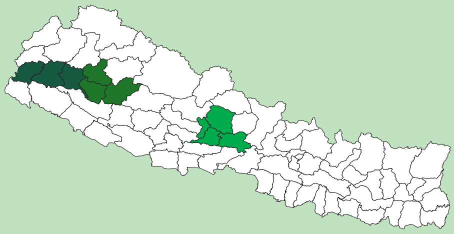
According to circumstances and the community's needs, MUS designs may assume the following elements:

- **"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.

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)



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

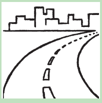
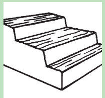
Comments: Multiple use water systems are a variation of gravity flow water supply and rainwater harvesting schemes which are planned and implemented within the Water Use Master Plan (WUMP) framework for poor communities in the rural mid-hills of Nepal.

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	Land users' initiative:	Field staff
Mitigation/reduction	Experiments/research	Land user
Rehabilitation	Externally introduced: 10-50 years ago	

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

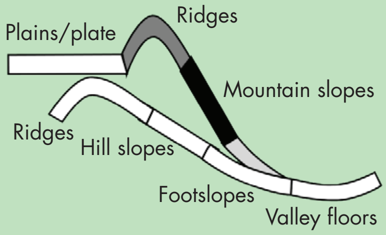
- high
- moderate
- low
- insignificant

Environment

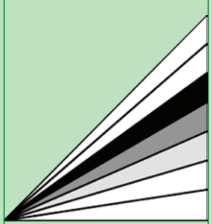
Natural environment

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

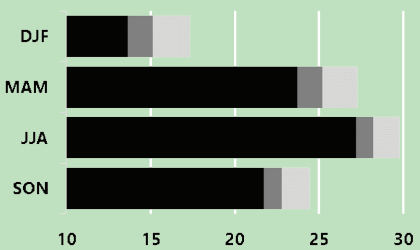


Slope (%)

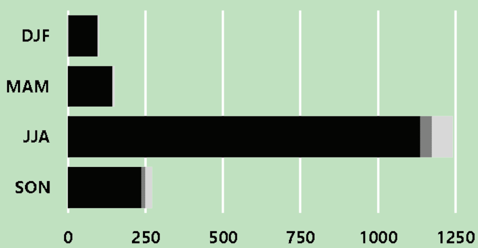


Climate change[1]

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: 1976 - 2005
Future climate: 2020 - 2039
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

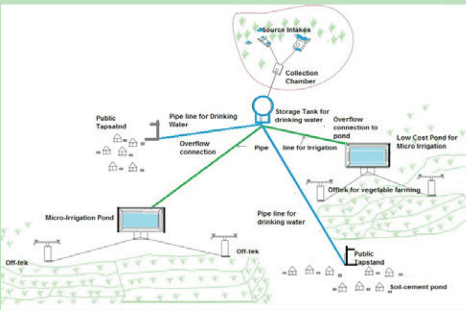
Human environment

Cropland per household (ha)

■	<0.5
■	0.5-1
□	1-2
□	2-5
□	5-15
□	15-50
□	50-100

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)



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

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Madan R. Bhatta, Programme Manager, Tel: +977 1 5524926; 9858051902 (M), HELVETAS Swiss Intercooperation Nepal, madan.bhatta@helvetas.org

Community Recharge Ponds

Nepal – सामुदायिक पुर्नभरण पोखरी

Unlined earthen community recharge ponds in the rural mid-hills of Nepal.

The climate of the Nepal mid-hills is characterized by a four-month rainy season (monsoon from June to September) confined by comparatively dry pre- and post-monsoon periods. This temporal precipitation pattern gives rise to dwindling surface, spring, and ground water sources toward the end of the dry season. Induced by decreasing groundwater levels, spring sources in elevated areas tend to be particularly prone to rapid depletion and early dry-up, causing severe water shortages in uphill regions. As a result, domestic water supply is often not adequate, i.e., sources are remote or intermittent and households spend on average two hours per day on fetching water, with a significant portion spent on queuing up at water sources. Climate change may further aggravate local water scarcity by accentuating variations in seasonal precipitation.

Multi-purpose recharge ponds represent a low-cost option to partly reconcile temporal imbalances in water supply on a local scale by replenishing natural soil moisture and ground water reservoirs, thus storing excess precipitation water for the dry season. Besides refuelling underground storage and recharging spring water sources, the collected water may also be used immediately for irrigation, watering animals, or domestic purposes like the washing of clothes. Furthermore, reduced surface runoff and increased percolation may reduce the downstream risk of flooding and landslides.

While the dimensions and specifications of the excavated earthen ponds are adapted to local conditions, they share some common characteristics:

- **Implementation on community level:** Ponds serve multiple households and are of a larger size than private ponds, with storage capacities between 60 and 1,500 m³.
- **Unlined pond walls and floors:** To enhance percolation and recharge of the surrounding ground.
- **Slope stabilization:** The pond outline is protected with a grass cover (local species like Dubo, Cynodondactylon or Napier, pennisetum purpureum) and a low masonry wall to reduce surface flow velocity, control erosion, and minimize soil deposition in the pond.
- **Selection of location:** Pond locations are selected according to the local terrain (natural depressions, existing conventional rural ponds) and their designated purposes (soil moisture recharge of adjacent agricultural fields, recharge of downhill spring water sources, irrigation, cattle watering). Where needed, life fencing keeps small children from falling into the pond, while ramps enable pond access for cattle to water and wallow.

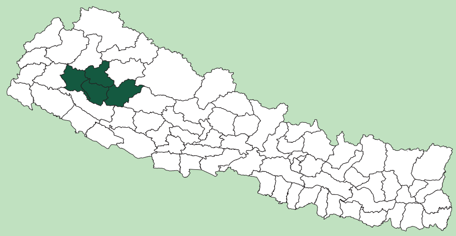
The recharge ponds implemented by the programme can be grouped as follows:

- **New earthen unlined ponds:** Newly excavated regular ponds
- **Improvement of conventional ponds:** Improvement of existing ponds usually involves increasing the ponds' storage capacity and implementing erosion control measures on the pond outline
- **Road-drainage ponds:** Constructed near sealed roads in sloping terrain, these ponds collect the roads' drainage water and are usually larger, due to their more extensive catchment area

The target group of the technology are financially and socially deprived communities, living mostly from subsistence farming in the Nepal mid-hills. The community's in-kind contribution amounts to about half of the necessary excavation works, which are carried out by manual labour with shovels and picks. The programme pays for skilled labour input, required for the erection of low masonry walls along the pond outline.

Left: Unlined earthen road harvesting pond in Dailekh district with a storage capacity of ~1,500 m³ (WARM-P)

Right: Unlined earthen recharge pond in Dailekh district with a storage capacity of 60 m³ (WARM-P)



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

Technology area: per pond 1–10 km²

Conservation measure(s): Structural, (Vegetative)

Land use type: Extensive grazing land

Climate: Humid subtropical

WOCAT database reference: QT NEP 45

Related approach: QA NEP 36

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

Date: June 2015

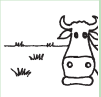
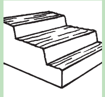
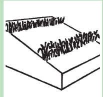
Comments: The community recharge ponds described here complement gravity flow water supply schemes (QT NEP 40) and are part of the water supply measures planned and implemented within the Water Use Master Plan (WUMP) framework for poor communities in the rural mid-hills of Nepal.

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

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 in uphill areas are often intermittent and prone to rapid depletion and early dry-up during the dry season; households spend upwards of two hours per day on water fetching and queuing at the water source
- Water sources can be compromised by floods and landslides

Land use	Climate	Degradation		Conservation measure(s)	
					
Extensive grazing land	Humid subtropics	Physical degradation: Decline of water quantity	Water erosion: loss of topsoil by water; gully erosion	Structural: excavation of earthen ponds, masonry walls along outline	Vegetative: plantation along pond outline

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

Main causes of local water scarcity

- **Natural causes:** temporary water scarcity during hot dry season (Dec.-May); 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
- increase local soil moisture level
- reduce surface runoff and soil erosion
- water storage for irrigation and cattle watering

Secondary technical functions

- reduce downstream risk of flooding and landslides

Legend

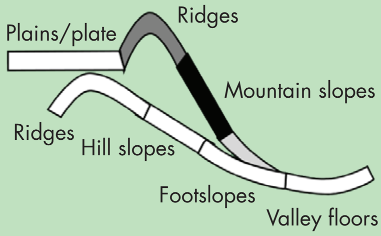
- high
- moderate
- low
- insignificant

Environment

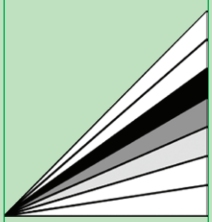
Natural environment

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

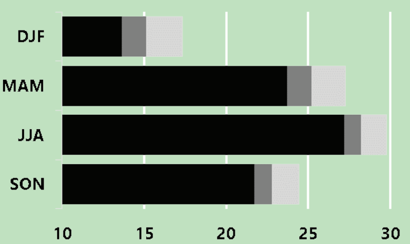


Slope (%)

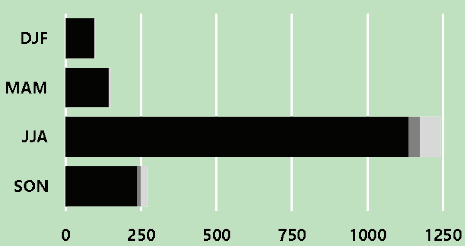


Climate change[1]

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

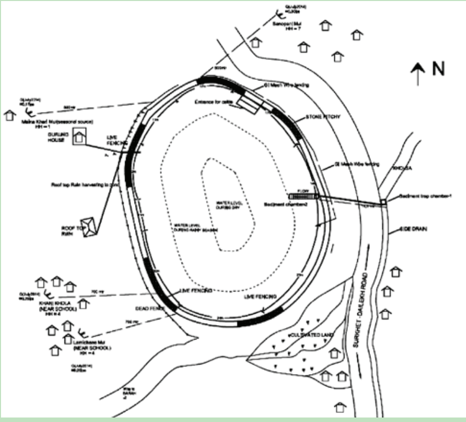
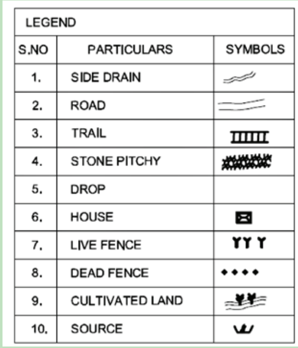
Historical climate: 2001 - 2010
Future climate: 2020 - 2039
Future climate: 2040 - 2059

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

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)	**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)
<0.5 0.5-1 1-2 2-5 5-15 15-50 50-100 100-500		**Technical drawing** Schematic of a road water harvesting recharge pond. 

Implementation Activities, Inputs, and Costs

Establishment activities

Establishment is carried out under the supervision of field staff using shovels and picks. Establishment is carried out in the dry period and can be completed in one to two weeks. The major establishment steps are as follows:

1. Clear the pond area of all undesired vegetation.
2. Outline the proposed pond shape with stakes.
3. Dig out the pond pit with shovels and picks. Deposit the soil on the shoulder around the pond, beginning with the lower side. Make sure that the side slopes remain stable by compacting the soil in layers.
4. Dig small drainage channels in the uphill area to direct runoff into the pond.
5. Foresee a spillway for overflow during heavy precipitation events.
6. Plant grass and shrubs as a surface cover on the fresh soil deposit (= live fencing)

Total establishment costs and inputs for a medium-sized recharge pond (60 m^3).

Inputs	Costs (US$)[1]	% met by users
Unskilled Labour (105 person days)	370	40
100 local grass seedlings (Dubo or Napier)	35	100
Bamboo for live fencing (30 pieces)	1	100
Construction tools (shovels and picks)	15	0
Total	**3,510**	**58**

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

Maintenance/recurrent activities

1. Cleaning pond floor of deposited sediment (at least every second year)
2. Maintenance of side slopes to prevent them from collapsing and repair of fencing (annually)
3. Fostering of seedlings, especially in the first few years.

Maintenance/recurrent inputs and costs per year (for above pond)

Inputs	Costs (US$)	% met by users
Labour (4 person days)	14	100%
Total	**14**	**100%**

Remarks: The above cost breakdown is based on the analysis of one medium-sized recharge pond implemented in 2014-15. Community contributions to the establishment costs typically range between 40% and 50%.

Assessment

Impacts of the technology			
Production and socioeconomic benefits		**Production and socioeconomic disadvantages**	
+ +	Improved water availability due to increased source recharge rates	– –	Loss of land for livestock grazing
+	Improved agricultural productivity due to increased soil moisture levels		
Sociocultural benefits		**Sociocultural disadvantages**	
+	Reduced incidents of water-borne diseases due to more reliable water access		None
Ecological benefits		**Ecological disadvantages**	
+ + +	Increased water infiltration and source recharge rates		None
+ + +	Increased soil moisture level in adjacent fields		
+ + +	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		
+++: high / ++: medium / +: low			

Analysis of benefits and costs	Benefits compared with costs	short-term	long-term
Recharge ponds 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. In contrast, maintenance activities are not seen as a big issue.	Establishment Maintenance/recurrent	negative neutral	as yet unknown as yet unknown

Acceptance/adoption

The implemented recharge ponds 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 implemented technologies. In principle, the combination of low-cost and low-tech facilitates the adoption by other communities. However, medium- to large-sized community ponds require substantial labour input, which only few communities are willing or able to put up by themselves. Replication by community members is generally observed on a smaller scale (pond size <10 m^3), i.e., on the household level with recharge ponds for surplus or wastewater fuelling kitchen gardens.

Concluding Statements

Strengths and ➔ how to sustain/improve	Weaknesses and ➔ how to overcome
The multi-purpose nature of recharge ponds allows customized designs, which may account for a variety of local needs and requirements (spring and soil moisture recharge, irrigation, cattle watering) ➔ careful analysis of local conditions and a participatory planning approach are vital to identify favourable pond locations and set-ups	Impact appraisals of recharge ponds prior to intervention are challenging, with geological conditions often unknown and seepage and percolation rates difficult to predict ➔ regard and employ recharge ponds as auxiliary measures with mid- to long-term impacts, which may evolve over time (e.g., infiltration rates may decrease with time due to colmatation of the pond floor)
Recharge ponds are straightforward to construct and maintain; especially smaller private ponds can be excavated by community members themselves ➔ in addition to building community ponds, consider showcasing the benefits of smaller ponds by building a few demonstration ponds on the household level	Ponds provide a potential breeding habitat for mosquitos and pose a danger to small children ➔ regular cleaning of pond scum keeps mosquito numbers in check while life fencing prevents small children from falling into the pond
Augmenting soil moisture levels by facilitating seepage into the surrounding soil not only increases agricultural productivity but also alleviates climate change impacts by building resilience to cope with flood and drought episodes ➔ adopt a more holistic "landscape" view and combine (multiple) recharge ponds with other conservation measures	Large ponds in steep terrain may break and flood/erode downhill areas ➔ reduce pond size in steep terrain; consider contour trenches and eyebrow basins); ensure regular maintenance of side slopes

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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Rooftop Rainwater Harvesting System with Ferro-cement Jars

Nepal – आकाशे पानी संकलन प्रणाली

Rooftop rainwater harvesting system with ferro-cement water jars for individual households.

The vast majority of the rural drinking water schemes in Nepal are gravity flow water supply schemes (QT NEP 40). However, in some cases, there is no feasible way to provide year-round access to safe water sources with gravity systems. This is the challenge in elevated and scattered settlements in hilly areas, where the technical and financial feasibility of gravity supply schemes is challenged by topography, as well as isolated individual households. By the same token, insufficient (seasonal) water yield or compromised water quality of accessible surface and ground water sources may render gravity supply schemes less viable. In these settings, rainwater harvesting systems can complement or temporarily replace other water sources.

Accordingly, the primary targeted group of the technology at hand are financially and socially deprived communities, living mostly from subsistence farming in areas of the Nepal mid-hills, where gravity schemes are deemed unfeasible. While average annual precipitation in this region amounts to about 1,600 mm, it features high inter-annual variability, including a pronounced dry season. As a result, many water sources, especially in higher elevated regions along ridgelines, dry up substantially in the dry summer months. In contrast, during the monsoon season, there is a risk of deterioration of spring water quality.

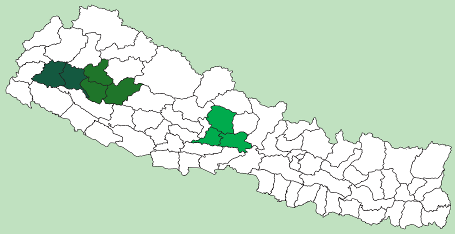
Roof rainwater harvesting systems, rather than representing an autarkic source of water supply, supplement existing surface and groundwater sources. They thereby reduce the need to fetch water from remote springs and help to alleviate temporal or spatial water scarcity. More specifically, they are designed toward bridging the peak dry season by providing enough storage capacity for a family of six to meet their very basic needs. The harvested water is mainly used as drinking water, but also serves other domestic needs. The employed design package aims at balancing long-term functionality with cost-efficient materials:

- **Catchment area:** Corrugated galvanized iron (CGI) sheets with a minimal surface area of 15 m^2 serve as catchment areas. CGI ensures minimal collection losses and remains corrosion-free over long time periods.
- **Conveyance system:** HDPE pipes (roof gutter and downpipes) collect and transport the roof water to the storage tank.
- **First flush diverter:** An extra HDPE pipe is installed between the roof gutter and the storage jar and prevents the initial batch of collected and presumably polluted roof rainwater from entering the tank during precipitation events.
- **Reservoir tank:** Ferro-cement jars with a volume of 6.5 m^3 serve as storage facilities. Ferro-cement represents an economic alternative to storage tanks made of block work, reinforced concrete, or masonry. Given proper maintenance, the jars reach operational lifetimes of more than 20 years. In this configuration, the average supply of one jar is 55 l per day. If only used for the peak dry period (March–May), the stored volume allows for 220 l per day.

During the implementation process, one to two rainwater harvesting workers ("mistri" in Nepali) are capacitated in each scheme to support construction and carrying out maintenance works later on. The sturdy design of the ferro-cement jars results in simplified operation and very low O&M costs. Combined with enhanced feelings of ownership (jars are the personal property of the respective households) it supports the system's longevity. The implementation of RWH systems is usually combined with hygiene and sanitation awareness promotion, as well as technical support for the construction of toilets, changs, and garbage pits (see QA NEP 42).

Left: An installed household rainwater harvesting system in Dailekh (WARM-P)

Right: Construction of rainwater jars where capacitated service providers and the beneficiaries join forces (WARM-P)



Location: Eight 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 46

Related approach: QA NEP 36

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

Date: June 2015

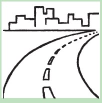
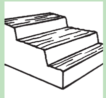
Comments: Rooftop rainwater harvesting systems are part of the water supply measures planned and implemented within the Water Use Master Plan (WUMP) framework for poor communities in the rural mid-hills of Nepal.

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

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 upward of two hours on water fetching

Land use	Climate	Degradation	Conservation measure(s)
			
Settlements, Infrastructure	Humid subtropics	Physical degradation: Local water scarcity	Structural: jar

Stage of intervention	Origin	Level of technical knowledge
Prevention	Land users' initiative:	Field staff [high]
Mitigation/reduction [high]	Experiments/research	Land user [low]
Rehabilitation	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 increase in temperature
- **Human-induced causes:** poor water governance; lack of infrastructure; increase in water demand due to to progressively higher living standards and augmented agricultural production

Main technical functions

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

Secondary technical functions

- none

Legend

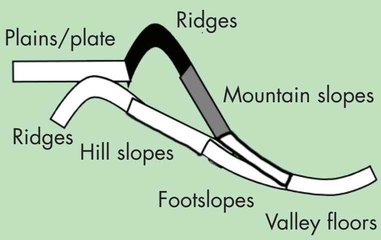
- high
- moderate
- low
- insignificant

- Gravity flow or pump systems are often either unfeasible or too costly for elevated and scattered settlements in hilly areas

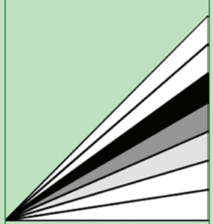
Natural environment

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

Landform

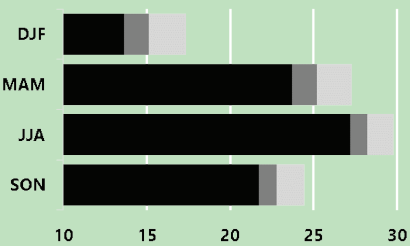


Slope (%)

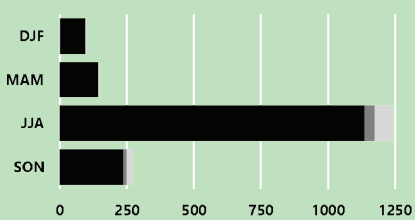


Climate change[1]

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 - 2039
Future climate:	2020 - 2039
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

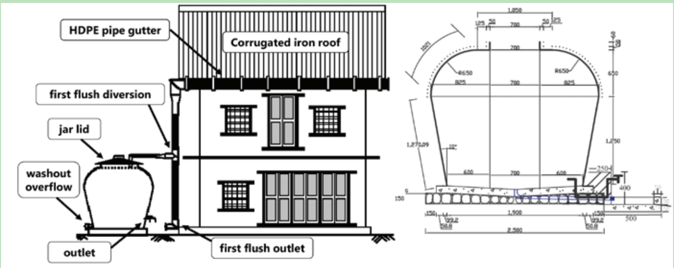
If sensitive, what modifications were made/are possible: increase storage volume (e.g., by adding overflow pond)

[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)

Cropland per household (ha): <0.5; 0.5-1; 1-2; 2-5; 5-15; 15-50; 50-100; 100-500



Technical drawing

Left: System overview

Right: Close-up of ferro-cement jar

[scale in mm]

Environment

Establishment activities

Provided all materials are available, construction is completed in about three to four weeks.

1. Selection of suitable site; site clearance
2. Stone soling (15 cm) with sand packing in a circular area of 2.5 m diameter.
3. Prepare and bend the steel rod for the base plate.
4. Construct the concrete base plate (10 cm; cement to sand-to-aggregate ratio of 1:1.5:3) while placing proper fittings for the washout overflow and the outlet. Finish with cement curing of base.
5. Bend reinforcement bars (Ø 8mm); attach them to the base plate and the circular rod on top. Form the main mould with the HDPE 32mm 6kg/cm² pipes.
6. Adjust and fit in the lip mould.
7. Wrap chicken wire mesh over the mould and tie with thin wire.
8. Apply a coat of cement sand on the outer surface (2 cm; cement-to-sand ratio of 1:3). Cover with plastic sheets to retain plastering moisture while curing.
9. Apply second coat of plastering (1.25 cm; cement-to-sand ratio of 1:3), followed by a curing period of at least five days while covering the cement with a damp cloth.
10. Meanwhile, carry out gutter and pipe fitting; including the flush pipe.
11. Remove shuttering, clean the inner side, and apply inner plastering (2 cm; cement-to-sand ratio of 1:3).
12. Cover the jar with damp jute bag to allow for cement curing for up to 14 days.
13. Remove the curing jute, clean the jar interior, and apply a white cement paitning on the outside.

Typical establishment inputs and costs per jar (2014)

Inputs	**Costs (US$)[1]**	**% met by users**
Skilled Labour (19 person days)	100	0
Unskilled Labour (24 person days)	85	100
Tools (137 USD per Toolset useable for up to 100 jars)	1	0
Construction Materials		
• Cement (750 kg)	110	0
• Chicken wire mesh (32 m), plain wire, binding wire	65	0
• Metal jar cover	15	0
• HDPE pipes for gutter and mold	30	0
• GI pipes, fittings and valves	20	0
• Plastic sheet and PVC screen	45	0
• Corrugated iron sheet (roofing)	80	0
• Reinforcement bar (Ø 8mm)	20	0
• Mould, gutter nails, thread cuttings, paint, waterproof compound	10	0
Local Materials (costs reflect unskilled labour effort for collection and portering)		
• Stone (0.94 m³)	10	100
• Sand (1.25 m³)	45	100
• Aggregate (0.5 m³)	15	100
• Bamboo	1	100
Total	**650**	**24**

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

Maintenance/recurrent activities

1. Cleaning jar once or twice a year
2. Cleaning the roof by flushing away the dirt after long dry periods
3. Emptying the first flush diverter of contaminated water after rainfall events

Maintenance/recurrent inputs and costs per year (for above pond)

Inputs	**Costs (US$)**	**% met by users**
Labour (5 person days)	18	100%
Total	**148**	**100%**

Implementation Activities, Inputs, and Costs

Remarks: The above cost breakdown is based on the analysis of 400 jars implemented in 12 schemes 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. Village Development Committees (VDC) finance the roof CGI sheets, which make up about 10% of the overall costs. Community contribution to the overall costs (including project management and all transportation costs for non-local materials) is typically between 20% and 25%.

Most operation and maintenance activities are carried out by the users themselves. Repair works are taken over by rainwater harvesting mistris ("mistri" is a Nepali word meaning a skilled worker) and are generally paid for by the users on an individual basis. In a few schemes where an O&M fund was introduced, repair works are financed out of the fund, which is managed by the scheme's User Committee.

Assessment

Impacts of the technology			
Production and socioeconomic benefits		**Production and socioeconomic disadvantages**	
+ +	Increased drinking/household water availability (~20 m³ per year)	–	Loss of land (to accommodate jar)
+ +	Decreased workload; reduced time for water fetching (on average two hours per day per jar)	–	Regular payments to O&M fund
Sociocultural benefits		**Sociocultural disadvantages**	
+ +	Significant reduction of reported incidents of water-borne diseases due to improved water supply		None
+ +	Increased school attendance of children		
Ecological benefits		**Ecological disadvantages**	
+ + +	Improved harvesting/collection of water		None
Off-site benefits		**Off-site disadvantages**	
+	Neighbors may benefit from stored water during dry periods as well		None
Contribution to human well-being/livelihoods			
+ + +	Decreased workload due to reduced time for water fetching: on average two hours per day per household. The saved time is reported to be spent on livestock raising, vegetable cultivation, and household chores.		
+++: high / ++: medium / +: low			

Economic costs and benefits per household (USD)	**Assumptions**
	▪ Saved time: two hours per day per household; assume that half of the saved time is spent on productive activities ▪ Local rate for one person day (eight hours) of unskilled labour: USD 3.5 O&M costs: USD 18 per year (~3% of total construction costs per year) ▪ Discount rate: 10%
Under the above assumptions, the break-even point is reached after 6.5 years. The net present value per HH (for an assumed lifetime of 20 years) is around USD 550 . The scheme has a Benefit/Cost Ratio of 1.7 and an Economic Internal Rate of Return (EIRR) of 21%. While establishment costs are too high for most poor communities to bear by themselves, O&M expenses are generally paid by the users. Economic benefits may increase further if surplus water is stored in irrigation ponds (QT NEP 42) and used for irrigation of vegetables.	

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 their water jar. On the other hand, 6.5 m³ jars 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**
The stored water represents enough supply for the whole household to bridge the peak dry season, thus providing temporary independence of other water sources ➔ ensure that the increased household water supply results in improved health outcomes by combining jar construction with hygiene awareness, as well as household water treatment and storage education campaigns	High costs: water jar technology is more expensive than, for example, a gravity supply system (USD ~650 vs. USD ~250 per household), making it too expensive for poor households to afford by themselves, which is reflected in low adoption rates ➔ (i) scale of implementation is crucial to profit from bulk acquisition; (ii) secure additional funding by disseminating and marketing WUMP); (iii) microfinance or governmental subsidy schemes may represent an additional funding source
As women and children are predominantly responsible for water fetching, less dependence on remote water sources reduces their workload and frees up time for other activities. The saved time resulted in higher school attendance and is reported to be spent on productive activities, household chores, child care, and rest ➔ consider how additional (income) opportunities could be seized (e.g., cultivation of vegetables in kitchen garden)	The supplied water can only partially fulfill domestic water demands. Households are thus still dependent on possibly remote, polluted, and/or intermittent ground and surface water sources ➔ (i) preserve/increase yield of existing sources by implementing source conservation and improvement measures); (ii) consider solar lifting schemes to cater to communities where gravity flow systems are not feasible; (iii) increase irrigational water supply by expanding rainwater harvesting with irrigation ponds)
Sturdy and fail-safe structure: 95% of the jars are functional five to ten years after construction, with a potential lifetime of more than 20 years ➔ Ensure adequate maintenance to keep schemes functional over the whole lifespan by fostering local ownership, capacitating local maintenance workers and user committees, and installing an operation and maintenance fund	The quality of the stored water may be compromised if the jar is not operated prudently ➔ Maximize quality of stored water by educating users on operational measures such as first flush diversion, cleaning of roof and gutter after long dry spells, or annual cleaning of the jar. Raise HWTS awareness and promote treatment methods such as SODIS, filtering, or boiling of water.

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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Soil-Ferro Cement Retention Ponds

Nepal – स्वायल-फेरो सिमेन्ट पुर्नधारण पोखरी

Soil-ferro cement water retention ponds for individual households.

Soil-ferro cement ponds with ferro-cement lining complement rooftop rainwater harvesting (RWH) jars at the household level (QT NEP 46) by adding storage facilities which retain overflow and waste water from the water jars, as well as from additional roof catchments. Consistent with the application area of the ferro cement jars, the retention ponds are implemented primarily in poor, water-scarce areas of the Nepal mid-hills, where gravity flow systems (QT NEP 40) are deemed unfeasible on technical or financial grounds. Although generally attached to rainwater jars, rooftop rainwater harvesting systems with soil-ferro cement ponds can also be implemented as a stand-alone technology to enable small-scale irrigated agriculture and provide (additional) water for livestock and sanitation purposes in water-short areas. When implemented independently, water from spring sources may be tapped instead or in addition to rainwater. Most of the households make use of the stored pond water by cultivating small vegetable gardens.

The primary targeted group of this technology is financially and socially deprived communities, living mostly from subsistence farming. Even though average annual precipitation in the project area amounts to about 1,600 mm, it features high inter-annual variability, including a pronounced dry season. As a result, many water sources, especially in higher elevated regions, along ridgelines dry up substantially in the dry summer months.

While the stored water in the ferro-cement jars (storage volume of 6.5 m^3) alleviates the most serious hardship related to water scarcity, the supplied water (on average 55 l/day per jar) can only partially fulfill domestic water demands. Households are thus still dependent on possibly remote and/or intermittent ground and surface water sources. The additional storage volume provided by the retention ponds reduces the need to fetch water for irrigation purposes during dry periods, thus freeing up other water sources (springs, jars) for more domestic use.

The designated pond volume of 3 m^3 is based on irrigational water supply requirements for a kitchen garden of 50 m^2. To reliably fill and utilize the ponds to their maximum storage capacity of 3 m^3, the roof catchment area attached to the pond should span at least 8 m^2, thus providing – on average – 30 l per day. Corrugated galvanized iron (CGI) sheets are used as roof catchment surfaces, ensuring minimal collection losses and remaining corrosion-free over long time periods. HDPE pipes (roof gutter and downpipes) then collect and transport the roof water to the rectangular-shaped retention pond.

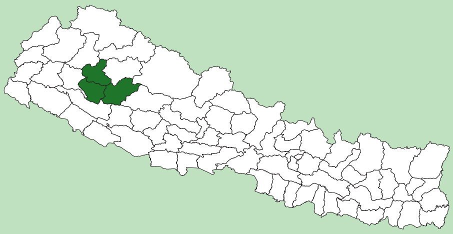
The well-compacted walls of the excavated pond are plastered with a thin base layer of soil-cement. Then, a ferro-cement lining – a mixture of Portland cement and sand reinforced with layers of chicken wire mesh – is applied. While ferro-cement is more expensive, it also makes for a more durable pond lining than plastic varieties, which become especially vulnerable if the ponds are left empty (QT NEP 42). Concurrently, the ferro-cement lining minimizes seepage and comes with low required maintenance, which is mainly limited to removing accumulated sediments and preventing livestock and humans from entering the pond.

Capacitated local village workers) chiefly manage the establishment of the ponds. The community contributes with local materials and by carrying out all unskilled labor works, whereas the programme covers expenses related to skilled labor works, as well as procurement and road transportation of non-local construction materials.

To facilitate irrigation projects on a community level, larger soil-ferro cement ponds with storage volumes of 6 or 10 m^3 are implemented occasionally. In this case, pond dimensioning is guided by the amount of surplus water (e.g., from gravity flow schemes) and the irrigated area.

Left: Roof rainwater harvesting jar (QT NEP 46) with attached rainwater harvesting pond, which retains excess water. (WARM-P)

Right: Rainwater harvesting pond with roof catchment area. (WARM-P)



Location: Three districts in the Mid-Western Development Region of Nepal: Dailekh, Jajarkot, and Kalikot

Conservation measure(s): Structural

Land use type: Settlements

Climate: Humid subtropical

WOCAT database reference: QT NEP 47

Related approach: QA NEP 36

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

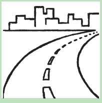
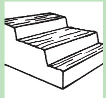
Date: June 2015

Comments: Rooftop rainwater harvesting ponds are an add-on to the ferro-cement jar technology and are 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.

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 upward of two hours on water fetching
- Need for a water storage technology on the household level which strikes a balance between cost and durability

Land use	Climate	Degradation	Conservation measure(s)
			
Settlements, Infrastructure	Humid subtropics	Physical degradation: Local water scarcity	Structural: pond

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

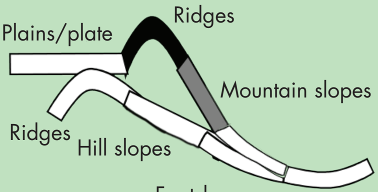
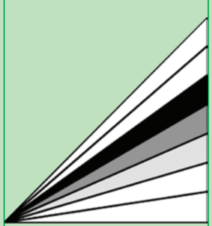
Main causes of local water scarcity

- **Natural causes:** temporary water scarcity during dry season (Dec.-May); 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 to progressively higher living standards and augmented agricultural production

Main technical functions	Secondary technical functions	Legend
• improve water access and increase water supply	• none	high moderate low insignificant

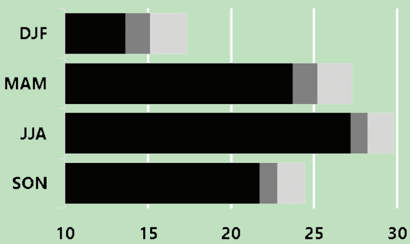
Environment

Natural environment

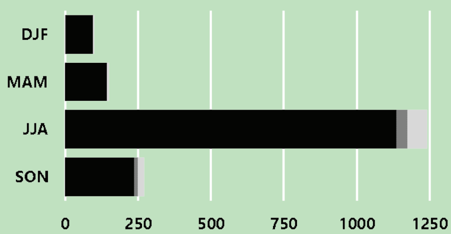
Average annual rainfall (mm)	Altitude (masl)	Landform	Slope (%)
>4000 3000-4000 2000-3000 1500-2000 1000-1500 750-1000 500-750 250-500 <250	>4000 3000-4000 2500-3000 2000-2500 1500-2000 1000-1500 500-1000 100-500 <100		

Climate change[1]

Temperature (T) in °C



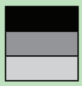
Precipitation (P) in mm



– 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: temperature increase; wind storms/dust storms; floods; decreasing length of growing period

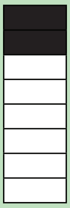
Sensitive to climatic extremes: seasonal rainfall increase/decrease; heavy rainfall events (intensities and amount); droughts/dry spells

If sensitive, what modifications were made/are possible: increase storage volume (e.g., by adding overflow pond)

[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

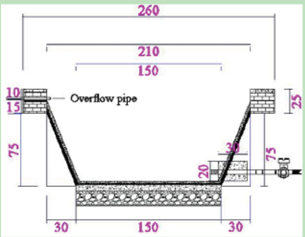
Cropland per household (ha)

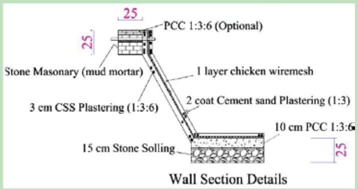


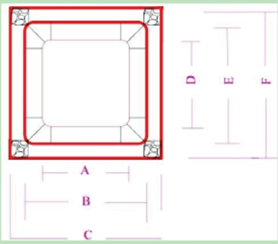
<0.5
0.5-1
1-2
2-5
5-15
15-50
50-100
100-500

Land user: individual/household, small-scale land users, disadvantaged land users, men and women
Population density: 120 persons/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)







Technical drawing

Upper Left:
Pond cross-section
(size indications in cm)

Upper right:
close-up of wall section
(size indications in cm)

Bottom:
Pond dimensions for different storage volumes

Implementation Activities, Inputs, and Costs

Establishment activities

Establishment is carried out under the supervision of local service providers using construction tools, which include measuring tape, spade, shovel, knife, hoe, hammer, trowel, and pan. Establishment can be completed in one week. The major establishment activities are as follows:

1. Selection of suitable site
2. Site clearance; measure and outline pond area
3. Excavation of pond to a depth of 1.1 m, remove protruding stones
4. Sole pond floor with stones (15 cm); apply sand filling to create a smooth surface
5. Stone masonry of walls with mud mortar (25 cm)
6. Apply a 7.5 cm plain cement concrete layer on pond floor (cement-to-sand to aggregate ratio of 1:2:4)
7. Apply a 3 cm-thick layer of cement-sand-soil plastering (1:3:6 ratio) on walls
8. Lay out a layer of chicken wire mesh on floor and walls and fix with u-nails
9. Apply two coats of 12.5 mm-thick cement plastering (cement-to-sand ratio of 1:3)
10. Apply a cement slurry painting
11. Level terrain around the pond
12. Install roof catchment area, as well as HDPE pipe gutter and conveyance system

Typical establishment inputs and costs per 3 m³ pond

Inputs	Costs (US$)[1]	% met by users
Skilled Labour (4.5 person days)	24	0
Unskilled Labour (15 person days)	53	100
Construction Materials		
• Cement (150 kg)	22	0
• HDPE and GI pipes	6	0
• Chicken wire mesh (12 m)	13	0
• Other construction materials	4	0
Local Materials (costs reflect unskilled labour effort for collection and portering)		
• Stone (1.2 m³)	13	100
• Sand (0.55 m³)	19	100
• Aggregate (0.2 m³)	5	100
• Soil (0.55 m³)	1	100
Total	**160**	**57**

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

Maintenance/recurrent activities

1. Prevent livestock and humans from entering the pond
2. Regularly clean gutter system to remove obstructing material
3. Cleaning pond once or twice a year by removing the accumulated sediments

Maintenance/recurrent inputs and costs per pond per year

Inputs	Costs (US$)	% met by users
Labour (2 person days)	7	100%
Total	**7**	**100%**

Remarks: The above cost breakdown is based on design cost estimates for 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. Community contribution to the overall costs (including project management and all transportation costs for non-local materials) is typically between 50% and 60%.

The few necessary operations and maintenance activities are carried out by the users themselves. Repair works are taken over by rain water harvesting mistris ("mistri" is a Nepali word meaning a skilled worker) and are paid for by the users on an individual basis. In schemes where an O&M fund was introduced, repair works are financed by the fund, which is managed by the scheme's User Committee.

Assessment

Impacts of the technology			
Production and socioeconomic benefits		**Production and socioeconomic disadvantages**	
+ +	Increased irrigation water availability (~10 m^3 per year) Given established market access, irrigation of vegetables and cash crops can raise household income	–	Loss of land (to accommodate pond)
+	Decreased workload; reduced time for water fetching		
Sociocultural benefits		**Sociocultural disadvantages**	
+ +	Improved food security/self-sufficiency, more nutritious diet.		None
+	Improved sanitation and hygiene level		
Ecological benefits		**Ecological disadvantages**	
+ + +	Improved harvesting/collection of water		
Off-site benefits		**Off-site disadvantages**	
	None		None
Contribution to human well-being/livelihoods			
+ +	Decreased workload due to reduced time for water fetching. 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
Most of the users (~90%) utilize the stored water for kitchen gardening. The additional vegetable production is valued highly. Without outside assistance, the establishment costs of soil ferro-cement ponds are prohibitively high for most users. Maintenance costs are perceived as manageable.	Establishment Maintenance/recurrent	negative neutral	positive positive

Acceptance/adoption

The implemented technologies 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 their water pond. There are several reports of spontaneous adoptions by neighboring communities upon seeing the implemented retention ponds. Replicated ponds tend to have plastic linings to economize on establishment costs and simplify construction.

Concluding Statements

Strengths and ➔ how to sustain/improve	Weaknesses and ➔ how to overcome
The stored water mainly serves the cultivation of small kitchen gardens (~90% of all ponds), thus increasing the availability of vegetables. Less frequently, the pond water is used for cattle feeding or sanitation purposes ➔ Provide training on kitchen garden farming techniques and on balanced nutrition to maximize impact of irrigational water	The programme provides fencing around the ponds for the larger community pond options (6/10/15 m^3) and recommends that users build a fence for household ponds (3 m^3) with local materials to prevent children and cattle from falling in. However, some (~20%) of the households never build such a fence ➔ consider making programme support conditional on the user's willingness to provide pond fencing on their own
The pond water helps households to meet the irrigational water demand, thus freeing up other water sources (springs, jars) for domestic usage ➔ ensure that the increased household water supply results in improved health outcomes by combining establishment of ponds with toilet construction, hygiene awareness, as well as household water treatment and storage education campaigns	The supplied water can only partially fulfill irrigational water demands. Households are thus still dependent on possibly remote and/or intermittent ground and surface water sources, especially to fulfill their domestic water needs ➔ (i) increase yield of existing sources by implementing source conservation and improvement); (ii) consider solar lifting schemes to cater to communities where gravity flow systems are not feasible
Straightforward and virtually maintenance-free operation render retention ponds well-suited for replication ➔ capacitated village maintenance workers spread the word and support adoption by neighboring communities by assisting in the procurement of materials and the construction process	Poor households may face difficulties in procuring non-local construction materials such as cement, HDPE, and GI pipes, lowering spontaneous adoption rates ➔ secure additional funding by disseminating and marketing WUMP (); capacitate user committees in procurement of construction tools and materials
The soil ferro-cement lining steers a middle course between costs and durability. After two years, 95% of the ponds were fully functional and the remaining 5% in need of minor repairs within the capacity of the community ➔ Ensure good workmanship and quality in construction by selecting construction supervisors with care	Soil-ferro cement ponds are based upon empirical design. Further monitoring (five to 10 years after construction) is needed to learn about long-term durability performance ➔ perform long-term functionality studies

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


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)

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.

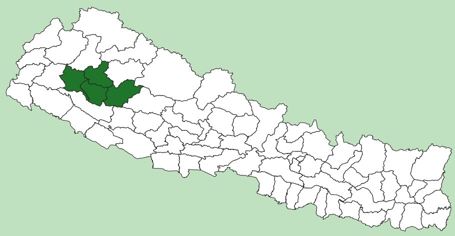
Depending on local circumstances, a suite of interrelated measures is deployed to protect drinking water sources. We distinguish between two types of safeguards: Strict protection measures shield the source from potential contamination and protect the intake structure. Conservation measures are implemented 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)



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

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

Date: June 2015

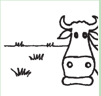
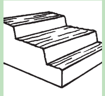
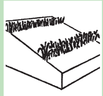
Comments: The water source conservation and protection technology described here complements gravity flow water supply schemes and is part of the water supply measures planned and implemented within the Water Use Master Plan (WUMP) framework for poor communities in the rural mid-hills of Nepal.

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

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

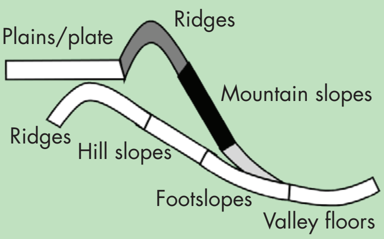
black	high
dark grey	moderate
light grey	low
white	insignificant

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

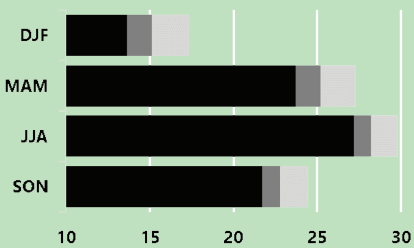


Slope (%)

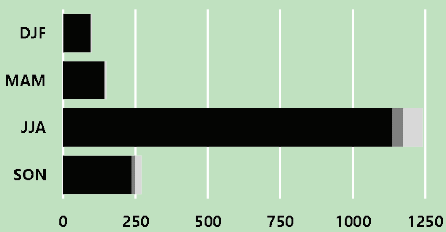
- very steep (>60)
- steep (30-60)
- hilly (16-30)
- rolling (8-16)
- moderate (5-8)
- gentle (2-5)
- flat (0-2)

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

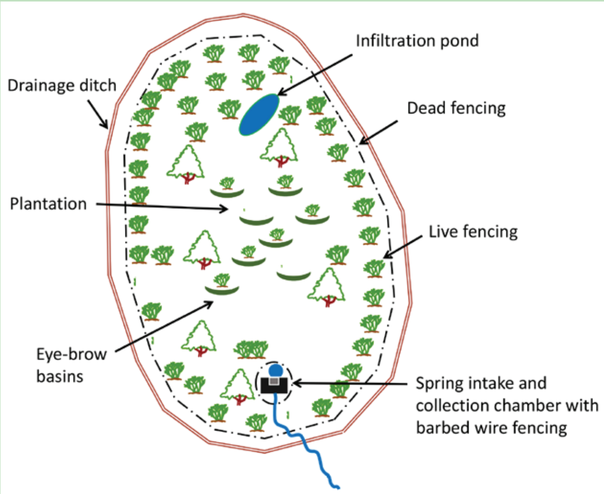
Human environment

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/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)



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 m³), 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 m³)	90	100
• Sand (3.5 m³)	255	20
• Aggregate 5-40 mm (0.85 m³)	55	50
• Wood (0.6 m³)	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 m³) 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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