Fit-for-purpose labs for monitoring and managing rural water supplies

Story of change: Key findings & emerging impacts

Summary

- In Nepal, Kenya and Bangladesh, researchers working with practitioners and local governments have established fit-for-purpose (FFP) laboratories to support reliable water quality monitoring and operational management of rural water systems.
- The FFP laboratories in each country setting are imbedded within a network of stakeholders, with support and engagement from water users themselves.
- FFP labs play a key role in ensuring safe drinking water supplies in rural areas by establishing water quality databases and motivating proactive responses.
- The broader diffusion and uptake of FFP labs by external actors within and beyond REACH program boundaries demonstrates high demand for the approach.

Nepal, Kenya and Bangladesh

REACH
Improving water security for the poor

FundiFIX

HELVETAS NEPAL

UK International Development
Partnership | Progress | Prosperity

UNIVERSITY OF OXFORD

SafePani সেফপানি

eawag aquatic research

Introduction

Water quality monitoring of rural water supplies is necessary to identify contamination risks and motivate proactive responses. Yet establishing consistent monitoring is challenged by many issues, including weak supply chains, inadequate understanding of water safety issues locally, difficult terrains, fragmented databases, low political commitment, and lack of technical capacity. As a result, monitoring in rural areas is currently minimal or absent, and when testing does occur, it is often limited to external public health surveillance checks facilitated by on-site test kits or centralized laboratories.

REACH researchers are investigating how fit-for-purpose (FFP) laboratories, defined as local labs designed to meet the operational and management needs of rural water supplies, can effectively address these challenges in Nepal, Kenya and Bangladesh. FFP lab arrangements are highly contextual, often with adapted monitoring methods and close integration with local institutions. A unifying feature of FFP labs is their focus on supporting water service providers to respond to risks in an informed and timely manner.

Key research findings

Water quality challenges

- In Nepal and Bangladesh, access to protected water points in rural areas is high. Users in Nepal making use of protected springs whereas users in Bangladesh source their water from deep tube wells. However, over the past decade little progress has been made extending access to drinking water supplies that are free from contamination in these countries.
- In Kenya, rates of access to at least a basic level of water service have gradually improved over the past decade. However, there is no national level estimates of water quality in rural zones of Kenya due in part to inaccessibility of water quality monitoring laboratories.

Diverse arrangements

- FFP labs make use of a range of methods and equipment to meet local monitoring and management needs (Figure 2).
- The SafePani lab in Khulna, Bangladesh uses the IDEXX Quanti-Tray method, which requires consistent power supply from the grid and/or a high-spec solar system.

Figure 1: Map locations of fit-for-purpose laboratories established by (left to right) SafePani in Bangladesh, Helvetas in Nepal, and FundiFix in Kenya. (Credit: Md. Ferozur Rahaman, Bal Mukunda Kunwar, Marisa Boller)

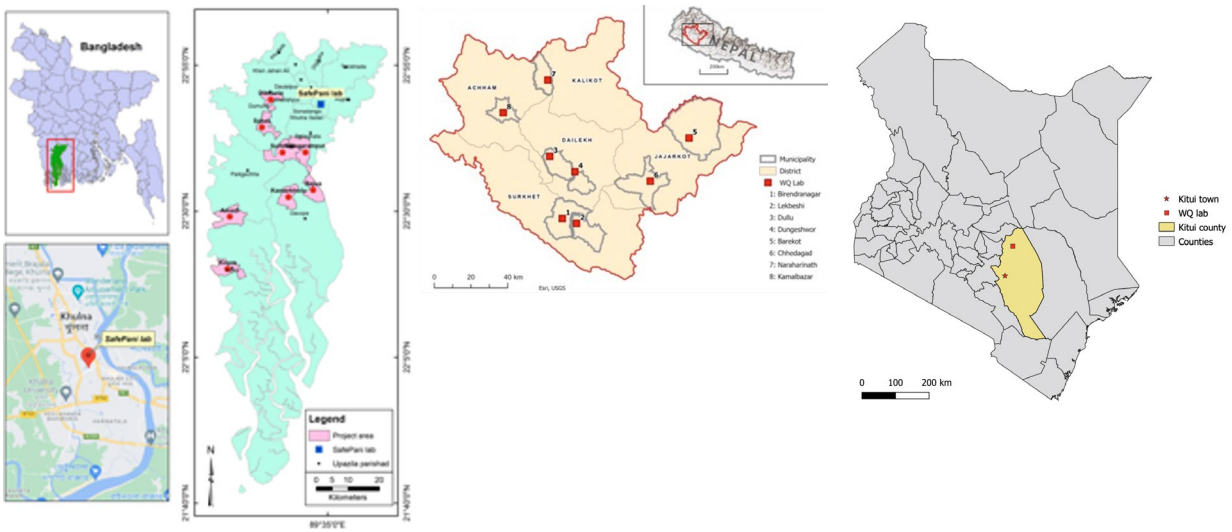


Figure 2: Laboratory set ups in Bangladesh, Kenya and Nepal. (Credit: Ferozur Rahaman, Jackline Muturi, Sara Marks)

- The FundiFix lab in Kitui, Kenya used the IDEXX Quanti-Tray method for several years before transitioning to membrane filtration to improve supply chains and reduce plastic waste.
- In Surkhet, Nepal, where the electrical grid remains unavailable to the surrounding rural community, 8 FFP labs make use of off-grid solutions such as the Del Aqua filtration unit paired with a solar-powered incubator.

A systems thinking perspective

- FFP labs alleviate issues of distance, time, and cost that often make it infeasible to send rural water samples to highly centralized laboratories. They provide leverage to improve rural water safety by creating local resources in terms of expertise, equipment, and supplies. These resources support consistent, well-informed rural water safety management activities.
- The sustainability and effectiveness of FFP labs are linked to the implementation of wider rural water financing, service provision, and regulation models. Policy and innovations that addresses barriers to and incentives for local supply chains are also important factors. The REACH FFP labs exemplify how monitoring can be adapted to three different institutional contexts.

Local supply chains

- The laboratories make use of simplified equipment options, such as locally constructed, solar-powered incubators (Figure 3) and locally available microbial testing materials.

Figure 3: Locally constructed solar-powered incubators in Nepal (Credit: Donat Crippa)

- The research team emphasises sourcing consumables locally as much as possible, with priority for supplies that have longer shelf life and minimal waste volumes.
- By serving a portfolio of water supplies across a rural service area, FFP labs can ensure economies-of-scale to maintain supply inventories.

Information flows

- NWASH is Nepal's national management information system (MIS) for drinking water quality. NWASH provides a robust, user-friendly platform aimed at supporting informed decision-making on water quality risks across space and time.

By harmonizing standard water quality metrics, NWASH enables the integration of localized operational monitoring data with district and national level public health surveillance. Such integrated platforms rely on smart phones equipped with custom software that delivers summary statistics and visualization tools through an open-access platform, which the Nepal FFP labs will utilise.

- In Kenya and Bangladesh, the FFP labs enable water quality reporting to communities and authorities (local and national government and regulatory authority as is contextually appropriate). A software-based MIS for drinking water quality is currently being developed by the SafePani team.

Adapted to local institutional context

- The FFP labs operated by the SafePani project in Bangladesh and by FundiFix in Kenya are embedded within broader water management and maintenance models. These models are funded through a blended finance approach that combines water user payments with sources of external funding.
- Embedding FFP labs within professionalised water service models creates administrative and operational efficiencies, develops an effective mechanism for water safety oversight, and can overcome perceptions that water quality investments are too costly to justify.
- The SafePani model involves clearly defining roles and responsibilities for ensuring safe water (Figure 4), including a cascade of action by service providers using different data sources (Figure 5), clear guidance on the thresholds for action, and iterative decision making by a steering committee on priorities for future investment.
- A promising approach for addressing capacity challenges in the sector involves embedding labs within local institutions. For example, a lab in Nepal was installed in a secondary school, where it is maintained by a science teacher who uses it also as a teaching classroom. In health clinics there may already be technical expertise available to support the water quality work.

Figure 4: Water quality testing by the SafePani project (Credit: Ferozur Rahaman)

Replication of the approach: A case study from Nepal

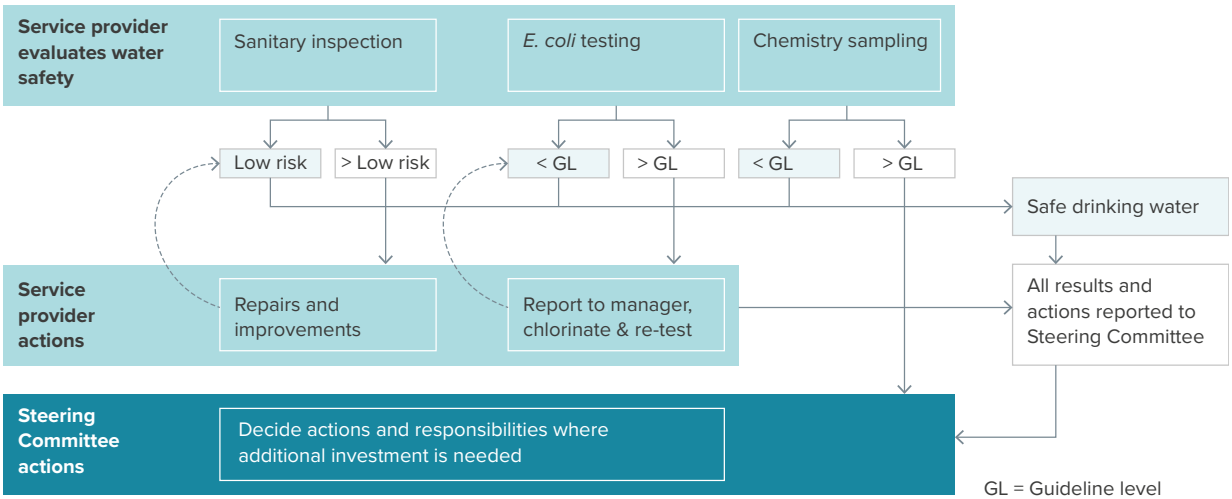
Western Nepal has low access to safe water and high rates of childhood diarrhoeal disease relative to nationwide averages. REACH partners Helvetas-Nepal and Eawag have implemented various water quality interventions, including FFP labs, water safety plans, and training sessions on water quality testing. Water quality data has been enhanced across the region given the establishment of the labs, which in turn has motivated broad adoption of system-scale chlorination processes. The strategies developed through this project have been taken up and replicated by external actors within and beyond Nepal.

Program expansion

The REACH research team in Nepal initially installed three FFP labs in 2018 for operational monitoring of faecal indicator bacteria, pH, turbidity and free residual chlorine across five piped schemes. The labs are run by trained technicians, with local volunteers collecting samples on a monthly basis.

Based on these successes, from 2018-2022 water quality monitoring coverage was expanded to five and eventually eight labs serving rural communities across Karnali and Sudurpaschim provinces (Figure 1).

Figure 5: Roles and responsibilities for ensuring safer drinking water (Credit: SafePani)



Currently, REACH-supported operational monitoring services are provided to a total of 145 piped systems serving over 60,000 people within Helvetas's program area. In 2023, in partnership with Charity Water, Helvetas completed construction on an additional 86 water schemes serving 50,480 people who are also benefitting from the REACH labs.

National replication

The SuSwa program works in 40 municipalities in western Nepal to construct and rehabilitate water supply infrastructure. A Technical Specialist from this program received REACH publications on the potential for in-line passive chlorination to treat gravity-fed piped supplies in rural communities (see Crider et al., 2021; Crider et al., 2022).

REACH collaborators are now advising SuSwa on the installation of passive chlorinators (Figure 6), including guidance on ongoing operational monitoring and control of the devices. These interactions have resulted in increased business for local chlorination vendors and led to discussions about future research opportunities on chlorination innovation. This example of replication of the REACH water safety approach in Nepal is further evidence of the growing demand for demonstrated water safety solutions for remote rural communities.

Figure 6: PureAll 100 device providing in-line chlorination for a piped supply in Karnali Province.

International uptake

Following on interactions with the Helvetas water quality team, Caritas has installed a similar lab for microbial and chemical testing in Banteay Meanchey province, Cambodia. REACH researchers supported this effort by providing guidance on equipment, materials and logistics, as well as coordinating remote training sessions. The lab currently serves a WASH intervention program being implemented in 100 schools, with plans to expand to additional schools in the near future.

Capacity building

The REACH water quality team conducts regular ongoing trainings on standard water testing methods (E. coli, pH, chlorine, turbidity, arsenic and manganese) across the three study countries, followed by regular quality assurance/quality control visits. At local level the trainings engage local water service providers, operators, and water committee members. At district and national level trainings are offered to government staff seeking to harmonize national surveillance protocols with ground-level operational monitoring. In 2023, the water quality team in Nepal expanded training opportunities to include delegates from municipalities, NGO staff, and other sector professionals. Additionally, REACH continues to provide opportunities for internships and student projects on water quality topics, especially for early career professionals and women (for example, see Bänziger et al., 2021; Sanju, 2021; Crider et al., 2022).

Outputs

Ambuehl, B., Tomberge, V.M.J., Kunwar, B.M., Schertenleib, A., Sara J. Marks, S.J. and Inauen, J. 2021. The role of psychological ownership in safe water management: A mixed-methods study in Nepal. *Water*, 13 (5): 589. doi: 10.3390/w13050589

Ambuehl, B., Kunwar, B.M., Schertenleib, A., Marks, S.J. and Inauen, J. 2022. Can participation promote psychological ownership of a shared resource? An intervention study of community-based safe water infrastructure. *Journal of Environmental Psychology*, 81: 101818. doi: 10.1016/j.jenvp.2022.101818

Bänziger, C., Schertenleib, A., Kunwar, B.M., Bhatta, M.R. and Marks, S.J. 2022. Assessing microbial water quality, users' perceptions and system functionality following a combined water safety intervention in rural Nepal. *Frontiers in Water*, 3: 207. doi: 10.3389/frwa.2021.750802

Crider, Y. S., Sainju, S., Shrestha, R., Clair-Caliot, G., Schertenleib, A., Kunwar, B.M., Bhatta, M.R., Marks, S.J. and Ray, I. 2022. Evaluation of system-level, passive chlorination in gravity-fed piped water systems in rural Nepal. *Environmental Science & Technology*, 56 (19): 13985-13995. doi: 10.1021/acs.est.2c03133

Marks, S., and Shrestha, R. 2020. Improving drinking water quality in rural communities in Mid-western Nepal. In: *Women in Water Quality: Investigations by Prominent Female Engineers*, Springer: 47-59. doi: 10.1007/978-3-030-17819-2_3

Nowicki, S. Data, Decisions, and Drinking-Water Safety: An interdisciplinary analysis of the complex adaptive response to monitoring in rural Kenya. DPhil/PhD thesis. University of Oxford (2021).

Nowicki, S., Koehler, J., & Charles, K.J. (2020). Including water quality monitoring in rural water services: why safe water requires challenging the quantity versus quality dichotomy. *Npj Clean Water*, **3**(1): 1–9. doi: 10.1038/s41545-020-0062-x

Sanju, S. 2021. Assessing microbial water quality for pre- and post-chlorination treatment on pipeline system and water management practices in rural communities, Dullu Municipality. MSc Thesis submitted to the Dept. of Environment and Natural Resources, University of Kathmandu, Nepal.

Schertenleib, A., Sigrist, J., Friedrich, M.N.D., Ebi, C., Hammes, F. and Sara J Marks, S.J. 2019. Construction of a low-cost mobile incubator for field and laboratory use. *Journal of Visualised Experiments*, 145: e58443. doi: 10.3791/58443

Tosi Robinson, D., Schertenleib, A., Kunwar, B.M., Shrestha, R., Bhatta, M. and Marks, S.J. 2018. Assessing the impact of a risk-based intervention on piped water quality in rural communities: The case of mid-western Nepal. *International Journal of Environmental Research and Public Health*, 15 (8): 1616. doi: 10.3390/ijerph15081616

Other outputs and selected events

Bänziger, C., et al. 2020. Assessing the impacts of a combined water safety intervention in rural Nepal. Sandec News No. 21, Eawag / Sandec.

Banziger, C. et al. 2022. Ensuring safe drinking water: successes in rural Nepal. Water Science Policy. doi: 10.53014/PFOC5176

Crider, Y., et al. 2019. System-level, automatic chlorination in community-managed water systems. Sandec News No. 20, Eawag / Sandec.

Crippa, D., et al. Fit-for-purpose labs for assessing drinking water quality in rural Nepal. Sandec News No. 24, Eawag / Sandec (in press).

Establishing a drinking water security strategy for mid-western Nepal: A REACH Accelerated Project. Video brief produced by Eawag / Sandec: youtu.be/Jihn8JZyiLY

Hope, R., et al. Delivering safely-managed water to schools in Kenya. REACH Working Paper 8. Oxford, UK (2021).

SafePani: Improving drinking water safety for schools and healthcare centres in Khulna district, Bangladesh. REACH Briefing note: January 2023.

Schertenleib, A., et al. 2017. Drinking water safety in mid-western Nepal: Insights from project scoping. Sandec News No. 18, Eawag / Sandec.

The REACH Project: Insights from recent drinking water research in rural Nepal. Webinar Series on WASH Issues in Nepal, August 2021, WAI and Skat Foundation, St. Gallen, Switzerland.

Is continuous water quality monitoring for rural water projects possible? Women in Water Stakeholder Forum, February 2023, Kitui, Kenya.

Systemic Requirements for Monitoring and Managing Water Quality. IRC All Systems Connect Symposium, May 2023, The Haag, The Netherlands.

Contacts:

Dr Sara Marks
Eawag

sara.marks@eawag.ch

Bal Mukunda
Research and Development Specialist, Integrated Water Resources Management Program

Helvetas Nepal

Professor Katrina Charles
School of Geography and the Environment, University of Oxford, UK

katrina.charles@ouce.ox.ac.uk

Story of change themes

REACH is a global research programme to improve water security for the poor by delivering world-class science that transforms policy and practice. The REACH programme runs from 2015-2024 and is led by Oxford University with international consortium of partners and funded with UK Aid Direct from the UK Government's Foreign, Commonwealth & Development Office, Project code 201880.