Water, Sanitation and Health Technologies in CAREC region

China case study: application of a novel type of infiltration gallery for centralized water supply in farming areas—Minhe County of Qinghai Province

China case study: use of new energy in water supply system of Gangcha County [1]

Under the program of China IWHR

and Qinghai Institute of Water Resources (QIWR)

Location: Gangcha County of Huaibei Tibetan Autonomous Prefecture, China.

Main challenges: Adjacent to Qinghai Lake, Gangcha County is a pasturing area with a relatively dispersed population, and drinking water supplied mostly via decentralized systems.

Before introducing the model, the target territory faced major issues with accessing water from wells. Gangcha County had no access to a power supply, so it was necessary to find a designated power source for water pumps. Internal combustion engines could perform the task, but this approach appeared too costly and would cause environmental damage. The total water demands of three demo projects was estimated as 24.56 cubic meters per day, 21.98 cubic meters per day, and 20.22 cubic meters per day, respectively. The fuel demand for water intake was approximately 0.2 liters per cubic meter. Supposing the price of a liter of fuel amounted to USD1.13, the daily water intake cost would approximate to USD0.22 per cubic meter.

Main goal: Provide access to drinking water supply for the villagers of three remote settlements by using advanced alternative water sources.

Main approach: The scheme utilizes three different water supply technologies using new (renewable) energy: (a) solar-powered, motor-pumped well, (b) shafts using solar-powered water pumps, and (c) motor-pumped wells using solar and wind power.

(a) Solar-powered, motor-pumped well—water source (well) → main solar-powered water intake → reservoir → secondary solar-powered water intake → user—the main water pumps are operating continuously with sunlight input. Most of the time, the system functions in 'high lift, low flow rate' mode—that is, the water drawn from the water source is stored in the reservoirs. If necessary, the solar power system switches from the main pump to the secondary water pumps. The secondary water pumps draw water from the reservoirs and pumps it to water tankers or troughs. In such instance, the whole system shifts to 'low lift, high flow rate' mode, and when it is complete, the mode resets back. The total capacity of the reservoirs in the system normally equals the daily water usage of the users.

For the scheme to operate efficiently, the water sources need to be wells more than 30 meters deep and the reservoirs need to be able to resist low temperatures. The project covers 10 households (23 residents), as well as supplying water for over 800 sheep and over

300 yak. The particular water source is a motor-pumped well (49m depth and 0.11m diameter) (see Figures 6 and 7).

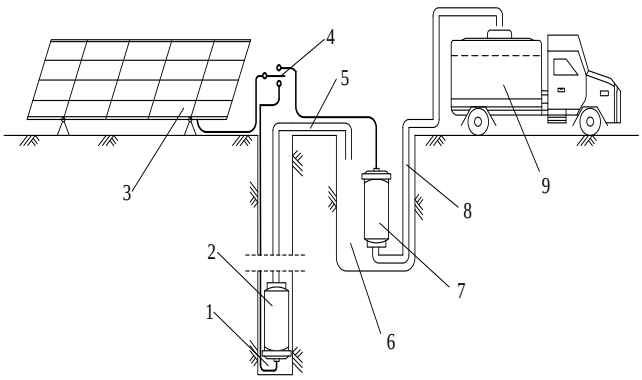

Figure 6. Configuration of the solar-powered, motor-pumped well system: 1 (water source), 2 (main water pump), 3 (solar power system), 4 (control system), 5 (upstream piping), 6 (reservoir), 7 (secondary water pump), 8 (downstream piping), and 9 (water tankers)

Figure 7. Photos of the demo project in Huanlunxiuma Village

(b) Solar-powered water pump shaft—water source (shaft) → solar-powered water intake → users—the solar power system provides electricity for the water pump to draw water from the water source, working continuously at sufficient sunlight input. The whole system is set in 'low lift, high flow rate' mode. The water pumped from the shaft is pumped directly to the user terminals.

For this scheme, the water sources need to be shafts less than 30 meters deep and for water sources with insufficient water, it is necessary to add reservoirs to the system. The project covers three households (11 residents). In addition, the scheme supplies water for over 900 sheep and over 210 yak. In this particular case, the water source is the shaft (6m depth and 0.8m diameter) (see Figures 8 and 9).

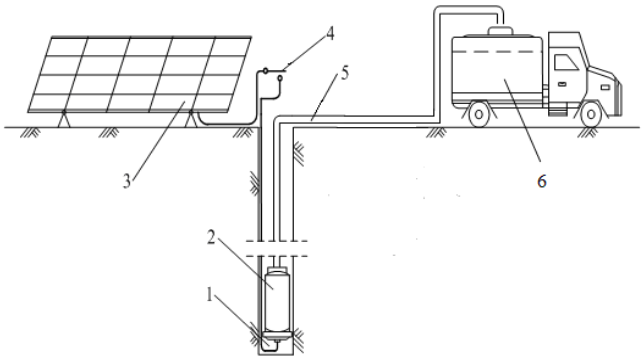

Figure 8. Configuration of shafts using solar-powered water pumps: 1 (water source), 2 (water pump), 3 (solar power system), 4 (control system), 5 (piping), and 6 (water tankers).

Figure 9. Photos of the demo project in Jiaoshikexiuma Village

(c) Motor-pumped wells using solar and wind power—water source (deep well) → main water intake → reservoirs → secondary water intake → users—this approach is applicable to deep (80m to 150m) motor-pumped wells in locations with a relatively high water supply demand. Whereas the main water intake system operates in 'high lift, low flow rate' mode to pump water to the reservoirs, the secondary water intake system works in 'low lift, high flow rate' mode to pump water from the reservoirs to the water tankers/troughs. During daytime, the system is mainly solar-powered, functioning like the solar-powered, motor-pumped well mentioned earlier. After 5pm (5pm to 9am) with few people actually using water, the system switches to wind power. The wind power system provides electricity to the main water intake system to pump water to the reservoirs. In case the users need water, the secondary water intake system operates as it does during the daytime. The project covers two households (eight residents) and supplies water for over 300 sheep and over 370 yak. The corresponding water source is the motor-pumped well (74m depth and 0.11m diameter) (see Figures 10 and 11).

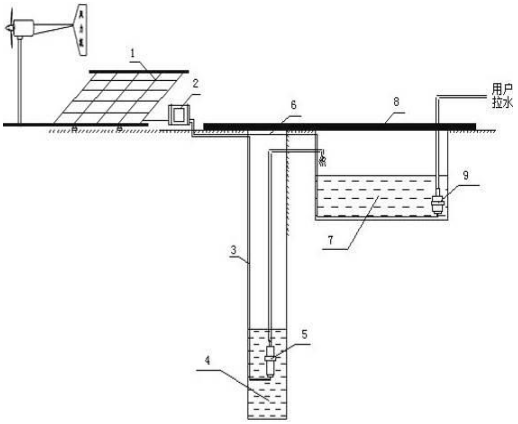

Figure 10. Configuration of motor-pumped wells using solar and wind power: 1 (power system), 2 (control system), 3 (cabling of main water intake system), 4 (water source), 5 (main water intake system), 6 (cabling of secondary water intake system), 7 (reservoir), 8 (heat preservation facilities), and 9 (secondary water intake system).

Figure 11. Photos of the demo project in Gangchagongma Village

All the water sources referred to in this section comply with the 'Standards for Drinking Water Quality (GB5749).'

Financial aspects: The Research and Application Special Fund (RASP) of Qinghai Province and the central finance supported the projects described in this section. Based on Table 15, the cheapest practice is the *Solar-Powered, Water Pump Shaft*; however, it cannot operate without sufficient sunlight. The most expensive model is the *Motor-Pumped Wells Using Solar and Wind Power*; this option allows water to be pumped at a stable rate thanks to the ability to switch between solar and wind power.

Table 15. Total cost of water supply equipment and water source projects for the three new energy water supply schemes

Village	Model	Number of households benefiting	Cost of water supply system (financed by RASP of Qinghai Province)		Cost of water source project (well) (financed by central finance)	
			Total	Per family	Total	Per family
Huanlunxiuma	Solar-powered motor-pumped well	10	USD4,995	USD499	USD5,295	USD529
Jiaoshikexiuma	Solar-powered water pump shaft	3	USD1,305	USD435	USD1,050	USD350
Gangchagongma	Solar- and wind-powered motor-pumped well	2	USD12,045	USD6,022	USD7,995	USD3,997

Main results: The application of this technology has greatly improved the water supply guarantee rate in the target area and, therefore, the overall health of the residents. In the meantime, the project has also addressed the shortage of drinking water for cattle, sheep, and goats, which is a significant contribution to the development of local animal husbandry. The life quality of local residents has also improved considerably. Each project covers three to ten households and is managed by its actual users.

The described technologies are environmentally friendly—for instance, saving up to 13.35 liters of fuel per day—that is, 4,873.5 liters per year—equaling an annual reduction in carbon dioxide emissions of 10.7 tons. Operating the projects for 25 years could save 122 cubic meters of fuel and prevent the release of 267.5 tons of carbon dioxide into the atmosphere.

Sustainability: The life span of solar power systems is usually 25 years, as against 8 years for internal combustion engines. Thanks to the control system, the water supply systems can operate automatically, requiring no manual control or management. During the whole life span (approximately 25 years), the system requires only a one-time maintenance of the power equipment and the water pumps to be replaced twice.

The main advantage of the *Solar-Powered, Motor-Pumped Well* model in Huanlunxiuma Village is that this technology can be used for deep wells rarely used before. However, the main drawbacks are that it is impossible to operate in insufficient sunlight (in cloudy weather or at night) and the high investment requirement.

The relatively low initial investment is the main advantage of the *Shafts Using Solar-Powered Water Pumps* model in Jiaoshikexiuma Village, which means that the approach can be fairly economical. However, the main disadvantage of such systems is the possibility of their failure in insufficient sunlight (in cloudy weather or at night).

Likewise, the management and maintenance of these two schemes can be relatively challenging. For the *Motor-Pumped Wells Using Solar and Wind Power* model in Gangchagongma Village, the main advantage is that it can function well without sufficient sunlight or wind. It is also easy to use, and the water supply guarantee rate is high. However, the main weaknesses of this technology are a relatively high construction cost, and high management and maintenance requirements.

Next required steps: The three water supply systems using new energy sources introduced in Gangcha County all have their own pros and cons, yet most of the time one of them could be suitable for a specific application scenario. Systems using only one kind of renewable energy (RE) (solar or wind) tend to lose stability in case of a power outage—easily caused by weather changes. This instability can lead to insufficient water supply and low water supply guarantee rate. Although the hybrid systems face instability issues, in practice the systems using both solar and wind power demonstrate a better performance than those using only solar or only wind, while systems using only wind power perform least well. Regarding economic analysis, the RE-based systems require a large initial investment, although the payback period is long, and long-term investment is much less demanding. Such systems can disburden rural residents from hard labor and greatly improve water use convenience, as well as reduce water fees. The application of RE removes the need to use fuels like petroleum for water supply purposes, thereby benefiting the environment. On average, each of the described demo projects can save labor force equaling five persons. The corresponding effect will grow exponentially with the broad application of the technologies. It is strongly recommended to deploy such systems in more pasturing areas.

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Innovation in financing mechanism

China case study: application of PPP in rural water supply projects

Location: Rucheng County, Hunan Province, China.

Main challenges: Rucheng is a county of Hunan Province at the junction of three provinces (Hunan, Guangdong, and Jiangxi) with a total area of 2,401 square kilometers. Rucheng County includes 14 townships with a total population of 4.08 million people, including 0.34 million in rural localities. It is listed as a critical county under the national poverty alleviation campaign. In the period 2005 to 2014, Rucheng County used USD22.17 million under the 11th and 12th five-year plans for the construction of rural drinking water projects. In total, 1,084 projects were executed, including 338 with a supply capacity of over 20 cubic meters per hour. Thanks to that, the overall RDWS situation in Rucheng County has significantly improved [1]. However, owing to the county's complex geographic situation, dispersed rural populations, and limited funds, the RDWS projects constructed before 2015 are mostly small scale and lack sufficient water treatment facilities—for example, using mountain brooks as a water source and therefore facing seasonal disruption [2]. Meanwhile, small-scale RDWS projects are directly managed by local communities, making 'effectiveness of their long-term operations a cumbersome task. To address the challenges of high construction costs and matching management and maintenance requirements, ensuring financing is a priority.

Prior to 2014, the construction within the framework of RDWS projects was mainly funded from the central and local budgets, followed by self-raised funds of residents, with only a minor percentage of non-government capital. For a long time, the construction of rural infrastructure has faced a funding shortage. According to the natural monopoly theory [3] and principal-agent theory [4], RDWS projects qualify both as public goods and natural monopolies. On the one hand, the external economy, high exclusiveness, and low competitiveness of RDWS projects can cause a lack of personal supply and difficulty in market distribution. On the other hand, the water supply industry is in a market of government-regulated natural monopoly. Compared with market distribution, such state-managed monopoly systems lack efficiency, as well as facing issues of principal-agent relationship between the government and water supply enterprises [5]. To resolve this problem, it is necessary to establish a system whereby the government and water supply enterprises could collaborate towards a shared cause. The former could introduce policies encouraging private enterprises to participate in RDWS projects and cooperate with the government, so that both the government and enterprises could better leverage their strengths, resulting in a highly efficient resource distribution.

Main goal: Establishing an effective financing mechanism in the rural settlements of Rucheng County, Hunan Province, through the introduction of PPP schemes as an effective method for financing the construction, operation, and management of RDWS projects.

Main approach: In 2014, the State Council of China issued 'Instructions on Encouraging Non-Governmental Capital to Participate in the Financing of Projects in Crucial Innovative Domains,' encouraging non-government capital to participate in the construction, management, and maintenance of profitable water conservancy (especially water supply) projects based on methods such as franchise agreement and stake holding [6].

From 2015 to 2017, Rucheng County made a consistent and continued effort to apply the PPP model to urban and rural water supply and drainage projects, including a USD0.17

billion province-level PPP demo project. The project incorporated all the centralized water supply projects and wastewater treatment projects of Rucheng County, and as a PPP project it was accessible to non-government capital. After the completion of construction, private enterprises could generate profit under franchise and make sure that their investments had a fair return by charging a usage fee and acquiring government subsidies. The duration of the cooperation, equity percentage, and investment return rate were all properly clarified by the government. The Rucheng Second Tap Water Plant was built in the Rucheng Industrial Park to cover all residents of nearby rural communities. Plant branches were also built to supply drinking water to rural residents living relatively far away from the county center. Urban–rural water supply system integration was thus realized countywide [7,8].

In February 2016, the government of Rucheng County, Beijing Enterprises Water Group Ltd (BEWG), and Hunan Second Engineering Ltd signed the *Memorandum of Sole Procurement Source Confirmation of Rucheng Urban–Rural Water Supply and Drainage Integration PPP Project*. In April of the same year, the *Contract of Rucheng Urban–Rural Water Supply and Drainage Integration PPP Project* and *Joint Investment Contract*—stating that the government should have a permanent stake holding percent of 20%—were both signed. Later, in November, Rucheng-BEWG Water Development Ltd was registered and construction began on the Rucheng Second Tap Water Plant and its branches [9]. Whereas the construction of water plants and main pipelines (from water plants to villages) was financed under the PPP project, the construction of the pipe systems inside villages was financed directly by county-level government. In January 2017, Rucheng-BEWG Water Development Ltd also officially took over the operation of the wastewater treatment plants of Rucheng County. In late 2018, the construction of the Rucheng Second Tap Water Plant, its branches, and pipe systems was completed.

The Rucheng county-level CCP (Chinese Communist Party) committee and Rucheng county-level government paid great attention to the management of PPP projects. The Rucheng PPP Project Management Lead Group was established—consultants: secretary of county-level CCP committee, chairperson of county-level People's Congress Standing Committee, and chairperson of county-level CPPCC (Chinese People's Political Consultative Conference)—leader: county magistrate—members: directors of all related departments. The PPP Project Management Office affiliated with the Lead Group was also established to deal with PPP-related affairs.

Financial aspects: According to the *Guideline on Contracts of PPP Projects* (trial version), an SPV (special purpose vehicle) can be established by non-governmental capital (a single enterprise or a union of multiple enterprises) or jointly by the government and non-governmental capital. They are responsible for the design, financing, construction, management, maintenance, ownership transfer, and so on of a PPP project [8]. In 2012, the government of Rucheng County set up the Rucheng Water Investment Group Ltd and invested USD7.65 million in it. In 2015, Rucheng County included all the centralized water supply projects and wastewater treatment projects in one bundle. Beijing Enterprises Water Group (BEWG) Ltd joined the construction of this large bundle. An SPV was set up by the government and the union of BEWG and Hunan Second Engineering Ltd with a total investment budget of USD1.66 billion [9].

The project specified a reasonable cooperation duration, cooperation mode, stake holding percentage, and investment return, so that the government subsidies could be properly utilized and thereby medium- and long-term financial risks could be averted. The

cooperation duration of this PPP project is 29 years, and the BOT (build-operate-transfer) mode was implemented. The shareholding ratio of the local government is 20%, in which upfront expenses—such as, expenses for land acquisition and demolition, land application and approval, and so on—are regarded as government supporting funds; the rest are all derived from social capital investors. The reasonable return of non-government capital investment was guaranteed by user fee payment and government subsidies. The internal investment return rate after tax was set at 6.8%, and the price alteration mechanism would be triggered if the internal investment return rate reached 12% [9].

Main results: As a result of the project, 0.22 million rural residents of Rucheng County gained access to safe drinking water. The application of PPP under the project significantly contributed to building local infrastructure, alleviating the debt pressure on local government, and curbing medium- and long-term financial risks. Its success encouraged the local market to make more investments, while serving as a great demonstration of a novel method to achieve sustainable WASH—namely, collaboration of governmental and non-government capital—instead of the traditional method with sole government participation.

The total water supply capability of the newly built Rucheng Second Tap Water Plant is 80,000 cubic meters per day. The water source is a nearby reservoir. It serves 285,000 people (130,000 urban and 155,000 rural residents living nearby). The branches cover 36,000 consumers. Thanks to this PPP project, the rural residents of Rucheng County can now enjoy a piped water supply system that is available to every household, with water meters installed for accurate accounting for usage. The water price was determined by the government after a public hearing, and a detailed water price plan was drafted by the effective operators and finally checked by the county-level NDRC.

Figure 12. Rucheng Second Tap Water Plant built under this PPP project

Sustainability: The PPP model applied in the target county demonstrates that this operation mode is feasible and qualifies as an effective financing method for the construction, operation, and management of RDWS projects. The PPP mode made good use of government strengths in strategy planning, market supervising, and rendering public services, while also benefiting from non-government capital advantages as to management efficiency and technology innovation. It also helped specify the line between the government and the market, so that the former could better perform its public service role. This project actualized water supply and drainage integration, and its large scale effectively reduced management costs under the target water supply and wastewater treatment projects, while at the same time facilitating the shaping of the professional operating team and greatly improving the overall quality of public service.

The project adopted the rules of risk distribution optimization, risk-return match, and controllable risk. Factors such as the government's risk management capacity, investment return mechanism, and the market's risk management ability were all considered to reasonably distribute risks between the state and non-state capital.

As a rule, PPP projects are rather long, and the determination of which non-government capital to choose is carried out at an early stage. This means that during most of the operation time, non-state operators face little competition and so the government has to be very cautious when choosing partners. The PPP modes applied under RDWS projects are BOT, TOT (transfer-operate-transfer), BOO (build-own-operate), and so on. The choice of a non-government capital partner should depend on the mode chosen. The method of choosing it—usually via open bidding, competitive negotiation, and so on—relies on the profit mechanism of a particular project and on the degree to which margins and limits are specified [10].

RDWS projects can be deemed semi-profit in the sense that the usage fees paid by consumers are insufficient to cover full cost. This lack of return requires that the government subsidizes operators and/or provides them with resources to compensate the spread. More precisely, the government can grant enterprises franchises and subsidies or make direct investment and hold stake, using modes like BOT [11].

Next required steps: For an RDWS project, it is necessary to assess which specific PPP mode could be applied. The key tasks of project identification include analyzing the appeal of the project, comparing the efficiency of traditional and PPP modes, and carrying out a VFM (value for money) assessment. To complete the analysis, three main aspects should be considered [12]: (a) the scale of investment should not be too small, and the investment should be stable in the long term; (b) paying due attention to VFM quantitative assessment and making sure it does not become a formality, influencing final decisions; (c) evaluating project needs from different stakeholder perspectives.

RDWS PPP projects should likewise apply the 'risk sharing principle' during the design phase by establishing a clear and reasonable risk identification and distribution system. The key points are: (a) risks should be assumed by the party that is best at dealing with them or most capable of managing them; (b) non-government capital should take charge of the investment, construction, and operation of the project and assume the corresponding risks. The government should assume the risks associated with policies, legislation, and so on. Under PPP contracts, it is also recommended to strive to quantify anti-risk plans.

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Change in maintenance system

Mongolia case study: school WASH in rural Mongolia

The efforts were implemented with financial

and other support of ACF, UNICEF, ADB and Australian Aid

Location: School WASH projects were implemented in 17 aimags of Mongolia, including Arkhangai, Uvurkhangai, Khuvsgul, Bulgan, Selenge, Tuv, Khentii, Sukhbaatar, Orkhon, Dornogovi, Dundgovi, Zavkhan, Bayankhongor, Govi-Altai, Khovd, Uvs, and Bayan-Ulgii [1].

Main challenges: The 2007 survey of school dormitory conditions by the Ministry of Education, Culture, Science, and Sports (MECSS) revealed the following [2]:

- 74% of 502 dormitories used water carried by hand from outside water kiosks and wells;
- 46% of water supplied to schools did not meet hygienic standards;
- 78% of schools had only outdoor latrines, most of which were unsafe and unhygienic.

Herewith, decentralized WASH facilities were deployed in rural areas, yet wastewater treatment installations were virtually non-existent in rural localities, including in schools.

The responsibility of local water and sewerage organizations represents another issue. Currently, local water and sewerage organizations are responsible for all activities associated with heating, water supply, apartment owner communities, and so on.

Water quality is extremely important for school-based WASH services; it is one of the main indicators to measure the reliability of rural WASH services. Unsafe water and hygiene practices are the main causes of diarrhea and hepatitis in children in rural Mongolia. Moreover, the Mongolian winter climate is harsh and cold, so technology suitable to a cold climate is necessary. Therefore, climate resilient technologies were taken into account while developing the school WASH program in Mongolia.

Main goal: Address the issues in schools and kindergartens without piped connection to centralized systems and improve WASH in schools in Ulaanbaatar City and rural areas of Mongolia.

Main approach: The school WASH program was launched in 2014 with the proposed approach stipulated in *Joint Decrees No. A253, 252 and 173 'Norms and Requirements for WASH in Kindergartens, Schools and Dormitories'* of 29 June 2015 and detailed in the *'Improving Water, Sanitation, and Hygiene in Schools' Guide [2]*.

The approach consists of the following main steps:

Step 1. Aimag and Ulaanbaatar City education departments consider needs, assess priority, execute lists of schools with WASH improvement needs, and propose the list of priority schools to local administrations and/or MECSS departments. Local governments, MECSS, and the Ministry of Finance review and prioritize requests for funding. The main financing sources include local development funds of local governments and/or central government (national) budget.

Step 2. Once a request is approved for funding, the local government and MECSS launch the bidding for engineering and project design (including measures to prevent freezing),

drawings, and cost estimation. A qualified contractor is awarded through competitive bidding and, as per Mongolia's laws and regulations, performs the corresponding construction work.

Step 3. O&M is important to ensure that a system operates properly for a long time, as well as to guarantee the maintenance and repair of WASH facilities and the delivery of hygiene education. For this purpose, PPP models to provide operation, maintenance, and repair were implemented. In this case, PPP forms included service contract, management contract, leasing, partnerships, BOT (build-operate-transfer) concessions, and so on. For this rural school WASH case study, Mobicom LLC is the private part of the solution. Mobicom Company is a sponsor and promoter of school WASH projects in rural areas of Mongolia.

Public service utility organizations are required to conduct regular checks of water and wastewater quality.

The proposed approach requires the involvement of different stakeholder groups. *Aimag public water supply and utility service organizations* are responsible for different aspects of O&M of WASH services in schools and are engaged in planning, improving, and managing WASH services in school, as well as regular testing of water and wastewater quality, thereby rendering professional services to ensure WASH operation. *Aimag educational departments* are responsible for hygiene education budget and funding, for allocating school budgets, conducting consultations on possible funding and other support sources, as well as the monitoring and evaluation of WASH facilities. *School management committees* are tasked with the regular cleaning of sanitation blocks, pump operation, as well as the routine maintenance and inspection of mechanical equipment. In addition, they are responsible for supervising and reporting to education departments, as well as the day-to-day management of the WASH facilities.

Huge attention was paid to capacity development and sharing knowledge on the school WASH program. For that, ADB developed a special guide, *Improving WASH in Schools. A guide for practitioners and policymakers in Mongolia*.

Financial aspects: The WASH school and WASH household practices were implemented in rural areas with financial support from ACF, UNICEF, KOICA, ADB, the state budget, and the private sector to improve water supply, sanitation, and hygiene in rural Mongolia. Mobicom LLC supported and financed school WASH practices in 17 aimags within the framework of its social responsibility efforts. More recently, WASH construction in schools and kindergartens has been financed by the state budget [3].

Sustainable WASH services rely on funding to cover routine, maintenance, and ad hoc expenditure on the repair and desludging of septic tanks, as well as covering hygiene education. It is therefore necessary to include adequate funding related to school WASH in state and local budgets, with local and Ulaanbaatar City education departments responsible for their designated allocation.

Main results: A total of 65,200 children in 105 schools and kindergartens in 101 *soums* of 17 *aimags* have benefited from school WASH projects by receiving access to improved WASH facilities and as a result of the successful implementation of school WASH projects in rural territories of Mongolia from 2014 to 2020. School WASH programs and water supply, sanitation, hygiene, and wastewater treatment projects have changed the living quality and

cultural civilization of Mongolians completely and positively, in particular in rural settings [4, 5].

The implementation of school WASH efforts in rural localities impacts a broad variety of sectors, including education, health, sanitation, hygiene, construction, water, public services, social development, labour and social protection, energy, and local development. WASH facilities likewise have created jobs for at least one to three rural residents depending on soum size, population, and the number of children in soum-level schools and kindergartens.

The national Water Commission has approved the tariffs for wastewater transportation, which include profit and revenue streams generated from centralized and decentralized options for rural schools and households. Establishing the tariff makes it possible to earn income, thus enhancing the attractiveness of the model for private companies.

Figure 13. Photos from pilot territories of school WASH projects in Mongolia

Sustainability: The sustainability of the proposed practice is ensured based on the following main parameters.

Firstly, the school management committee and specific school principal are responsible for the day-to-day management and oversight of the WASH facilities. They are also tasked with checking the quality of construction materials, and the main construction dimensions and components to ensure proper construction as per drawings and specifications.

Secondly, effective coordination and enhanced networking are crucial for the successful implementation of school WASH programs. In 2021, within the scope of the joint project 'Introduction of community-based, climate-resilient water supply, sanitation and hygiene services' the national Ministry of Health, KOICA, and UNICEF plan to execute an initiative to improve drinking water supply and sanitation facilities in 62 soum-level schools, kindergartens, dormitories, health centers, and public establishments in Bayankhongor, Govi-Altai, and Zavkhan aimags [6].

Thirdly, private sector involvements and PPP/concession schemes have greatly contributed to WASH development in rural territories and delivering better WASH services to the population.

The aimags connected to centralized networks and systems have no difficulties ensuring water quality. All the aforementioned wastewater treatment options require protection against freezing.

Next required steps: The following steps are necessary to further promote the proposed practice:

- Strengthen local public service organizations to address the issues associated with decentralized WASH construction in rural areas;
- Improve basic WASH services in urban and rural schools and kindergartens at national level, and reach 90% coverage in the long term;
- Reflect current expenditure for the WASH sector in state and local budgets;
- Design measures to ensure frost resistance of WASH facilities;
- Ensure and strengthen effective stakeholder coordination and networking crucial for the successful implementation of school WASH programs.

Mongolia's school WASH scheme includes funding and planning components for improved WASH. The validated operational details and climate resilient technologies can be replicated in other CAREC countries within the scope of domestic school WASH programs; however, it is necessary to analyze country specifics to ensure the solid performance of the model, since country peculiarities and context need to be reflected in national policies, plans, programs, and projects.

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Change in maintenance system

Mongolia case study: WASH in rural Mongolia

Target projects were implemented with the financial support of ADB

Location: The nationwide WASH related infrastructure and service development projects were implemented in Umnugovi, Dornogovi, Arkhangai, and Uvurkhangai aimags. Umnugovi and Dornogovi Aimags are located in southern Mongolia and include the Central Region. Arkhangai and Uvurkhangai Aimags are located in central Mongolia and include Khangai Region [1].

Main challenges: According to UN analysis in 2018, out of 334 soums only 20 had centralized water supply systems in their central parts and 34 soums did not have drinking water sources meeting Mongolia's drinking water standard. In some soum administrative centers, water supply systems relying on district-level heating systems (installed before Mongolia started the transition from centrally planned to market economy) had failed because the district-level heating systems were no longer operational [2].

Nevertheless, Mongolia is embarking on economic growth efforts—such as, mining in Dornogovi and Umnugovi Aimags—and the trade corridor with China is expanding.

Mongolia's harsh winters make the provision of WASH services in rural areas an uphill task.

The separated locations of rural soums and the long distances between them make it impossible to provide centralized systems. Therefore, the decentralized WASH model has been gaining momentum in rural localities with almost no wastewater treatment installations. In addition, local public service organizations require capacity building to address the problems related to rural area decentralized WASH construction.

Main goal: The project's main goal was to support the provision of infrastructure and service improvements in urban areas in Southeast Gobi of Mongolia.

Main approach: The project's main approach was to enhance the economic development and standard of living in aimag administrative centers, and in the mining and border towns in Southeast Gobi. The expected outcomes include improved urban development and governance, and expanded access to sustainable infrastructure and public utility services in urban communities in Southeast Gobi. The key outputs include urban roads, water supply networks, wastewater, district heating, and solid waste collection and disposal systems, as well as urban service delivery reforms.

The government played the main role in strategic decision-making on investment and the ratification of loan agreements. The national Ministry of Finance was the key negotiator for the loan and project agreements, ensuring timely provision of project funding. Aimag (local) governments were responsible for project implementation, including administration, technical matters, monitoring and evaluation, safeguard compliance, and emergency response with the assistance of consultants. The Ministry of Construction and Urban Development was responsible for coordinating efforts by the implementing agency, financial management, and administration.

Local communities were involved in selecting WASH facility and cost-sharing schemes for improved household toilets in Uvurkhangai and Arkhangai Aimags, as well as organizing community groups, construction, and supervision.

The design of target projects took account of Mongolia's cold climate and included the protection of water delivery systems against freezing, including burying lines below the soil frost zone or heating the lines in some way [3].

Operational safety is also very important; therefore, complicated maintenance and repair needs require measures and engagement on the part of both aimag- and national-level agencies. Public service utility organizations need to check water and wastewater quality regularly. Onsite tasks at WASH facilities include the regular cleaning of sanitation blocks, pump operation, routine maintenance of equipment, and deficiency checks—for example, leaks.

24-hour operational automatic (smart) water supply wells or kiosks were constructed. QR code, QPay, and MonPay systems were used to pay for water, hot water, and wastewater fees. In addition, this smart technology provides water consumption monitoring.

Financial aspects: On 19 April 2010, ADB approved a grant of USD15 million from its Asian Development Fund for the Southeast Gobi Urban and Border Town Development Project to support the provision of infrastructure and service improvement in urban areas in Southeast Gobi. Under the project, the piped water connection fee to the central water and sewerage system was calculated at 800,000 MNT (approximately USD340) in the form of a one-time payment per household for improving the water supply and sanitation services for residents of Dalanzadgad Soum [4, 5].

This WASH rural household model is capable of covering costs, with each target household willing to pay the fee of 33,000 MNT to 66,000 MNT (about USD11.6 to USD23.2) for wastewater treatment service in one to two installments per year. The tariff of 33,000 MNT (USD11.6) was approved by the Water Commission and includes a profit margin. Cost sharing was proposed to provide access to WASH services in rural areas under ADB projects. The cost for each improved facility was 2 million MNT to 3 million MNT (about USD702 to USD1,052), with 10% to 20% of the cost paid by households, 20% to 30% from the local budget, and 50% from ADB funds.

Both the WASH centralized and decentralized service options can generate revenue through the tariff payment. As the level of centralized systems is very low, only 30% of the revenue can stream from the WASH centralized service and 70% from the WASH decentralized service option.

Main results: The project was implemented successfully and yielded the following main results [1]:

- Almost 95% of ger area dwellers in the project soums received access to drinking water within 300 meters of their dwellings;
- A total of 39.4km of water supply piping were installed;
- Nine water kiosks were constructed and are currently in operation;
- One 1,000 cubic meter and three 100 cubic meter water reservoirs were constructed;
- A total of 35.9km of sewerage piping was installed and is currently in operation;
- Two wastewater treatment plants were constructed;
- Three sewerage pumping stations were constructed and are currently in operation;

- 2.8% of the population received access to WASH services.

Figure 14. Photos from new water supply and sanitation infrastructure for residents of Dalanzadgad Soum

Sustainability: Water supply, sanitation, hygiene, and wastewater treatment projects have completely and positively altered the life quality and cultural civilization of Mongolians, particularly in rural areas. Moreover, the implemented practices accounted for the technological development suitable to the Mongolian climate and environmental protection.

The applied approach also involved different stakeholder groups—such as, MCUDs, aimag governments, local public water supply and/or utility service organizations—in decision-making. This, in turn, achieved more sustainable results and engaged local communities in the systems' O&M.

Water quality is monitored by aimag-level auditing organizations. Their main functions include ensuring water quality in rural areas and conducting water quality analysis every three months. Aimags connected to centralized lines and systems have no difficulties ensuring water quality.

This practice brought certain financial benefits. The loan agreement for the rural drinking water and wastewater treatment systems was successfully implemented. The Water Commission approved the tariff for wastewater transportation for each household, which includes a profit margin. In certain soums, the operation of WASH facilities created jobs for at least one to three rural residents.

However, private companies are still not taking part in decision-making. Local public urban service organizations can participate in decision-making for rural areas. The procurement of all goods, works, and services is done based on international and national competitive bidding; therefore, there is room for private sector involvement.

The described practice demonstrates the innovative solutions that can be used for drinking water and wastewater treatment in rural Mongolia.

Next required steps: It is important to develop an overall plan covering aimag, soum, and bagh levels backed with sufficient investment and financing to achieve the main WASH objectives of Mongolia.

A broad awareness-raising campaign targeting local communities is necessary in order to disseminate information, brochures, and leaflets on WASH facilities and instructions on building improved WASH facilities and toilets in soums. It is also necessary to disseminate the outcomes and best WASH rural practices in other aimags, soums, and baghs.

Overall, WASH services are not developed at soum level, but the decentralized option—clean, dry, and eco toilets and facilities—is applicable. Open defecation is mainly practiced by nomadic herders. It is necessary to reconsider this approach and develop specific options for nomadic herders in rural Mongolia.

From a financial perspective, it is difficult for rural households to pay fees. Therefore, various financial stimuli need to be introduced to support vulnerable populations and to increase the capacity to pay among rural populations.

It is likewise necessary to build the capacities of local water and sewerage organizations on stakeholder and user services. The future development of WASH services in the country requires the involvement of qualified private companies and the local communities.

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Change of financial mechanism

Tajikistan case study: HRBA to water governance—from unbundling systemic underperformance towards financial sustainability

Based on the experience of SDC-funded projects:

TajWSS,[1] RRWSSP,[2] RWSSP FV,[3] SDWSMP[4]

Location: The practice was launched and replicated across 45 communities (villages) through 35 WASH schemes serving around 125,000 rural residents, with target communities located in 13 districts across all regions of Tajikistan (including mountainous areas)—namely Rudaki (Direct Rule Districts), Shamsiddin Shokhin, Khovaling, Baljuvon, Muminobad, Farkhor, Hamadoni, and Shaartuz (Khatlon Region); Isfara, Maschoh, Spitamen, Asht, and Kanibadam (Sughd Region).

Main challenges: The sector of drinking water supply and sanitation in Tajikistan has been facing the so-called 'vicious cycle' comprising systemic underperformance, management constraints, low sustainability, and service failure. The common source of such a crisis lies arguably in the current 'ineffective' tariff policies. Tariffs for drinking water, both in urban and rural settings, have traditionally been maintained significantly below the full-cost recovery threshold and remain critically low; tariffs for most systems are at least three or four times less than full-cost recovery.

The revised Law on Drinking Water and Sanitation [5] directly recognizes consumer water fees as one of the sources of financing; however, the legislation largely lacks references to tariff-setting principles—that is, full-cost recovery, transparency and accountability, social responsiveness, pro-poor approach, and so on. At national and regional levels, the National Antimonopoly Agency (AMA) under the Government of the Republic of Tajikistan (GoRT) is the sole WASH tariff regulator and, therefore, service providers are responsible for agreeing tariff schemes with it. Although the recently endorsed guidelines[5] for tariff setting provide a comprehensive mechanism for designing full-cost recovery schemes, service providers as well as practitioners report that the mechanism has not received either broad endorsement or implementation [6].

The comprehensive analysis implemented under the TajWSS Project revealed conflicting views among the key stakeholders within the duty-bearer and rights-holder network—that is, (a) national and local authorities, (b) regulator agency (AMA), (c) service providers, and (d) consumer groups [7]. The recurrent mutual objections within the group comprise a series of challenges that prevent tariff improvement towards full-cost recovery.

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For example, consumers demand improved/adequate services and only then would they be ready to pay due and improved tariffs; suppliers object that service improvement cannot happen without due and improved payments. Furthermore, supplier organizations demand that regulating agencies approve tariff upgrading in order to render improved services. In its turn, the regulating agency, on the one hand, expects both good governance and consumer rights to be properly implemented and protected while consumers demonstrate their willingness and ability to pay higher tariffs but, on the other hand, feels reluctant to introduce higher tariffs owing to political pressure from national and local authorities in connection with any rise in prices for basic services, including water supply and sanitation. National and local authorities suggest that higher transparency and accountability measures need to be implemented locally, and that the process should be monitored and documented through public discussion.

A major confidence crisis between water suppliers and consumers was described as prevalent for rural communities and systems and, consequently, the lack of willingness to pay and poor fee collection had impacted upon the capacities of suppliers and upon the overall sustainability of service systems.

Main goal: The main purpose of the practice/exercise was to demonstrate how application of HRBA influences achieving full-cost recovery tariffs and consequent improvements in fee collection rates. HRBA was designed and agreed as a tool to address the aforementioned mutual objections between participating groups in tariff policy design and implementation. The core principles of transparency, accountability, and participation are deemed instrumental in building confidence within supplier-consumer networks, and thereby ease the path towards tariff upgrading (that is, towards cost recovery) and improved fee collection.

Main approach: While the actual implementers of the tariff schemes recognize full-cost recovery tariffs as the primary requirement for system sustainability, the immediate shift to such tariffs does not necessarily lead to success unless consumer willingness and ability to pay have actually improved. It is therefore important that a policy agenda promoting all-round support in the short- to mid-term meets the needs and demands of all stakeholders. A comprehensive support mechanism should comprise concrete actions through two sets of interlinked policy actions.

The first set of actions is designed to develop an improved tariff policy along with pilot implementation actions—such as, the elaboration of tariff-setting methodologies for drinking water supply and sanitation, capacity-building efforts for consumers and service providers on developing full-cost recovery schemes, and submission to and approval of such schemes with designated government regulators. Fully fledged training programs are necessary to support the entire process for supply organizations by invitation from local authorities and national-level regulator agencies.

The second set of actions aims to assist the development and application of good governance and consumer rights protection mechanisms, promote adequate consumer behavior as to their responsibility to pay for water supply and sanitation services, and introduce feedback mechanisms. Transparency and accountability mechanisms are tools that both suppliers and consumers should feel encouraged to benefit from.

The pilot implementation included over 20 service providing entities, such as small-scale community organizations, medium-sized and large operating companies in several major

cities, and district administrative centers. Most of these are run by communities (public organizations, *dehkan* farms, WUAs, and private companies), others by large urban and district *vodokanals* (utility organizations).

Financial aspects: Supply organizations were supported (through the exercise) to: (a) determine their full-cost recovery tariff schemes, (b) develop a strategy for consecutive moderate tariff improvements, and (c) implement rights-based approaches aiding improved fee collection.

Main results: The approach was initially piloted among 12 WASH schemes supported by Oxfam and UNDP in selected districts of Khatlon and Direct Rule District (DRD) Regions, but certain elements were tailor-made and replicated among more than 25 other schemes via projects supported by ISW, MSDSP, and IFAD in other regions of Tajikistan. The institutional models involved included WUAs, VOs, LLCs, dehkan farms, and a few state-operated systems (SUE KMK).

The design of the training program was based on the training module elaborated jointly by the UNDP Water Governance Facility at SIWI (WGF), Cap-Net, WATERNET, and Water Integrity Network (WIN). Three separate modules with ten thematic sessions were delivered to all participating entities. Public Advisory Councils (PACs) were established in two large cities of Dushanbe and Khujand, as well as five district centers run by city and district administrations, respectively. The PACs were first launched in 2013 in Mumibobad District, and then in Dushanbe (2015) and Khujand (2016) with UNDP and GoAL WaSH support. Later the approach was replicated by Oxfam GB in four additional rural districts with WB's TWISA Project support—that is, in the districts of Rudaki, Kulyab, Vose, and Farkhor.

The exercise concluded with substantial progress made against almost all the project objectives (the initial 12 schemes). First of all, the project successfully managed to change the perception among regulating bodies and authorities that tariffs may differ from system to system and, therefore, regulators (and others) are now able to understand how tariffs are constructed. The new tariffs were then agreed upon and step-by-step increases towards full-cost recovery levels were executed. It was considered a major breakthrough, as the new tariffs for 12 target systems provided the required precedents for consecutive policy change in the sector.

Moreover, the exercise also demonstrated that the application of governance and consumer rights protection measures helped to improve water fee collection rates across most target systems. Service providers became more transparent thanks to sharing more information with consumers, as well as more accountable and responsive owing to regular reporting on their efforts and handling consumer inquiries and complaints systematically. In that sense, the initiative demonstrated that, overall, the balanced approach has resulted in positive progress towards improved economic viability and system sustainability.

Furthermore, the exercise managed to improve confidence among not only suppliers and consumers, but also national and local authorities and regulators. The exercise enabled institutional confidence building through the support of Public Advisory Councils (PACs) inside supply organizations that bridged suppliers and consumers on a practical level, and further with national government agencies on a policy level.

Sustainability: Oxfam GB, UNDP, ISW, and MSDSP have since replicated the described practice in a number of other districts across Tajikistan, thus deeming it worthwhile for

improved tariff policy implementation in rural settings. While the implementation approaches differed in substance (tailor-made), the core principles remained the same across all schemes. Some of the latest progress from target organizations is presented in Table 16.

Table 16. Tariff improvement progress and fee collection rates [7]

Implementing agency/project	**Tariff improvement progress:** *average for all project-supported schemes*		**Collection rate:** *average for all project-supported schemes*	
	Baseline (year)	*Present (year)*	*Baseline (year)*	*Present (year)*
Oxfam GB/TajWSS (7 schemes in 2 districts—DRD and Khatlon Regions)	29% (2011)	49% (2020)	55% (2015)	80% (2019)
UNDP/LITACA (5 schemes in Khatlon Region)	42% (2011)	55% (2020)	66.4% (2015)	69% (2017)
ISW/RRWSSP (7 schemes launched in Sughd Region in 2009)	100% (2009)	100% (2020)	67% (2013)	75% (2019)
ISW/RWSSP FV (7 schemes launched in Sughd Region in 2017)	100% (2017)	100% (2020)	80% (2014)	80% (2019)
MSDSP/SDWSMP (10 schemes launched in 10 districts of Khatlon Region in 2017)	73% (2017)	73% (2020)	64% (2018)	78% (2019)

Further to the progress noted above, the national authorities and regulatory agency have agreed to allow a moderate consecutive increase (by increments of about 10% to 15%) in tariffs over time towards reaching the target.

All systems demonstrated improved collection rates compared with the baseline year with some level of consistency. Few systems showed some decline (by approximately 6%) in certain years, reportedly in part undergoing adaptation to higher and newly endorsed tariff schemes.

The PACs established to extend the application of good governance and consumer engagement mechanisms, have consequently also contributed to improving water fee collection rates (by 11% on average) during 2014 to 2017.

Next required steps:

- Conduct national ability-to-pay surveys to establish better justification for consecutive tariff escalation;

- Sustain and scale up knowledge-based, awareness-raising campaign to support further efforts to achieve transparency and accountability;
- Adequately document as a good governance mechanism and include PACs in regulatory documents and national development plans;
- Ensure further institutional strengthening and capacity building for the Consumers Union to facilitate better prospects for scaling up designed approaches in the future, and provide an enabling environment for deploying rights-based approaches in the sector.

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Change in management system

Uzbekistan case study: water supply and sanitation practices

Supported by SDC projects [1-3]

Location: Villages in Okhunbabayev, Rishton, Pakhtabad, Makhamat, and Ulugnor Districts of Ferghana and Andijan Provinces, Uzbekistan.

Main challenges: Deficit of drinking water supply and sanitation in the village of Uqshi-Dasht for the last 20 years, where the residents used 15lcd to 20lcd before receiving yard/house connections.

In addition, a complex care facility (tuberculosis early treatment clinic and sanatorium) was established in the village in 1967. Initially, it served as a regional hospital specializing in the treatment of active tuberculosis. In 1997, it was converted into an early treatment clinic and regional hospital with capacity for over 200 patients; only patients suffering from latent tuberculosis are currently treated there. Yet, the medical center had neither water supply nor sanitation facilities.

Main goal: The project's objectives included infrastructure development, capacity building for village water committees, hygiene education for women and young people, improving system operational reliability, as well as the quantity and quality of rural water supply.

Main approach: The project's approach was based on decentralized management and on the principle of rural communities deciding how to address water supply issues themselves. Principles included organizing village community meetings involving village dwellers—respected village elders, women representatives of schools, water supply organizations, and other village stakeholders—to discuss how to set up and manage a water supply system for the village. The model capitalized on community engagement—namely, the involvement of village men, women, and children—in the project facilitation, defining their needs and common solutions, and providing technical expertise to set up the village's own water supply system management.

Among other things, the SDC projects included information campaigns for villagers on hygiene. Precise and targeted explanations concerning acceptable hygiene practices—such as handwashing and thorough cleaning of water containers—helped to reduce several widespread diseases primarily affecting children.

To operate and maintain WASH services, drinking water organizations (DWOs) were established to take charge of managing and maintaining the services, including billing and tariff collection necessary for proper maintenance. Their role in the community is highly relevant.

Financial aspects: A full cost-covering tariff (including electricity for the pump, maintenance services, salaries of the staff and technicians, amortization, and so on) was calculated to ensure long-term sustainable system management and likewise the expansion of the system over time. The residents of the target villages presently pay a monthly rate to cover running costs—such as electricity for pumps, maintenance, and salaries. This share set aside for amortization can account for as much as 30% of the water tariff.

The tariff for a single cubic meterage is approximately USD0.4, which is comparatively high for water supply service alone. But it is up to 35 times cheaper than the amount people pay

for water delivered by truck vendors. This tariff reaches its breakeven point if 85% of the population pays for its water, thus leaving room to accommodate poor populations that would not be able to afford the price of water. According to opinion after a transition period, the collection rate can be as high as 90% to 95% and remains at that level as long as people continue to receive water and are satisfied with the work of their DWOs.

Main results: Decentralized water management systems were launched and fully functioning in three provinces of the Ferghana Valley with sustainable operation being carried out by local organizations. During the process of establishing the scheme, one of the focuses was on supporting the umbrella organization and local public and private institutions. In total, the projects helped target communities build a water distribution system for 15,000 users and for 250 patients in the tuberculosis medical center. The water delivered by the systems is disinfected by chlorination and fully corresponds to WHO standards.

In addition, increasing the availability of drinking water has improved the living standards of local residents and the overall well-being not only of individual families but also of entire villages, since water is now readily available through house and/or yard connections. Women and girls no longer need to fetch water and can therefore dedicate their time to other activities.

Thanks to the project's intensive hygiene education program, project interventions also contributed to public behavior changes (mostly with respect to handwashing and household hygiene associated with cooking and indoor water storage). Among other things, the hygiene education program has led to improved key indicators on several major water-borne diseases.

Figure 15. Photos from pilot villages in Ferghana and Andijan Provinces, Uzbekistan

Sustainability: The villagers learned to build and maintain their water supply networks in the long term. As of today (after more than three years of operation), they themselves ensure that the pumps are in good working condition, and monitor the disinfection system, pipelines, reservoirs, and wells. They are also responsible for ensuring that the water network is protected from freezing.

Village committee meetings make joint decisions on water supply. The fact that the residents themselves could participate in decision-making improved the project's public acceptance and made it even more sustainable.

Overall, the system is sustainable owing to the drinking water tariff (approximately USD0.4 per cubic meter) entirely covering all the required costs.

However, certain unsolved issues related to the introduction of the practice remain. For example, the ownership of the rural water supply assets is yet unclear: Article 306 of the new regulations issued by MHCS refers only to ownership of urban water systems without any reference to rural water supply investment.

Next required steps:

- Analyze and compile a list of rural settlements where the model can be applied, thus paving the way for its successful replication throughout Uzbekistan;
- Create a transparent mechanism for involving the public in decision-making on WASH services management, and include it in further legislation;
- Clearly define property ownership of rural water supply assets to support the future development of the WASH sector and attract investment;
- Conduct broad awareness-raising and an information campaign on consumer rights, as well as possibilities for engaging in systems management—key elements for understanding the new approaches.

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Change in management system

Uzbekistan case study: construction of drinking water supply system in Samarkand Kupaki Community (Mahalla) and in Ferghana Gulistan Community

With financial support under UNDP projects [1,2]

Location: Kupaki Mahalla, Samarkand Region, and Gulistan Mahalla, Ferghana Region.

Main partners: WUA in Gulistan Village and WUA 'Musojon Ismoilov.'

Main challenges: Over the past 20 years, owing to dilapidated water supply systems in the two target villages, the local authorities applied temporary solutions by delivering water to the residents, local school, health center, and kindergarten.

Households in the Kupaki Community in the Payaryk District of the Samarkand Region had lived without access to drinking water supply for many years, and were forced to build deep wells—7m to 8m in depth—to get to water of extremely poor quality. This had a negative impact on the health of local residents—namely, 80% of disease incidence was caused by low water quality.

Since 1998 the population of Gulistan Village in the Fergana Valley has almost doubled; water demand has also grown, making the need for a permanent and sustainable water supply solution even more acute.

Main goal: The project's objectives included infrastructure development for two target villages and transferring it to the balance of the managing companies.

Main approach: The rural populations were involved in decision-making about improving access to drinking water. However, the projects did not include a hard component (physical system building) or a budget to cover maintenance and operation (O&M) costs.

Figure 16. New water supply systems in Kupaki and Gulistan Mahallas

However, based on a request from the community, the project was allowed to go ahead and construction works were carried out. In March 2020 the drinking water system was completed. The total cost of the construction of the drinking water system for the Kupaki Mahalla was USD75,000. But the EU project was not involved in the O&M costs. The operation of the system was handed over to the regional drinking water management organization ('suv-oqava').

To provide high-quality service to water consumers, an emergency dispatch service was established to respond to accidents on water supply lines, as well as a service unit to ensure timely accounting and payment by the consumers.

Financial aspects: The total construction cost of the drinking water system for the Kupaki Mahalla amounted to USD75,000 and USD30,000 for the Gulistan Mahalla. The projects were not involved in the systems' further O&M costs (Table 17).

Table 17. Efficiency of project financing of drinking water supply systems [1]

№	Investigation site	Investment amount, million UZS	Total income, million UZS/year	Investment project payback period	Return on investment ratio	Net present value (NPV)
1	Construction of drinking water system (Samarkand)	550,000,000	202.5	2.7	0.36	>0
2	Construction of drinking water system (Ferghana)	247,497,653	102.8	2.4	0.41	>0

In case of Kupaki Mahalla, after the construction was completed, the drinking water supply system was handed over to the authorized state company—management department SAMSUVSOZ Company of Samarkand Region Water Supply System—for further O&M. The tariff was about USD0.3 to USD0.35 per cubic meter of water from the pipe. State support programs are available for the population who are unable to pay; in some cases, the wealthier part of the population covers part of the cost through donations.

In the case of Gulistan Mahalla, the drinking water supply system was transferred to WUA 'Musojon Ismoilov' (NGO), currently ensuring its operational control.

Main results: The Kupaki Village Rural Drinking Water Facility provides access to water for the 2,300 residents, school (450 students), kindergarten (120 children), and rural medical center.

The new drinking water system in Gulistan village supplies water to around 700 households (over 4,500 residents) in the Kuva District in the northeast of the Fergana Region, 20km from Fergana City, where the regional administrative center is situated.

Sustainability: The SAMSUVSOS Company is responsible for maintaining the water supply network, ensuring that the pumps are in good working order, and monitoring the disinfection system, piping, and well.

In addition, both the Kupaki and Guliston Mahalla Committees take part in the review and decision-making (for example, about tariffs), ensuring proper administration. The corresponding systems are fully sustainable thanks to the water tariff entirely covering the required costs.

All rural consumers in the area were identified and installed water meters; the communities established tariff payment schedules agreed among all residents.

Next required steps:

- Clearly define all rural consumers in the area covered by the systems, complete the installation of water meters, and ensure timely payment conditions as per the tariff, as well as involve the public in decision-making and system management;
- Conduct an information campaign explaining consumer rights and obligations, as well as the possibility of engaging in systems management;
- Develop action plans for specific water supply improvement scenarios depending on population growth and increasing water demand;
- Provide opportunities to improve the quality of drinking water supply services for the population and create conditions for attracting extra-budget funds to upgrade the facilities after a certain period of operation;
- Ensure the economically justified profitability of the organization (WUA 'Musojon Ismoilov')—namely, providing water supply to receive a return on investment.

References:

1. https://eeas.europa.eu/delegations/uzbekistan/55145/sustainable-management-water-resources-rural-areas-uzbekistan-technical-capacity-building_en
2. http://www.sie-see.org/en/project/water-sanitation-programme-uzbekistan/