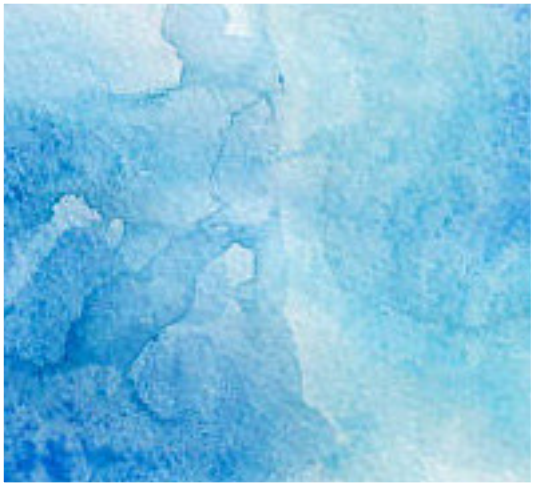
Impact Evaluation

Impact of Cost-Shared Water Supply Services on Household Welfare in Small Towns

Ex-Post Impact Evaluation of a Project in Nepal



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NOTE

In this report, "$" refers to United States dollars.

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Abbreviations

ADB	–	Asian Development Bank
DWSS	–	Department of Water Supply and Sanitation
EIRR	–	economic internal rate of return
FGD	–	focus group discussion
IED	–	Independent Evaluation Department
IPWRA	–	inverse probability weighted regression adjustment
MDG	–	Millennium Development Goal
PSMatch	–	propensity score matching
SDG	–	Sustainable Development Goal
TDF	–	Town Development Fund
TOC	–	theory of change
WSS	–	water supply and sanitation
WUA	–	water user association
WUSC	–	water user and sanitation committee

Currency Equivalents

Currency Unit – Nepalese rupee/s (NRe/NRs)

Currency		**At Appraisal** (16 August 2000)	**At Completion** (30 November 2008)	**At Independent Evaluation** (30 October 2017)
NRs1.00	=	$0.0138	$0.0135	$0.0096
$1.00	=	NRs72.55	NRs74.00	NRs103.88

Contents

Acknowledgments

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THE EVALUATION IN BRIEF

IMPACT OF COST-SHARED WATER SUPPLY SERVICES ON HOUSEHOLD WELFARE IN SMALL TOWNS

Impact evaluations go beyond the standard project assessment criteria and add value by explicitly estimating the development impact of Asian Development Bank supported interventions on the intended beneficiaries. The subject of this ex-post impact evaluation was the Small Towns Water Supply and Sanitation Sector Project implemented in 29 towns in Nepal between 2000 and 2009. This evaluation aimed to add to the thin evidence base on cost-shared community-based water supply and sanitation interventions in small towns, and to fill broader gaps in global evidence and knowledge especially on the institutional and non-health impacts of water supply and sanitation interventions.

The project and evaluation of its impact. At the request of the Government of Nepal, the Asian Development Bank (ADB) approved a sector investment project which was to support the government's Fifteen-Year Plan for Small Towns Water Supply and Sanitation Development, 2000–2014. Main project inputs were cost-shared water supply and sanitation facilities, public awareness campaigns, and health and hygiene education carried out by nongovernmental organizations, and technical support to water user and sanitation committees which included technical and financial training. The primary aim of this ex-post impact evaluation was to assess the impact of the project on the sustainability of water service providers and on household welfare. A quasi-experimental design and mixed methods combined qualitative and quantitative primary data collected during the evaluation. A purposive sample of 10 project towns were matched with 10 comparison towns, and a random sample of households in 20 towns were interviewed using a structured questionnaire. Semi-structured interviews were conducted with water user and sanitation committees, water supply and sanitation divisional offices and municipalities. In the absence of baseline data on outcomes at the town or household level, the evaluation estimated differences in outcomes between project and comparison small towns at a point in time, and between households in these towns by using econometric methods.

FEATURED THEME:

Water Supply in Small Towns in Asia-Pacific

- The **Sustainable Development Goals** set out demanding new targets for water and sanitation, like achievement of universal and equitable access to safe and affordable drinking water for all by 2030.
- The **rapid pace of urbanization in Asia** puts pressure on towns and cities to provide its inhabitants with basic amenities and services—none more important than the provision of clean drinking water and adequate sanitation.
- **Small towns**, with typically fewer than 50,000 inhabitants, have been largely neglected in water supply and sanitation investments, and **lack viable models for water service provision**.
- **Small towns provide a critical role linking rural and urban economies**, providing access to markets and acting as centers for non-farm activities.
- **Cost-shared water supply projects, managed by the community with initial support from governments or international organizations**, are increasingly common in South Asia. But evidence is thin on their effectiveness in small town settings.

Impact evaluation findings. The evaluation found that:

(i) In small towns in Nepal supported by the ADB project, a cost-shared, community-based approach to provision of water supply and sanitation services infrastructure, together with training, awareness campaigns, and institutional development improved the operational and financial sustainability of water services providers, compared to providers in towns that did not receive this support.
(ii) The improved operational and financial sustainability of the water service providers resulted in household access to greater quantity, better quality, and greater continuity of water supply services in project towns compared to towns that did not receive this package of investments.
(iii) Despite the use of best available methods to mitigate selection bias, there could be residual upward bias in the estimated impact of the project.
(iv) In project towns, improvements in performance of the providers translated to improved health and better non-health outcomes like education and increase in women's personal leisure time from reduced burden of water collection.
(v) Findings also suggest that the project contributed to increases in wage income and household consumption expenditure; while there are plausible explanations for these impacts, the evidence must be interpreted cautiously since the chain of causation could not be established conclusively.
(vi) Some avoidable technical design flaws in project towns were observed; had these been correctly anticipated during project preparation, the sustainability gains would have been demonstrably greater. Another shortcoming was the lack of subsidies for poorer households, which was remedied in subsequent phases.

Lessons. The lessons gathered from this evaluation are:

(i) The impact evaluation shows that in small towns, the project approach to water service provision of community-managed systems of cost-sharing with government and institutional support and training is more successful than an approach that is less comprehensive, and community based.
(ii) Progressive tariffs, which are essential for financial viability, are made easier to accept through transparent reporting of the financial status of the water schemes and through demonstrated improvements in level of service.
(iii) Technical design flaws that are not anticipated can impact significantly on sustainability of water supply systems, irrespective of the capacity of the water service provider. Institutional and household gains would have been greater had these issues been addressed.
(iv) Baseline data collected from project and comparison groups are superior to the approach of generating counterfactual data from ex-post identification of comparison group, and will lead to higher quality impact evaluations.

Recommendations. For future ADB operations, this paper offers the following recommendations:

(i) Further test the model that was the object of this evaluation (cost-shared, community-managed water supply systems with institutional support) in other countries with a similar context to see whether it can be replicated and scaled-up.
(ii) Devote more attention to understanding the geohydrological setting when preparing water supply systems in multiple small towns, so that variability in quality and quantity of the source water can be better accommodated in project design.
(iii) Strategically plan and implement impact evaluations for future programs or projects that have potential for replication and scale-up as identified by sector and thematic groups.

Executive Summary

Impact evaluations go beyond the standard project assessment criteria and add value by explicitly estimating the development impact of interventions on the intended beneficiaries. This impact evaluation aims to add to the thin evidence on the impact of cost-shared, community-based water supply and sanitation interventions in small towns. It also aims to fill broader knowledge and evidence gaps on the institutional and non-health impacts of water supply and sanitation interventions. This evaluation found that in the small Nepalese towns supported by an Asian Development Bank project, a cost-shared, community-based approach to the provision of water supply and sanitation services infrastructure, together with training, awareness campaigns, and institutional development, improved the operational and financial sustainability of water services providers, compared to providers in towns that did not receive this support. Households in project towns had access to greater quantity, better quality, and greater continuity of water supply than households in towns that did not receive this package of investments. In project towns, this translated to improved health and better non-health outcomes like education and an increase in women's leisure time from the reduced burden of water collection.

Evidence also suggests that the project contributed to increases in wage income and household consumption expenditure; while there are plausible explanations that these impacts can be related to the project, the evidence must be interpreted cautiously since the chain of causation could not be established conclusively. The model could have been made more inclusive through targeted support for the poor and vulnerable sections of the community. Recommendations are to (i) further test the model that was the object of this evaluation (cost-shared, community-managed water supply systems with institutional support) in other countries with a similar context to see whether it can be replicated and scaled-up; (ii) devote more attention to understanding the geohydrological setting when preparing water supply systems in multiple small towns, so that variability in quality and quantity of the source water can be better accommodated in project design; and (iii) strategically plan and implement impact evaluations for future programs or projects that have potential for replication and scale-up as identified by sector and thematic groups.

Context and Rationale

Cost-shared water supply projects managed by the community with initial support from governments or international organizations are increasingly common in South Asia and elsewhere in developing countries. Evidence on their effectiveness in a small-town setting is, however, thin. More broadly, while there is some evidence on the impact of water supply and sanitation interventions on health, there are gaps in evidence and knowledge on institutional and non-health impacts. Impact evaluations go beyond the standard project assessment criteria and add value by explicitly estimating the development impact of interventions on the intended beneficiaries.

In Nepal, small towns have rapidly developed along the main east–west and north–south highways, and near the border with India. These urban areas contribute significantly to economic growth and poverty alleviation. Water supply and sanitation services in these towns represent key infrastructure constraints. Operational and financial sustainability of water users and sanitation committees, which are the water services providers for the water users' associations in these smalls towns, are at risk from low water tariffs setting and poor collection ratios, poor asset management, and inadequate technical and institutional capacity. Poor awareness and hygiene practices can furthermore negate the beneficial impacts of the water supply delivered. At the request of the Government of Nepal, the Asian Development Bank approved a sector investment project which was to support the government's Fifteen-Year Plan for Small Towns Water Supply and Sanitation, 2000–2015. The Small Towns Water Supply and Sanitation Sector Project was implemented during 2000–2009, and its impacts

are the subject of this evaluation. These are (i) the impact of cost-shared, community-based projects on the efficiency and sustainability of water service providers; and (ii) the impact of piped water supply on premises on the education of children, labor force participation, and household consumption.

The cost-shared, community-based approach to water supply and sanitation services, coupled with training, awareness campaigns, and institutional development, was novel at the time in Nepal. Households in project towns contributed 50% to the investments through in kind (up to 15%), cash contributions (minimum of 5%), and a loan through the Town Development Fund (30%), and received piped water supply connections on their premises. Progressive tariffs were envisaged in project design to cover operation and maintenance costs, debt service, and ensure long-term sustainability.

Data and Methodology

This ex-post impact evaluation used a mix of quantitative and qualitative data sources to assess the impact of the project at the institutional and household levels. All towns that were interested in participating in the project submitted applications. Of these, 29 small towns were selected based on seven selection criteria established to prioritize support. The seven criteria were: (i) poverty incidence and average income levels; (ii) quality, quantity, and coverage of existing facilities in the service areas; (iii) quality and distance of water sources; (iv) average time spent by individuals to collect water; (v) percentage of cash and in-kind contribution by Water User and Sanitation Committee; (vi) percentage of cash and in-kind contribution by local bodies or other sources; and (vii) existence of a structure plan for the town. The weightings of these criteria indicate the intention was to select towns that had lower than average household income levels and poorer existing water supply and sanitation infrastructure. The potential for selection bias—that the capacities of water utilities and unobserved characteristics like leadership and community cohesion were better in project than comparison towns at the time of project start—is an inherent risk of all ex-post impact evaluations. However, best available town characteristics and household level matching were used to minimize this risk.

Ten project towns were purposively chosen to capture the heterogeneity of water sources and development status. In the absence of detailed town-level baseline data on selection criteria scores, identifying the comparison towns posed a challenge. To do this, geospatial characteristics were used that served as proxy indicators of the selection criteria to ensure that they were comparable to project towns; this included area of urban extent using remotely sensed data in the year 2000 at project start.

Since towns had to express interest to participate in the project, a quasi-experimental method was used to estimate impact at the household level. In the absence of baseline data, advanced econometric methods were used to match project and comparison households using a small number of variables that were not affected by the intervention. The difference in impact between households in project and comparison towns was also estimated using the same econometric method of inverse probability weighted regression adjustment. The limitations of quasi-experimental methods were highlighted. These included the potential for bias resulting from unobserved differences between project and comparison towns and households, and a real-world counterfactual in which many households in comparison towns also had access to some level of piped water supply services through previous government funded programs. Internal validity of the design adopted for this evaluation is inferior to randomized evaluation, but the external validity is better.

The semi-structured institutional survey in project and comparison towns included visits to water supply infrastructure in the towns, interviews with institutions, and collection of annual financial statements from the water users and sanitation committees. Households were randomly chosen in each town with equal allocation, and a 10-module questionnaire was administered to all 2,510 households included in the sample, 1,250 in the project towns and 1,260 in the comparison towns. Focus group discussions were conducted in selected project and comparison towns.

Institutional-Level Outcomes

The fundamental difference between this project model and previous models of water supply was that it formalized the principle of cost-sharing between government and communities living in small towns, coupled with targeted institutional training and public awareness campaigns. The viability of the project model is most visibly manifest in the fact that the government's scheme for small towns across Nepal now follows the same model. Training of water users and sanitation committee staff on technical, financial, and administrative issues was effective in developing competent institutions with the capacity to effectively manage and operate their water supply schemes. The levels of water supply service provided in project towns outperformed comparison towns across a range of indicators. Household survey responses to questions on the levels of service corroborated these findings—households in project towns reported higher levels of service than comparison towns on the perception of water quality, duration of service, speed of repairs to disruptions, and overall satisfaction with the water service provider. Some avoidable technical design flaws in project towns were observed; had these been correctly anticipated during project preparation, the sustainability gains would have been demonstrably greater. Another shortcoming was insufficient provision for poorer households, which was addressed in the design of follow on projects through output-based aid and a reduction in community contribution to 30%, comprising 5% cash and 25% loan.

The impacts of community participation on levels of service and sustainability are difficult to measure because all village and small-town water supply schemes in Nepal are community-based. In this regard, the importance of leadership in project and comparison water service providers was observed. Households from project towns, however, had somewhat higher rates of community participation at water users and sanitation committee meetings compared to comparison towns. Attendance at tariff setting meetings was low for both project and comparison towns, showing the challenge to get community buy-in for setting adequate tariffs. Nonetheless, project towns reported higher tariffs, with periodic increases, to a greater degree than comparison towns. Interviews with all stakeholders confirm that the model adopted through this project promotes ownership, transparency, and accountability. Although tariff increases continue to be a contentious issue, the principle of progressive tariff setting to ensure expected levels of service and sustainability is gradually being accepted.

Household-Level Outcomes

The impact of the project at household-level was assessed for multiple outcomes. These were health and education outcomes, time savings and time use, labor force participation rates and wages, and household consumption in project towns compared with households in comparison towns. The evidence from analysis of the survey data indicates that the package of investments made in the project improved household welfare in health and non-health dimensions. Specifically, the household welfare improvements resulted from the access to greater quantity, better quality, and continuity of water supply services that were confirmed in the institutional assessment of service delivery and validated by findings from the household survey. The positive impact estimated for health outcomes is consistent with findings reported in the literature, while the positive impact of water supply on education as estimated for this project is reported less frequently in the literature. A key finding is women's use of time savings for personal leisure that suggests an increase in their discretionary time, implying a reduction in time poverty. The evaluation also found some evidence of higher wage income and consumption expenditures for households in project towns. While there are plausible explanations for these impacts, the evidence must be interpreted cautiously since the chain of causation could not be conclusively established. If the estimated non-health impacts are attributed to the project and included in the stream of project benefits, the economic internal rate of return would be higher than the 11.7% reported in the validated project completion report.

Implications

This evaluation demonstrated that the principle of cost-sharing between the government and the communities living in small towns coupled with targeted institutional support and training,

resulted in better levels of service and sustainability of water supply systems. The model could have been made more inclusive by refining the degree of cost-sharing and including provisions for targeted support to poor and vulnerable households measures that have been adopted in later phases of this project.

Despite the use of the best available methods to mitigate selection bias, there could be residual upward bias in the estimated impact of the project.

Some of the larger towns may be beginning to outgrow the community-based approach and may need to transition to a corporate water utility, management board or private model. At the household level, evidence from this evaluation suggests that a package of investments like that provided through this project to provide piped water supply can have an impact on health and non-health outcomes. The key finding of women's use of time savings for personal leisure implies a strong positive effect on reducing their time poverty by increasing discretionary time available; it also shows the limitations of improved water supply services in providing more opportunities for labor market involvement.

Lessons

The impact evaluation shows that in small towns, the project approach to water service provision in community-managed systems, of cost-sharing with the government, and institutional support and training is more successful than an approach that is less comprehensive and community-based.

Progressive tariffs, which are essential for financial viability, are made easier to accept through transparent reporting of the financial status of the water schemes and demonstrated improvements in the level of service.

Technical design flaws that are not anticipated can impact significantly on the sustainability of water supply systems, irrespective of the capacity of the water service provider. Institutional and household gains would have been greater had these issues been addressed.

Baseline data collected from project and comparison groups are superior to the approach of generating counterfactual data from ex-post identification of comparison group, and will lead to higher quality impact evaluations.

Recommendations

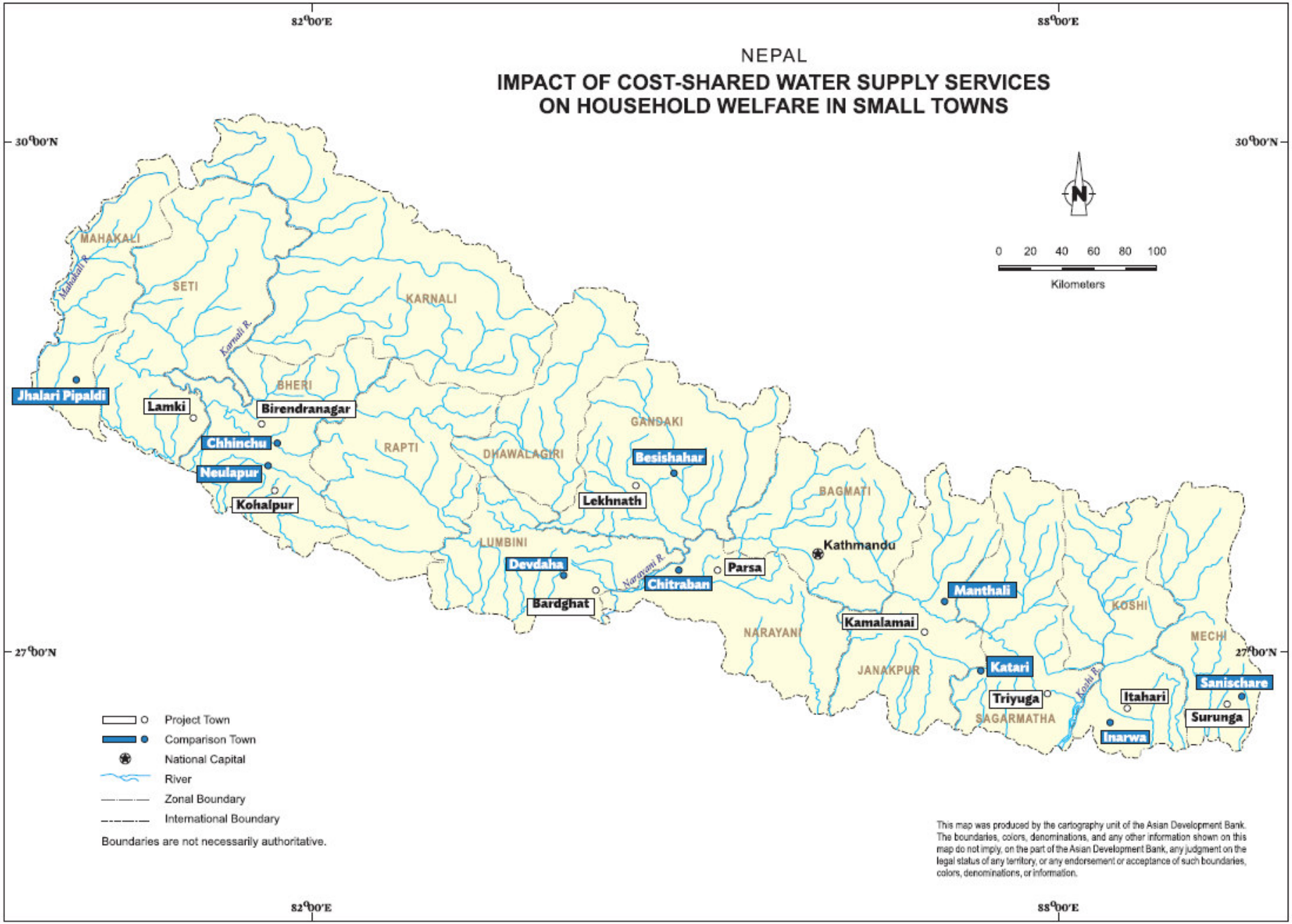
Recommendation 1. Further test the model that was the object of this evaluation (cost-shared, community-managed water supply systems with institutional support) in other countries with a similar context to see whether it can be replicated and scaled-up.

Recommendation 2. Devote more attention to understanding the geohydrological setting when preparing water supply systems in multiple small towns, so that variability in quality and quantity of the source water can be better accommodated in project design.

Recommendation 3. Strategically plan and implement impact evaluations for future programs or projects that have potential for replication and scale-up as identified by sector and thematic groups.

Linkage Between Findings and Recommendations

Findings and Issues	Recommendations
The project introduced the concept of cost-sharing between community and government together with targeted training programs and support, which has resulted in water service providers with better sustainability and levels of service than in towns without this support (Table 1). The levels of service were higher in project towns and the need for tariff increases was explained through meetings with the consumers. These are two essential ingredients to bring customers on board and allows water service providers to efficiently cover operation and maintenance costs, expand their distribution network, thereby increasing revenue further and improving debt service capacity (para. 67). Household survey responses to questions on levels of service corroborated institutional findings—households in project towns reported higher levels of service than comparison towns concerning perception of water quality, duration of service, speed of repairs to disruptions, and general satisfaction with water service providers (Table 2). Household welfare was higher in project towns, when compared with comparison towns, including reductions in the incidence of diarrhea, which is consistent with existing global evidence. Education outcomes like school attendance and reduction in absences from school are less frequently confirmed findings. The key finding of women's use of time savings for personal leisure implies a strong positive effect on reducing time poverty by increasing discretionary time available (Table 3).	Further test the model that was the object of this evaluation (cost-shared, community-managed water supply systems with institutional support) in other countries with a similar context to see whether it can be replicated and scaled-up.
Some towns had problems with both quality and quantity of water as design discharge has not been sufficient at the water treatment plant from the source and the water treatment plant has not been able to handle the high turbidity of the surface raw water during the dry season. Another town faced challenges supplying water due to high calcium levels and the distribution pipelines got blocked due to deposition of calcium in the pipes (para. 68). Design flaws were observed in some project towns concerning source water quality and availability, that could have largely been anticipated through proper technical due diligence to develop a robust conceptual understanding of the geohydrological context (para. 102).	Devote more attention to understanding the geohydrological setting when preparing water supply systems in multiple small towns, so that variability in quality and quantity of the source water can be better accommodated in project design.
Despite the use of best available methods to mitigate selection bias, there could be residual upward bias in the estimated impact of the project (para. 97). Baseline data collected from project and comparison groups are superior to the approach of generating counterfactual data from ex-post identification of comparison group, and will lead to higher quality impact evaluations (para. 103).	Strategically plan and implement impact evaluations for future programs or projects that have potential for replication and scale-up as identified by sector and thematic groups.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National Capital
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Boundaries are not necessarily authoritative.
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CONTEXT AND RATIONALE

Highlights

Institutional level hypothesis. Investments in cost-shared community-led water supply utilities lead to improved levels of service and sustainability in small towns water service providers, compared with towns with similar characteristics without the suite of investments provided by Asian Development Bank.

Household level hypothesis. In towns that received Asian Development Bank support, the package of investments provided by this kind of project improves household welfare in multiple dimensions when compared to households in towns that did not receive this package.

A. Context

1. Urbanization has been a defining characteristic of Asia's growth during the 21st century. Half of the world's urban population lives in Asia and cities account for some 80% of Asia's gross domestic product.[1] Projections estimate that the urban population in Asia will exceed 60% by 2050.[2] Small towns are at the interface of this rural–urban transformation and represent the most numerous urban centers by far, comprising 51% of the urban population in the least developed countries. There is no globally agreed definition of small towns,[3] but they provide a critical role linking rural and urban economies, providing access to markets, and acting as centers for non-farm activities. Along this urbanization trajectory, as the urban population exceeds the rural one, increasing pressure is placed on these small towns to provide its inhabitants with basic amenities and services—none more important than the provision of clean drinking water and adequate sanitation. These basic services are a foundation for health and well-being, environmental sustainability, and economic development.

2. Due to economies of scale and bias towards larger urban centers, small towns have been largely neglected regarding investments in water supply and sanitation (WSS).[4] The absence of viable models for the provision of water services in the small towns that bridge the interface between rural point source provision and the more structured network with household-level connections demanded in urban settings is fundamental to this neglect. The most recent evaluation of the World Bank Group's support for WSS identified small towns as a neglected cohort, receiving low levels of engagement.[5]

3. While the global Millennium Development Goal (MDG) target for improved sanitation was not achieved, the drinking water target was largely met. For example, 93% of the population in South Asia were using an improved drinking water source in 2015, compared with 73% in 1990.[6] Despite this progress, rural-urban inequalities remain. The Sustainable Development Goals (SDGs) set out more demanding new objectives for drinking water, including the achievement by 2030 of universal and equitable access to safe and affordable drinking water for all. World Bank Group's Independent Evaluation Group estimates that three times the current level of investment will be required to achieve these targets (footnote 5).

4. In Nepal, the focus of this evaluation, the MDGs' targets for access to safe drinking water and basic sanitation were achieved. By 2015, some 84% of households had access to an improved source of drinking water, and 81% had access to

[1] UN HABITAT. 2013. *State of the World's Cities 2012/2013*. Nairobi (United Nations Human Settlements Programme [UN-HABITAT]).
[2] United Nations World Urbanization Prospects 2014.
[3] The Global Network of Cities, Local and Regional Governments (UCLG) defines small towns as any urban center with fewer than 50,000 inhabitants, which is convenient for this evaluation, but definitions vary widely across countries. https://www.uclg.org/
[4] M. Tutusasus and K. Schwartz. 2018. Water services in small towns in developing countries: at the tail end of development. *Water Policy*. 20(2).
[5] Independent Evaluation Group (IEG). 2017. *A thirst for change: An IEG Evaluation of the World Bank Group's Support for Water Supply and Sanitation, with Focus on the Poor, FY2007–FY2016*. Washington, DC.
[6] UN. 2015. The Millennium Development Report 2015. New York.

basic sanitation.[7] However, when the project subject of this impact evaluation was approved in 2000, national coverage was only 73% for drinking water and 30% for sanitation. The SDG 6 target goes further than the MDGs and requires that the improved drinking water source be also safely managed, i.e., located on premises, be available when needed, and be free from contamination. SDG estimates for 2015 indicate that in Nepal, only 25% of the rural population and 34% of the urban population have safely managed water supply.[8]

5. Nepal's urban population continues to grow steadily, albeit from a lower base than the region. Data for 2016 indicate that almost 20% of the country's 28.3 million people live in urban centers.[9] But with the introduction of the federal structure in the country and restructuring of local bodies, the municipalities have grown in number from 58 in 2011, to 293 in 2017 including 6 metropolitan cities, 11 sub-metropolitan cities and 276 municipalities with a total municipal population of more than 58%,[10] however, the actual urban extent of these municipalities may vary. The changes in demography in Nepal are reflected in the increasing population density in Kathmandu and in towns along the main east-west and north-south highways and near the border with India. Infrastructure is a major constraint for leveraging the comparative advantages of these urban centers. Urban areas are a major contributor to gross domestic product growth and poverty alleviation: in 2011, urban areas in Nepal accounted for 62% of gross domestic product; and 15% of the urban population were below the poverty line in urban areas, compared with 27% of the rural population.[11] Small towns are not a formal urban development jurisdiction in Nepal; however, based on the National Urban Policy of 2007, these are towns with a population of between 5,000 and 50,000.

6. Amongst the infrastructure deficits in these small towns, water supply and sanitation services are key. Water users and sanitation committees (WUSCs) are the water service providers in small towns and villages in Nepal, reporting to their water user associations (WUAs). Therefore, all such schemes are community-based; however, a cost-sharing approach between government and community has not typically been applied. The WUSCs are formed and registered with the District Water Resources Committee as required under Water Resources Act 1992 and Drinking Water Regulation 1998. They have nine members including four office bearers with at least three of its members being women, with at least one woman as office bearer. The WUSC members are elected by the members of the WUA through secret ballot and have a tenure of 2 years. At the annual general meetings of WUA, the audited financial reports are presented for the members' approval.

7. Due to low levels of investment in infrastructure, low availability and poor quality of drinking water are major challenges in Nepal.[12] The operational and financial sustainability of institutions in this subsector are at risk from low tariffs and insufficient government budgets, poor asset management, and inadequate technical and institutional capacity. Women are disproportionately affected by the poor water supply system because it forces them to spend more time fetching water and fulfilling their household role of caring for those who fall ill from contaminated water. This reduces the time they have for income-generating activities or leisure, or in the case of school-aged girls, for study.

8. In response to these challenges, the Government of Nepal approved in the year 2000, the Fifteen-Year Plan for Small Towns Water Supply and Sanitation Development, 2000–2014, and asked the Asian Development Bank (ADB) for

[7] Government of Nepal, National Planning Commission. 2016. *The Millennium Development Goals, Final Status Report, 2000–2015*. Kathmandu.

[8] WHO/UNICEF JMP. 2017. *Estimates on the use of water, sanitation and hygiene in Nepal, July 2017 Update*. (Joint Monitoring Programme for Water Supply, Sanitation and Hygiene. WHO/UNICEF). https://washdata.org/

[9] ADB. 2017. *Key Indicators for Asia and the Pacific 2017*. Manila.

[10] Government of Nepal, Ministry of Finance. 2016. *Economic Survey 2016–2017.* Kathmandu.

[11] E. Muzzini, and G. Aparicio. 2013. *Urban Growth and Spatial Transition in Nepal: An Initial Assessment*. Directions in Development. Washington, DC: World Bank. http://documents.worldbank.org/curated/en/722941468291027381/Urban-growth-and-spatial-transition-in-Nepal-an-initial-assessment.

[12] ADB. 2013. *Nepal Country Partnership Strategy, 2013–2017, Sector Assessment on Water Supply and Other Municipal Infrastructure and Services.* Manila.

assistance in preparing a sector investment project in support of the plan. The Small Towns Water Supply and Sanitation Sector Project (STWSSSP) was implemented during 2000–2009.[13]

9. The project's expected impact was enhanced human development and reduced poverty through improved and sustainable WSS systems in small towns. This was to be achieved by improving health conditions, increasing the number of children attending school, and increasing the productive time available to residents who previously would have had to travel to fetch clean water. The project framework in the report and recommendation of the President did not include quantitative indicators or targets. However, a key feature of this project was community co-financing of the capital costs, targeted training and support for the WUSCs, and community management of water supply infrastructure.[14]

10. At the time of project appraisal, only 35% of the people living in urban areas outside of Kathmandu had access to piped water supply; however, shared community taps were common and even with piped connection, supply was intermittent and typically only a few hours per day. Households without piped connections in small towns relied on springs, streams, and dug wells.[15]

11. The project comprised four components: (i) public awareness campaign and health and hygiene education, carried out by nongovernmental organizations; (ii) water supply and sanitation facilities, predominantly water supply provision; (iii) technical support to WUSCs, including technical and financial training; and (iv) project implementation assistance. Of the total project cost of $51.0 million, civil works comprised $38.9 million for water supply compared with $2.7 million for public sanitation, drainage, and private latrines.[16] Improved water supply access was provided for 593,000 beneficiaries, representing 76% of houses connected in the project service areas. Additional water supply outputs were 2,115 institutional taps provided for hospitals, schools, and government offices. For sanitation, the project provided 10,022 on-premise latrines for ultra-poor households and 54 public latrines. Health and hygiene education reached 3,152 users, half of whom were women.

12. The primary aim of this ex-post impact evaluation was to assess the impact of the ADB-supported STWSSSP on (i) the capability and sustainability of WUSCs in small towns, and (ii) household welfare in small towns. Small towns that participated in the project were the unit of analysis for capability and sustainability of WUSCs, and households in these towns were the unit of analysis to assess improvements in household welfare.

B. Rationale

13. Impact evaluations go beyond the standard project assessment criteria and add value by explicitly estimating the development impact of ADB supported interventions on the intended beneficiaries. This ex-post impact evaluation aims to add to the thin evidence base on cost-shared, community-based water supply and sanitation interventions in small towns, and to fill broader evidence and knowledge gaps on the institutional and non-health impacts of water supply and sanitation interventions. While there is some evidence for impacts of rural community-based water supply schemes, evidence for such schemes in the urban context is sparse. Knowledge typically focuses on household-level impacts with minimal attention paid to institutional issues. The current evidence base is explored in this section.

14. The debate on appropriate models for water supply provision have often been reduced to a binary discussion on public versus private—a middle way through community or cooperative

[13] The plan was approved by the government on 29 February 2000. ADB. 2000. *Report and Recommendation of the President to the Board of Directors: Proposed Loan to Nepal for the Small Towns Water Supply and Sanitation Sector Project*. Manila.

[14] Communities in selected towns must be willing to co-finance a minimum of 20% of the construction cost and repay an additional 30% of the cost over time through water tariffs. The communities may contribute their share of the construction cost in a mix of cash, labor, or local materials, but with a minimum of 5% of the cost in cash.

[15] See Footnote 13.

[16] ADB. 2010. *Project Completion Report: Small Towns Water Supply and Sanitation Sector Project (Nepal).* Manila.

arrangements offer viable alternatives to conventional approaches.[17]

15. Community water supply projects, implemented and managed by the community with initial support from governments or international organizations has been a common WSS strategy, particularly for rural communities. Community-based organizations' engagement in the water supply is widespread globally, where they fill gaps in service that public and private service providers cannot provide: namely their ability to mobilize the community and act in locations that are beyond the reach of public and private entities. However, the expected long-term benefits of these schemes fail to accrue fully and the sustainability of these schemes is at risk from a range of issues, including attitudinal, institutional, and economic factors, and community participation approaches alone do not guarantee success. [18] One assessment of such schemes in Sri Lanka concluded that a capacity building program, along with an institutional arrangement to provide the support services by the authorities, was critical to ensuring their sustainability.[19]

16. Our review of the literature yielded only one instance of an impact evaluation of water supply and sanitation services in small towns; a study in Ethiopia compared the service characteristics between eight intervention towns and eight control towns in 2016.[20] The focus of that study was on household-level impacts and did not cover institutional or sustainability issues. A case study of a community-based water service provider in a single Terai town in Nepal in 2018 assessed a cost-sharing approach. The good performance of the water service provider since it began operations in 2004 was attributed to "participation, responsiveness, financial transparency, accountability and overall strong commitment and vision, as well as strong technical assistance."[21]

17. The financial viability of institutions is at the core of the Independent Evaluation Group's most recent evaluation of WSS interventions undertaken with support from the World Bank Group in 2017 (footnote 5). The authors report that low-cost recovery by water service providers was a major issue impacting on sustainability, largely due to the inability to implement progressive tariff systems. Insufficient bridging support from the government through fiscal transfers exacerbated this situation. The consequence has been the deterioration of built infrastructure and perpetuation of a culture of dependency on financial support from government and donors.

18. The challenges facing this sector were summarized in a 2010 article in which the authors concluded that the "reasons for the limited progress towards universal access to an adequate water supply include high population growth rates in developing countries, insufficient rates of capital investment, difficulties in appropriately developing local water resources, and the ineffectiveness of institutions mandated to manage water supplies (in urban areas) or to support community management (in rural areas)." [22] The authors also called for better research including randomized controlled studies at the community and household level.

19. A global evidence and gap map for water, sanitation, and hygiene interventions based on existing evidence from 23 systematic reviews and 139 impact evaluations provides a visual overview of what is known and not known about health and non-health effects of different water, sanitation,

[17] K. Bakker. 2008. The ambiguity of community: debating alternatives to private sector provision of urban water supply. *Water Alternatives*. Vol. 1 No. 2. pp. 236–252.

[18] R. C. Carter, S. F. Tyrrel, and P. Howsam. 1999. Impact and sustainability of community water supply and sanitation programmes in developing countries. *Journal of the Chartered Institution of Water and Environmental Management*. Vol. 13 No. 4. pp. 292–296.

[19] M. Amerasinghe, and Nishanthi. 2009. A study of the factors affecting the sustainability of community-managed rural water supply schemes in Sri Lanka. *Tropical Agricultural Research*. Vol. 23 (1). pp. 51–60.

[20] M. Adank, et al. 2016. Looking beyond headline indicators: water and sanitation services in small towns in Ethiopia. *Journal of Water, Sanitation, and Hygiene for Development*. Vol. 6 (3). pp. 435–446. DOI: 10.2166/washdev.2016.034.

[21] S. Rautanen and P. White. 2018. Portrait of a successful small-town water service provider in Nepal's changing landscape. *Water Policy*. Vol.20 (S1). pp. 84–99. DOI: 10.2166/wp.2018.006.

[22] P. Hunter, A. MacDonald, R. Carter. 2010. Water Supply and Health. PLoS Medicine. 7(11). https://doi.org/10.1371/journal.pmed.1000361

and hygiene interventions.[23] The evidence and gap map identified several systematic reviews assessing the effects of water, sanitation, and hygiene interventions on diarrhea, but few systematic reviews assessed effects on other outcomes such as time use, safety and musculoskeletal injury (particularly for women and girls), and economic outcomes. The impact evaluations collected data on health and non-health impacts, and on intermediate outcomes such as access, time use, and willingness to pay. The evidence and gap map indicate that there is good impact evaluation evidence for health impacts, but the evidence is thin for potential non-health impacts like education, labor market, safety, income, consumption, and poverty, and intermediate outcomes like time use and willingness to pay. Such potential impacts are often included in the theories of change on which actual project proposals are based. While this impact evaluation will look into health impacts, the emphasis is on the other impacts of water and sanitation interventions for which assumptions are often made, but less evidence is available, namely non-health impacts like education, labor market outcomes, income, and household consumption.

20. **Findings of relevant completed Independent Evaluation Department evaluations.** An earlier evaluation of the impact of WSS in 2009 covered mostly much smaller and rural communities (in Punjab, Pakistan) but applied a similar community-driven approach, though with no cost-sharing element. It found that in the circumstances of that project, the time saved from fetching water documented in the evaluation had not been translated into more income generation, contrary to the project's assumptions.[24] The evaluation also showed that the project improved high school attendance among girls in the middle socioeconomic group but had no significant impact on primary health, such as the incidence and intensity of diarrhea, or on labor force participation and hours worked. The evaluation noted that the majority of the community-based organizations managing these subprojects lacked resources for capital replacement and routine maintenance work—a situation perhaps more acute for small rural villages than for small towns.

21. A 1999 impact evaluation of ADB support in the WSS sector in Indonesia found that operations and maintenance were inadequate in most cases, largely due to weak institutions and heavily subsidized tariffs.[25] A wider but more limited evaluation of WSS projects in seven countries using a case study approach highlighted that it was not enough to simply provide adequate quantities of good quality water—sanitation, hygiene, and health promotion programs are needed in parallel and are key factors for success.[26] A review of ADB's project completion reports for urban WSS projects in 2015 emphasized the importance of institutional reform for long-term sustainability, something that projects have often attempted but has eluded them.[27]

22. **Conceptual framework of the impact evaluation.** The theory of change (TOC) used for the evaluation of the impact of the Small Towns Water Supply and Sanitation Sector Project is presented in Figure 1. It reflects our interpretation of the thinking and the assumptions that have translated into the project's design and monitoring framework.[28] The TOC is that small towns projects in this sector, apart from infrastructure investments (such as civil works, pipes and machinery), need community

[23] International Initiative for Impact Evaluation (3ie). 2017. Water, Sanitation and Hygiene evidence gap map. http://www.3ieimpact.org/en/evidence/gap-maps/, accessed on 15 March 2017. The global evidence and gap map was based on a comprehensive global search for systematic reviews and impact evaluations. It mapped the existing evidence for water supply, water quality, and hygiene and sanitation programs and projects.

[24] Independent Evaluation Department. 2009. *Impact Evaluation Study of Rural Water Supply and Sanitation in Punjab, Pakistan.* Manila: ADB.

[25] Independent Evaluation Department (IED). 1999. *Impact Evaluation Study of Bank Assistance in the Water Supply and Sanitation Sector in Indonesia*. Manila: ADB.

[26] Operations Evaluation Department. 2002. *Impact evaluation study on water supply and sanitation projects in selected developing member countries.* Manila: ADB.

[27] IED. 2015. *Sustainability of Urban Water Supply Sanitation Operations: Findings and Lessons*. Manila: ADB.

[28] The theory of change (TOC) is a statement of how the inputs provided to a project lead to the intended outcomes and impacts. The TOC identifies the steps in the causal chain linking inputs to outcomes and impacts, and the underlying assumptions that need to hold for the theory to operate as expected. Indicators along the results chain are required to test the plausibility of the impact pathway, to check the availability and ease of collecting data to track these indicators (i.e., evaluability), and to develop the evaluation framework. These indicators also feed into the design of the primary data collection tool, a survey questionnaire.

participation, a good institutional capacity of the community-based operator and contributions in cash or kind from the beneficiaries to cover part of the capital cost. The institutional capacity is enhanced through technical and financial training of local water supply services operators to optimize the impact of the project. In addition, users receive hygiene and health education.

23. At the institutional level, the TOC is that inputs provided by the project will lead to better trained technical and financial WUSC staff with a well-managed tariff setting, billing, and collection system. These inputs, together with technical support from the Department of Water Supply and Sanitation (DWSS), will yield improved cost recovery and improved service delivery. Community participation through co-financing and design and implementation of the water supply infrastructure is deemed to foster greater project ownership. The TOC also assumes that better performance by water supply institutions results in consumer satisfaction with water supply services, which leads to higher cost recovery and supports more capable and sustainable WUSCs and infrastructure.

24. At the household level, the changes are expected to manifest in the service delivery outcomes of access to safe, reliable, and affordable piped water, lower coping costs, and higher quality and quantity of water. Reduced burden of water collection is anticipated to lead to time savings, which is expected to result in more time available for leisure, school, or work. These outcomes, in turn, are expected to lead to improved health, higher school attendance, and higher household income, consumption, or expenditures. The time savings and health and education outcomes are more closely linked to the intervention, while the higher-order outcomes of household income, consumption, or expenditures, which are mediated by external factors, may have weaker links to it.

25. Corresponding to the TOC, the key hypotheses for the institutional and household impacts are presented below.

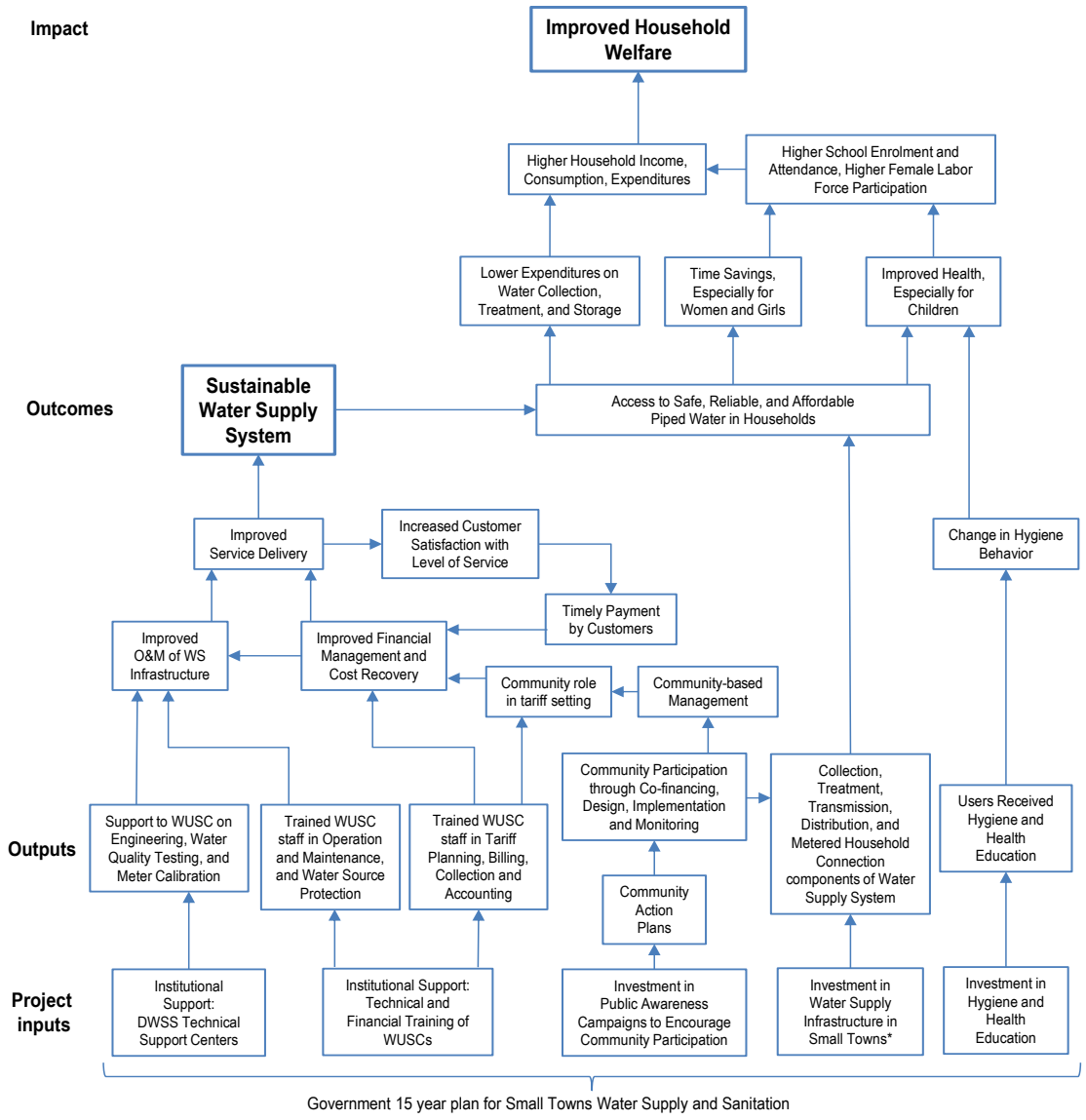
26. **Institutional level hypothesis.** The primary institutional hypothesis is that investments in cost-shared, community-led water supply utilities lead to improved levels of service and sustainability in small towns water service providers, compared with towns with similar characteristics that have not received the suite of investments provided by ADB. To test this hypothesis, the following questions were asked:

(i) Is this kind of approach a viable institutional model for water supply provision in small towns?
(ii) How does technical, administrative, and institutional support of this kind impact on the sustainability of and service delivery outcomes?
(iii) How does community participation contribute to improved service delivery and sustainability?

27. **Household level hypothesis.** The primary hypothesis at the household level in towns that received project support is that the package of investments provided by this kind of project can improve household welfare in multiple dimensions when compared to households in towns that did not receive this package. To test this, the following questions were posed:

(i) Do households in project towns have better health and education outcomes than households in comparison towns?
(ii) Do households in project towns save more time than households in comparison towns, and how do they use this time?
(iii) Do households in project towns have higher labor force participation rates and earn higher wages than households in comparison towns?
(iv) Is household consumption higher in project towns than in comparison towns?

Theory of Change for the Small Towns Water Supply and Sanitation Sector Project



Assumptions
Project Inputs: appropriate design; people are aware of and want the project, and are willing and able to pay upfront fees to participate.
Project Outputs: facilities are properly implemented and used; the communities participate and contribute to operations and maintenance cost; trained WUSC staff are retained.
Project Outcomes/Impacts: time savings are used to increase participation in education and work

* Investments in sanitation are not included in this theory of change and was limited to some surface drainage, public latrines and private latrines for low-income groups.

DWSS = Department of Water Supply and Sanitation, O&M = operation and maintenance, WS = water supply, WUSC = water user sanitation committee.
Source: Asian Development Bank (Independent Evaluation Department).

28. The rest of this report is structured as follows. Chapter 2 outlines the data and methods used for the ex-post impact evaluation. Chapter 3 reports on the institutional-level results. Chapter 4 reports on the household-level results. Chapter 5 discusses implications, lessons and offers recommendations for ADB.

C. Summary

29. Viable models for water service provision in small towns that could bridge the interface of rural point source provision and the more structured network with household-level connections demanded in urban settings are virtually nonexistent. Small towns have been largely neglected in the water supply and sanitation sector, receiving low levels of engagement. The ADB-supported small towns WSS project in Nepal aimed to enhance human development and reduce poverty through improved and sustainable WSS systems in small towns, to be achieved through improved health conditions, increased school attendance of children, and increased productive available time as outcomes from the project. Community water supply projects that are implemented and managed by the community with initial support from governments or international organizations has been a common WSS strategy for rural communities. A notable feature of the project is the principle of cost-sharing between government and communities in small towns, coupled with targeted institutional support and responsibility of operation and maintenance to the community.

30. Focusing on the Nepal small towns WSS project, this impact evaluation aims to add to the thin evidence base on cost-shared community-based water supply and sanitation interventions in small towns, and to fill broader gaps in global evidence and knowledge especially on the institutional and non-health impacts of water supply and sanitation interventions. At the institutional level, the evaluation will test the hypothesis that investments in cost-shared community-led water supply utilities lead to improved levels of service and sustainability in small towns water service providers, compared with towns with similar characteristics without the suite of investments provided by ADB. At the household level, the evaluation will test the hypothesis that the package of investments provided by this kind of project can improve household welfare in multiple dimensions in towns that received ADB support, when compared to households in towns that did not receive the package.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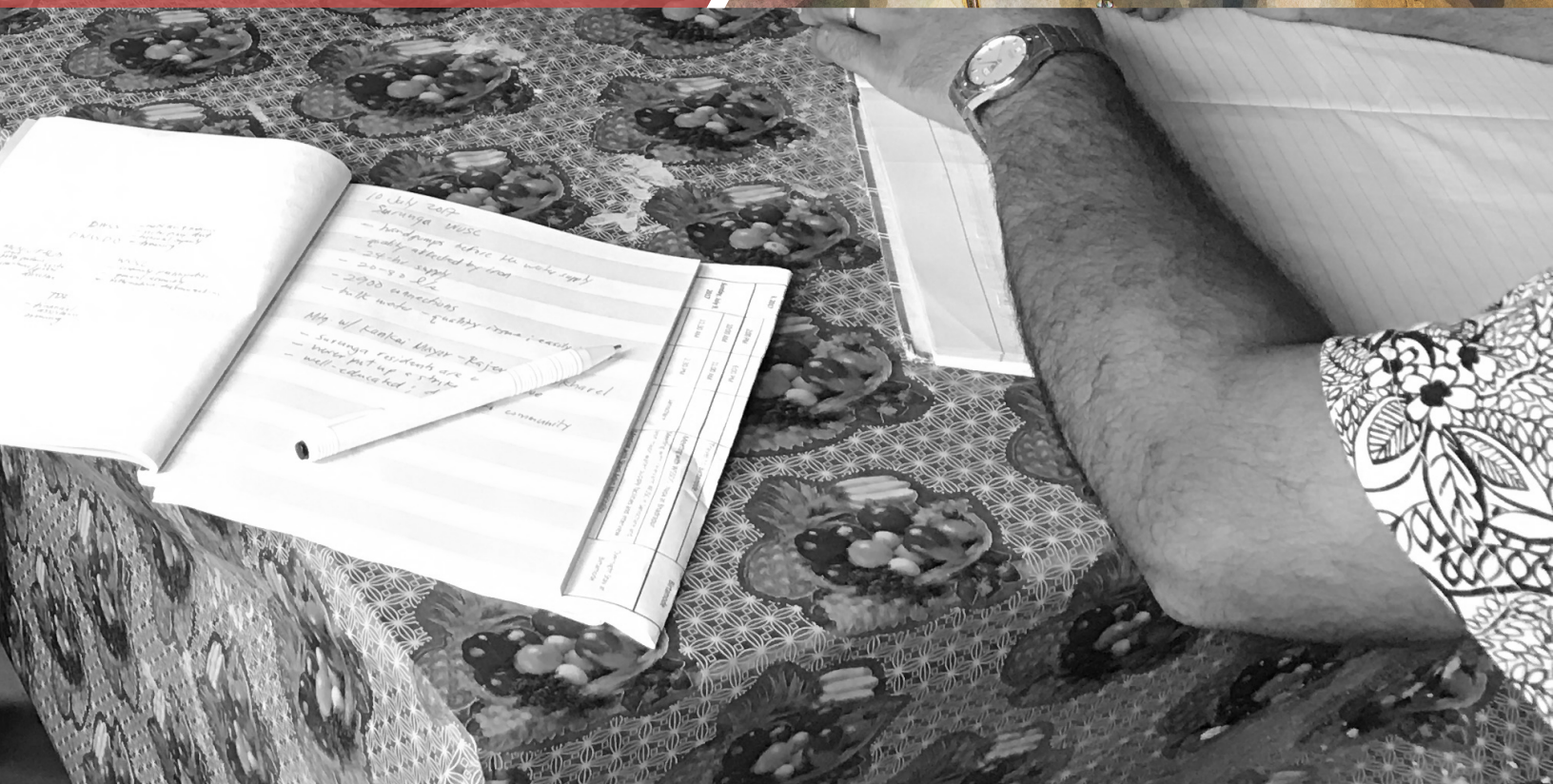
2

DATA AND METHODOLOGY



Highlights

A quasi-experimental design was adopted for this evaluation, and a mix of quantitative and qualitative data sources were used to test hypotheses and links in the causal chain in the theory of change.

In the absence of baseline data, this evaluation made innovative use of geospatial characteristics as a proxy for the original selection criteria established to prioritize towns for participation in the project.

External validity of the design adopted for this evaluation can be considered better than randomized evaluation since it included analysis along the causal chain of the theory of change, the sample of households was representative of the population, the intervention has wide potential for application, and the economic logic of the findings applies more broadly.

31. Impact evaluations compare the outcomes and impact of a program against a counterfactual that shows what would have happened to beneficiaries without the program. Unlike other forms of evaluation, impact evaluations use experimental and quasi-experimental designs to attribute observed changes in outcomes and impact to the program being evaluated. A central feature of this type of evaluation is to credibly establish causal links between the project and potential outcomes and impact, i.e., not just gather evidence that impacts have occurred, but to understand the intervention's role in producing them. For ex-post impact evaluation of a project with no baseline data available, this is typically accomplished through a quasi-experimental evaluation design and by applying mixed methods using a combination of qualitative and quantitative primary data. This ex-post impact evaluation design required the identification of a control or comparison group to estimate the counterfactual. This chapter describes the evaluation design and data sources, data generation, estimation methodology, and ends with comments on the internal and external validity of the design.

A. Evaluation Design and Data Sources

32. This evaluation used a mix of data sources and methods to triangulate and find the convergence of results. Since the project (treatment) towns were not randomly selected to participate in the project, this evaluation used a quasi-experimental design to identify comparison towns that were as similar as possible to the pre-project (baseline) characteristics of the treatment towns. To estimate household-level outcomes and impact, quantitative data were collected through household surveys implemented in the project (treatment) and comparison towns, and qualitative data from focus group discussions (FGDs) implemented in a subset of project and comparison towns. The institutional survey included visits to water supply infrastructure in many towns, interviews with responsible authorities of WUSC, water supply and sanitation divisional offices, municipality, and collection of data and information from WUSC including their annual financial statements. Water service delivery outcomes reported by institutions were cross-validated with household survey responses.

B. Sampling and Household Data Generation

33. **Selection of towns for participation in the project.** The Small Towns Water Supply and Sanitation Project was the first project to introduce the concept of community cost-sharing in upgrading water supply services in small urban areas in Nepal. The government's Fifteen-Year Plan for small towns was approved in 2000 and identified 209 towns as eligible for support. The project implementing agency, DWSS, distributed information to the local authorities and WUSCs of these towns about the procedures for project formulation and held regional workshops to inform stakeholders about the project. Communities had the right to decide whether or not to participate in the project. Selection criteria were established to objectively prioritize towns for participation in the project. The seven criteria were (i) poverty incidence and average income levels; (ii) quality, quantity, and coverage of existing

facilities in the service areas; (iii) quality and distance of water sources; (iv) average time spent by individuals to collect water; (v) percentage of cash and in-kind contribution by WUSC; (vi) percentage of cash and in-kind contribution by local bodies or other sources; and (vii) existence of a structure plan for the town. The weightings of these criteria indicate the intention was to select towns that had lower than average household income levels and poorer existing water supply and sanitation infrastructure. In later project phases the request for town participation was oversubscribed.[29]

34. **Selection of treatment towns for the evaluation.** The selection of the treatment towns was straightforward. The treatment group was chosen from among the 29 treatment small towns where the project was implemented. Specifically, a representative sample of 10 treatment towns was purposively selected to capture the heterogeneity in geography (the Terai and hill) and water sources. The 10 treatment towns were also representative of the range of piped water supply coverage provided to the population before project implementation; two towns had good coverage (>75%), five towns had satisfactory coverage (30%–75%), and three towns had poor coverage (<30%).[30] The estimated water supply coverage for project and comparison towns in the year 2000 before the project started is presented in Appendix 1.

35. **Identifying the comparison towns.** The selection of the 10 comparison towns was not straightforward. The ideal comparison group consists of towns that are identical to the treatment towns at the beginning of the project in all respects except that the treated towns received the project and the comparison towns did not. Given the lack of baseline data on the town scores used for project selection, either from project documents or official government publications, the evaluation used geospatial characteristics.

36. The rationale for using geospatial characteristics is that they are a proxy for the selection criteria established to prioritize towns for participation in the project. The extent (percentage area) and pattern of urbanization (contiguity) were adopted as indicators of the level of urban development and, by extension, coverage levels with basic services. The cost of providing water supply services is a function of the pattern of urbanization—linear or scattered settlements, for example, will require longer distribution networks than more contiguous and compact urban areas. The elevation of the town is indicative of the source of water and, by extension, the cost of building water supply infrastructure, the distance to water source, and the time taken to collect water. The cost of constructing water supply infrastructure would, in turn, influence the community's willingness to contribute 5% cash up front for the capital costs.[31] Urbanization and distance to a highway are also indicators of the state of socioeconomic development of the towns at the time of project start and are proxies for income level. In the absence of data on the scores received by the towns for selection into the project, geospatial characteristics were the best available data on comparable initial conditions of the towns. The 10 selected comparison towns, like their project counterparts, also reflected the same heterogeneity in geography and water sources and had a similar range of piped water supply coverage provided to the population at the time of appraisal.

37. Besides shortlisting comparison towns using geospatial characteristics, this evaluation sought local expert opinion to confirm that the comparison towns were as similar as possible to the project towns at the start of the project period in terms of the seven selection criteria. The comparison towns were drawn from the same district (or same development region), lending further credence to comparability of initial conditions in project and comparison towns.

[29] In the third phase of this project, 56 towns are known to have applied to participate and these were ranked based on the same scoring systems applied in the project. The available project budget was sufficient to cover the 21 best ranked towns.

[30] These estimates of water supply connection coverage at project start are based on interviews with the WUSCs and based on pre-project descriptions in ADB. 2012. *Nepal: Strengthening the Town Development Fund Capacity for Public-Private Partnership* (Financed by the TA Special Fund) Technical Assistance Consultant's Report, TA-7669.

[31] This upfront 5% is estimated at approximately NRs2,500 per household on average.

38. For each project town, three comparison towns in the same or neighboring district were shortlisted for assessment. After confirming that no WSS projects were ongoing in the towns at the time the household surveys were to be implemented, the best-matched town was identified and served as the comparison for the evaluation. This meant that the 10 comparison towns selected had some government investments in water supply infrastructure before the time of the survey but not the package provided by the ADB-supported project with the new community-based, cost-sharing approach.

39. The evaluation made innovative use of remotely sensed spatial data on land cover at baseline.[32] A supervised machine learning algorithm was used to identify comparison towns with urbanization patterns that matched project towns at the time of project start (2000). Remotely sensed spatial data for the year 2000, the year when the project started, was used to identify geospatially similar comparison towns for each of the evaluation project towns. A 2-kilometer radius was designated as the scope for the land classification. The spatial characteristics identified include land cover classes such as cropland, forest, urban built-up area, water body, and open space. The quantitative proportions of the urban built-up area (plus a visual assessment of urban contiguity of the processed images), elevation, and proximity to the east-west highway were used to identify matching comparison towns.[33]

40. **Sample size determination and sampling.** In the absence of data on characteristics of the target population, this evaluation made an approximation to compute the sample size. Following the recommendations in Lohr,[34] the sample size was determined by assuming a proportion of 0.5,[35] margin of error of 3%, and 0.05 level of significance. This yielded a sample size of approximately 1,067 households, which was rounded up to 1,250 per treatment arm for a total sample size of 2,500 households.[36] Given the desired sample size, households were randomly chosen in each of the selected treatment and comparison towns with equal allocation.

C. Collection of Data from Households

41. A household survey was designed to collect quantitative data from the 10 project towns and 10 comparison towns identified for the evaluation (Appendix 1, Table A1.1). The survey questionnaire had the following sections: (i) household roster, (ii) education, (iii) health, (iv) household and community work, (v) market work, (vi) water supply conditions, (vii) institutions, (viii) housing characteristics and assets, (ix) household income, and (x) household expenditure. Project towns completed 1,250 household questionnaires and comparison towns 1,260. Qualitative data was collected through FGDs in the selected project and comparison towns (Appendix 1, Table A1.2).[37] The household survey and FGDs were carried out from 26 July to 8 September 2017. Stata 13 was used to analyze household survey data, and NVivo 7 was used to analyze the FGD transcripts.[38]

D. Estimation Methodology

42. In a quasi-experiment, a valid counterfactual analysis requires a treatment group and a suitable comparison group. Wooldridge (2010) identifies the assumptions needed to allow a causal analysis using observational data like in

[32] United States Geological Survey/NASA Landsat 7 landcover database. https://landsat.gsfc.nasa.gov/landsat-7/ (accessed 1 April 2017). Whenever the Landsat 7 data from the year 2000 appeared insufficient to provide reliable classification information, data from Google Earth historical timeline was also used to improve classification results, i.e., land classification spatial results were compared with Google Earth historical timeline as accuracy cross-check.

[33] The elevation of the town was a proxy for water source and, by extension, the technology that would be needed for the water supply infrastructure—towns in the plains have access to groundwater, while towns in the hills mainly rely on surface water.

[34] S. Lohr. 2010. *Sampling: Design and Analysis*. 2nd ed. Boston: Brooks/Cole Cengage Learning. Sample size = $(Z^2_{\alpha/2}S^2)/e^2$. $Z_{\alpha/2}$ is the Z value at 0.05 level of significance, i.e., 1.96; S^2 is the variance (0.25=0.5*0.5), and e is the margin of error (.03).

[35] Maximum variance is at proportion of 0.5.

[36] The treatment arms are (i) towns with project (treatment) and (ii) towns without project (comparison).

[37] The following themes were explored in the focus group discussions: (i) water sources, quality, availability, and reliability; (ii) health benefits; (iii) hygiene and sanitation practices; (iv) time savings and use of time saved; (v) participation in water users' meetings; (vi) registration and tariffs; and (vii) household use of water.

[38] Stata is a general-purpose statistical software package created by StataCorp. NVivo 7 is a software that supports analysis of qualitative data.

this evaluation, namely, (i) ignorability or unconfoundedness, and (ii) overlap.[39] Ignorability is defined as conditional on the covariates, the treatment variable, and the outcomes are independent. Overlap, on the other hand, states that each individual has a positive probability of receiving each treatment level. The identification of the treatment and comparison groups and the corresponding estimation methodologies to analyze household survey data, improve the chances of satisfying the two assumptions of a valid counterfactual causal analysis.

43. A technical summary of the econometric methods and estimation procedures is in Appendix 2. The three econometric methods used to estimate the average treatment effects were: (i) town matching (town pairs), (ii) propensity score matching (PSMatch), and (iii) inverse probability weighted regression adjustment (IPWRA).[40] The IPWRA method uses propensity score weighting and regression adjustment to generate impact estimates. This method is doubly robust because only one of either the propensity score model (treatment model) or the regression adjustment model (outcome model) needs to be correctly specified to generate consistent estimates of impact. Given the sampling used in the evaluation, the IPWRA estimation adjusted for clustering of standard errors at the small town level.

44. **Choosing the household level matching variables.** Since the data on household characteristics were generated from post-implementation survey, the choice of covariates (or matching variables) to be used should be limited to those that are not readily affected by the treatment to satisfy the unconfoundedness (ignorability) assumption.[41] Among the candidate variables not readily affected by the treatment are the characteristics of the household head, e.g., age, sex and education, and the estimated family size at the start of the project (2000). The age and sex of the household head are not affected by the treatment. Given the plausible assumption that the household heads would have already completed their education by the year 2000, this also will be exogenous to the treatment.[42] Finally, the number of children at the start of the project is also not affected by the treatment.[43]

45. **Balance analysis.** The characteristics of the treatment and comparison groups are compared to test for balance. The balance of socioeconomic status between treatment and comparison households ensures that near-identical households are compared so that differences in outcomes can be attributed to the treatment. Balance analysis of the socioeconomic variables after matching and weighting are presented in Appendix 3.

46. **Overlap.** The other important assumption in treatment effect estimation besides conditional independence is the overlap, i.e., $0<p(x)<1$, where p(x) is the propensity score of being in the treatment group. Comparison between the treatment and comparison groups will be hampered if there is a lack of overlap at all values of x. The existence of the overlap will be checked in the analysis.

47. **Limitations.** There were two sources of selection bias—towns chose whether or not to submit an application to participate in the project (self-selection), and project towns were selected from this pool of applicants. To reduce bias from self-selection, the treatment and comparison small towns were matched using observable baseline characteristics that were a proxy for selection criteria established at the start of the project period, and households were matched based on a small number of observable

[39] J. Wooldridge. 2010. *Econometric Analysis of Cross Section and Panel Data*. 2nd ed. MIT Press. Underlying these assumptions is independent and identical distribution, which is also known as Stable Unit Treatment Value Assumption (SUTVA) in the treatment effects literature.

[40] The average treatment effect is the average impact of treatment on the entire eligible population.

[41] Footnote 39, pp. 909–910.

[42] The more popular indicator of socio-economic status is household income or expenditure, but these indicators are endogenous. The education of the household head, on the other hand, is known to be highly correlated with household income or expenditure but will not be affected by treatment under the plausible assumption that household heads have completed their education before the beginning of the project. This assumption is plausible since the average age of heads of household was 50 in project towns, and 49 in comparison towns.

[43] The model covariates are age of household head, square of age of household head, sex of household head, education of household head, and family size in 2000.

characteristics that are not affected by the project. Matching on observable characteristics assumes that there are no unobserved differences in the treatment and comparison towns and households that are also associated with the outcomes of interest. There may be unobserved characteristics that differ between treatment and comparison towns and households that affect the outcome and could result in biased estimates. Although a matched difference-in-difference method can reduce the risk of bias in the estimation, this was not feasible due to the lack of baseline data at the household level. Matching at the town and household levels mitigated bias due to observable characteristics, but residual bias from unobserved characteristics could persist. If there were unobserved characteristics like more charismatic leaders or better community cohesion in project towns that led these towns to apply to participate in the project, the magnitude of the impacts attributable to the project could be lower than the estimates reported in this evaluation, i.e., the estimated impacts could be biased upward.

48. Another limitation is that many households in comparison towns also had some level of access to piped water supply in the household through previously implemented government or development partner activities.[44] In this case, the differential impact would have been much greater if the comparison towns had had no access to piped water supply—a situation that is no longer prevalent in Nepal.

E. Internal and External Validity

49. This evaluation adopted a quasi-experimental design, with no baseline data available at the household level. Treatment and comparison towns were matched on observable baseline characteristics, and households were matched on a small number of covariates that are not affected by the treatment. Since there is a potential for bias arising from unobservable characteristics, the internal validity of this design is inferior to that of a randomized evaluation design.

50. The external validity of the design adopted for this evaluation can be considered better than randomized evaluation since it included an analysis along the causal chain of the TOC, the sample of households was representative of the population, the intervention has wide potential for application, and the economic logic of the findings applies more broadly.

F. Summary

51. This evaluation used a mix of quantitative and qualitative data sources to test the household-level hypotheses and links in the causal chain in the TOC. For the household survey, selection of project towns was straightforward, with 10 towns purposively selected to capture heterogeneity in geography and development status. Matching comparison towns were selected using geospatial characteristics that served as proxy indicators of the original selection criteria. Households were randomly chosen with equal allocation per town, and a 10-module questionnaire was administered to all households included in the sample. FGDs were conducted in the selected project and comparison towns. Three econometric estimation procedures were used to estimate the average treatment effect. Given the lack of baseline data at the household level, a small number of variables not affected by the treatment were used to match households in treatment and comparison towns and compared for balance. The limitations of quasi-experimental methods were highlighted. These included the potential for bias resulting from unobserved differences between treatment and comparison towns and households, and a real-world counterfactual in which many households in comparison towns also had access to some level of piped water supply services through previously implemented activities of the government or other development partners. The internal validity of the design adopted for this evaluation is inferior to randomized evaluation, but the external validity is better.

[44] Government of Nepal, Central Bureau of Statistics. *Nepal Living Standards Survey, 2010–2011*. Kathmandu. The most recent wave of the Nepal Living Standards Measurement Survey (2010–2011) estimated that 49.3% of the urban population and 14.1% of the rural population had access to drinking water piped into the household.

3

INSTITUTIONAL-LEVEL OUTCOMES

Highlights

Viability of chosen model. The project formalized the principle of cost-sharing between government and communities in small towns, coupled with targeted institutional support and responsibility of operation and maintenance vested to the community. Viability is manifest in that the government's own scheme for small towns across Nepal now follows the same model, and that small towns applying the same approach now have better and more sustainable water supply.

Training. Training of staff from water users and sanitation committees on technical, financial, and administrative issues was critical in developing competent institutions with better capacity to effectively manage and operate their water supply schemes in the long run.

Sustainability, service delivery, and community participation. Community-based and cost sharing model promotes ownership, transparency, and accountability, thereby improving community participation and contributing to improved levels of service and sustainability.

52. Institutional issues related to water supply systems in small towns were not studied in detail in previous impact evaluations. Yet, much of the literature identifies institutional issues as a critical factor in their success and long-term sustainability. This evaluation presents evidence collected through semi-structured interviews with WUSCs, regional offices of the DWSS (Water Supply and Sanitation Divisional Offices), and municipalities, including with their mayors. Qualitative and quantitative data were collected with a focus on (i) viability of the adopted institutional model, (ii) impact on sustainability and service delivery, and (iii) contribution of community participation to outcomes.

A. The Viability of the Institutional Model Chosen

53. The Small Towns Water Supply and Sanitation Project, the first project to introduce the concept of community participation in the upgrading of water supply services in small urban areas in Nepal, arose directly in response to the government's Fifteen-Year Plan for Small Towns Water Supply and Sanitation Development, 2000–2014 (footnote 13). The selection criteria were established to objectively prioritize towns for participation in the project, with the intention of selecting towns that had lower than average household income levels and poorer existing water supply and sanitation infrastructure, as well as a willingness of the community to contribute to upfront capital costs (Chapter 2). Cost sharing between government and community was on a 50:50 basis. The 50% provided by the community was funded through a 30% loan from the Town Development Fund (TDF), to be paid off in 15 years through progressive tariffs, 15% in-kind contribution, and 5% upfront cash contribution. Under the 50:50 modality, the service areas were curtailed in some instances and poor and marginalized groups were generally excluded due to their inability to make a financial contribution. The shortcoming was reported in the project completion report and confirmed by the Independent Evaluation Department (IED) validation report.[45] In later phases of the project, the overall community contribution was revised to 30% (5% cash and 25% loan), and in-kind contribution removed, and output-based aid was introduced to serve poor and marginalized groups (Appendix 4). However, the over-riding point is that the principle of cost-sharing for water supply infrastructure between communities in small towns and government, coupled with targeted institutional support, was accepted by all stakeholders and seen as a viable model.

54. The WUSCs elected by the communities' WUAs were involved in the project from the planning stage and were fully responsible for the operation and maintenance of the system after its construction. These committees were generally very active, and their members worked voluntarily to serve the community.

[45] Footnote 16; IED. 2012. *Validation Report: Small Towns Water Supply and Sanitation Sector Project in Nepal*. ADB: Manila.

55. The WSS divisional offices played an important role during the preparation and selection of towns and helped create awareness of the project among the community, encouraged them to apply for the project, and assisted them in preparing their application. They also provided technical support to the committees after completion of the project. Such support focused especially on water quality and electro-mechanical equipment. However, the activities proposed in the project for meter calibration were not effective.

56. Support from municipalities or local bodies was key to project implementation as they provided land for water supply facilities and helped resolve disputes relating to the sources of the water. As WUSCs are formed with the consent of municipalities, the coordination between the municipality and WUSC is generally good. However, coordination could be improved in road construction and maintenance. In one case, in the Terai, the lack of coordination between local government and the WUSC on road widening activities led to ruptured water pipes and valve chambers, which lowered water supply service levels. In another case, in the hills, uphill road maintenance increased the sediment load to the source water, which overwhelmed the water treatment plant of the downhill small town.

57. The DWSS and TDF conducted the training needs assessments of the WUSCs and standard training modules were developed for WUSC members and WUSC technical, financial, and administrative staff. The DWSS provided technical training either in the district or at its central training center in Kathmandu. The TDF developed a number of training modules and provided training to selected staff during the construction stage. The training modules included: (i) a training in the operations and accounting manuals for managers; (ii) training in the billing software; (iii) training in office operation and maintenance, including writing of job descriptions; (iv) training in the accounting manual including financial and budget preparation; and (v) bank account operation training.

58. During the early stages of the project, tariffs were fixed unilaterally by the WUA and usually set at too low a level, jeopardizing sustainability. Now, the tariff rate is fixed taking into account recommendations of the TDF. The TDF's role is to provide transparent information to the community about how the tariff is being calculated and what will happen if progressive tariffs are not applied.

59. The WUSC is accountable to the community for providing an improved supply of water as per the agreed performance standard. The consumers can directly evaluate the performance of the WUSC based on the level of service provided. All consumers have voting rights for the election of WUSC members and chairperson and have the power to vote out nonperforming chairperson and WUSC members.

60. Finally, the water supply systems in these towns was designed for projected population for 15 years and many have exceeded their design capacity and now require expansion. At least two towns, Itahari and Birendranagar, have over 100,000 inhabitants, at the time of evaluation, raising the issue of how long these larger towns can be sustained on a community-based model and at what point should they transition to an alternative model, such as a corporate water utility, management board or private system. In fact, Lekhnath, Birendranagar, and Itahari have grown so much in population that consumers are not allowed to attend the annual general meeting, but the attendance is made through their representatives selected by ward or locality. A related issue is the parallel statutory responsibility of municipalities to provide water and sanitation services to their inhabitants. Local elections were successfully held in 2017, for the first time in almost 20 years; and, Nepal is now embarking on a new federal structure. In our interviews, with municipalities and recently elected mayors, they generally indicated their support and appreciation for the WUSCs and their activities, which they plan to coordinate through policy, planning, and facilitation. There may be a need to clarify the governance arrangements between the WUSCs and the municipalities. Overall, ADB and the government have found the institutional model for water supply provision through community participation and cost-sharing to have worked well and proved a viable model for scaling up across Nepal. ADB is now supporting the third phase of the small towns WSS projects, covering over 70 towns. This cost-sharing for WSS services in small towns has

represented a paradigm shift and has been adopted as government policy in co-financed projects, typically on a 70:30 basis. Whether this evaluation can confirm the impacts of the project approach on institutional sustainability and levels of service is assessed in the next section.

B. Impact on Sustainability and Service Delivery

61. Table 1 presents the indicators on institutional sustainability and levels of service for the project and comparison towns. This section presents the average values for these towns, while the results for individual towns are presented in Appendix 5, indicators for water supply levels of service are presented in Table A5.1 and indicators for institutional sustainability in Table A5.2.

62. Consumers in project towns reported better service level than those in comparison towns in both quantity and quality of water (Table 1). The impact evaluation registered that the duration of water supply is better in project towns (14 hours per day) than in the comparison towns (8 hours per day) by about 6 hours. This is, however, an average: three project towns—Bardghat, Parsa, and Surunga—are providing 24-hour supply to consumers throughout the year. These towns are located in the Terai and have groundwater as their water source. Three project towns in the hills—Birendranagar, Kamalamai, and Triyuga—have, however, been supplying less than 4 hours per day on average and are prone to face severe water shortage during the dry season. Nevertheless, this situation is better than those of the comparison towns in the hills—Chhinchu, Katari, and Manthali—only have supply 2 or fewer hours per day. All these six towns have surface water as their source and WUSCs reported severe water shortages during the dry season. The conclusion remains that the project had notable effects on the duration of water supply in both the hills and the Terai towns, but there is still need for improvements, particularly for surface water sources.

Table 1: Sustainability and Service Delivery Outcome Indicators Derived from the Institutional Survey

Indicator	Project Towns Average	Comparison Towns Average
Level of Service		
Supply duration (hours)	14	8
Daily volume of supply (m^3)	3,641	908
Metered connections (% of total connections)	99	98
Annual supply disruption frequency	3	5
WUSC capacity for major repairs	Yes (9 towns); No (1 town)	Yes (4 towns); No (6 towns)
Water testing facilities available	Yes (6 towns); No (4 towns)	Yes (2 towns); No (8 towns)
Staff per 1,000 connections	4.67	6.92
Computerized billing system	Yes (9 towns); No (1 town)	Yes (1 town); No (9 towns)
Sustainability		
Collection ratio (%)	90.87	93.70
Operating ratio (%)	0.73	1.57
Expansion of network from its own funds	Yes (8 towns); No (2 towns)	Yes (2 towns); No (8 towns)
Water connection charge (NRs)	13,602.00	9,659.50
Tariff for 10 m^3 (NRs)	148.75	136.11
Tariff for 15 m^3 (NRs)	258.22	190.70
Water safety plan status	Yes (5 towns); No (2 towns); In process (3 towns)	Yes (4 towns); No (5 towns); In process (1 town)

m^3 = cubic meter, NRs = Nepalese rupees, WUSC = Water User Sanitation Committee.
Source: Asian Development Bank (Independent Evaluation Department). Institutional survey of 20 towns July–October 2017.

63. Water treatment plants have been constructed in all project towns except Parsa, where the raw water (groundwater) is of good quality and only chlorination is needed. Only five comparison towns have water treatment plants. The chlorination in project towns is better organized and is done more routinely than in comparison towns, where manual chlorination is done only occasionally. Similarly, the water quality monitoring in comparison towns is limited due to a lack of availability of water testing kits. Six project towns have water testing kits and the remaining four towns are in the process of procurement, but only two comparison towns have water testing facilities.

64. The project towns have introduced advanced technologies in the management of utilities compared to the non-project towns. All of the project towns except Triyuga have computerized billing and accounting systems in use, while only 1 of 10 comparison towns has introduced a computerized billing system. Lekhnath has also introduced mobile-based metered reading and online payment of bills and other project towns are also preparing to introduce online bill payment system.

65. The average revenue collection ratio in project towns is 91% while this ratio is higher at 94% in comparison towns. The lower average collection ratio in project towns is, however, due mainly to the very low collection ratio of 66% in Triyuga, where the water service level is poor and leadership of WUSC has not been encouraging consumers to pay their water bills on time. Triyuga is an example of the impact that the lack of a committed WUSC leadership can have on the sustainability of the intervention, despite the measures taken by the project. Another conclusion is that computerized billing does not seem to be crucial for the effective collection of tariffs, although it does improve efficiency and support follow-on initiatives like online billing.

66. All project towns have been able to finance their operation and maintenance expenditure from the revenue generated from the water sales, except Triyuga. The average operating ratio of project towns is 0.77.[46] The operating ratio of the three towns that have 24-hour supply is less than 0.70 showing the strong financial condition of these utilities. The average operating ratio of comparison towns is 1.532, with 6 out of 10 towns having operating ratios above 1.0, meaning that they get less revenue than their operational expenditures. This shows the weaker financial condition of water service providers in the comparison towns, and the dependence on government support to sustain the water supply. Consistent with these results is that eight of the project towns (except for Triyuga and Kamalamai) have been able to extend the distribution network within their service area from their own resources while the WUSCs of only two comparison towns were able to do this.

67. The water tariff is higher in the project towns, indicating the greater readiness of the population to pay for services.[47] Project towns' households have been accepting progressively higher tariffs in contrast to comparison towns (Appendix 6). Our evaluation indicates that there needs to be a demonstrated improvement in the level of service before the community accepts tariff increases. Project and comparison towns both struggle with convincing households of the need for tariff increases, as reflected by the similarly low levels of attendance at tariff meetings. However, the project towns succeeded in convincing households of the need for progressive tariffs through demonstrated improvements in the levels of service. This observation reinforces the approach outlined in ADB's Water Operational Plan, 2011–2020 that links tariff reform to improved service delivery.[48]

68. The three project towns which have maintained 24-hour supply have been able to pay back their loan to the TDF ahead of the payment schedule. Four other towns have been making debt service payments as per schedule. The remaining three project towns—Kamalamai, Kohalpur, and Triyuga—have not been able to start repayment of the loan, though have paid a part of the interest. Kamalamai and Triyuga have had problems with both the quality and quantity of water. Design discharge from the source has

[46] Operating ratio = annual operating expenditure/annual operating revenue.

[47] Average cost for consumption of 10 cubic meters: NRs152.40 (project town), NRs138.20 (Comparison Town).

[48] ADB. 2011. *Water Operational Plan, 2011–2020*. Manila. https://www.adb.org/sites/default/files/institutional-document/33022/files/water-operational-plan-2011-2020.pdf.

not been sufficient and the water treatment plant has not been able to handle the high turbidity of the surface raw water during the dry season. In Kohalpur, the WUSC has faced challenges supplying water due to high calcium levels, as the distribution pipelines got blocked due to the deposit of calcium in the pipes. Some of these issues reflect poor investigations at the feasibility stage—these issues should have been better diagnosed and addressed in the design.

69. Interviews with the WUSC in the comparison towns indicate that they refrained from taking loans, opting instead for government grant funding. Some comparison towns did not apply for the project because they wished to wait and see how the project performed. Some towns were not confident about their ability to pay back the loan and others were of the opinion that the government was responsible for funding capital investment in water supply services. These perceptions were generally based on the opinion of the leaders of the water users committee rather than the community itself. Field interviews with locals did not raise doubt that the project towns had a more affluent population or had councils with more financial resources.

70. To validate the results of the institutional survey, the household survey included modules that captured customers' experience of the quality of services provided. The findings are summarized in Table 2. In most cases the results from the household survey corroborate the results from the institutional survey.

71. Levels of service indicators such as the duration of supply, water quality, frequency of disruptions, and speed of repairs were consistently better in project towns. Project households reported statistically significant higher levels of perceived water quality in terms of odor, clarity and taste. In addition, the household survey data indicate that nearly 89% of households had access to piped water in project towns, while 47% had access in comparison towns. However, overall household satisfaction with the water service providers in project and comparison towns was not statistically different. While the number of major disruptions to service was not statistically different at 2–3 per year, some 72% of households in project towns reported that major disruptions are fixed within 2 days in comparison to only 26% that reported this in the comparison towns.

Table 2: Household Survey Indicators of Service Level and Satisfaction with Water User Sanitation Committee

Indicator	Project Towns Average	Comparison Towns Average	T-value	P-value
Level of Service Indicators				
Duration of supply (hours/day)	12	7.5	9.8	0.000
Major supply disruption (per year)	2.62	2.72	0.1	0.938
Major disruption fixed within 2 days (%)	72	26	27.9	0.000
Water quality (clear)	81	77	3.3	0.001
Water quality (no odor)	95	84	10.4	0.000
Water quality (taste)	78	70	5.0	0.000
Water quality (satisfied with quality)	81	72	5.7	0.000
Household Satisfaction with WUSC				
Attended WSP meeting (%)	24	21	2.828	0.005
Attended tariff setting meeting (%)	13	13	0.979	0.328
Tariff setting procedure fair (% of respondents)	59	68	(3.404)	0.001
Tariff affordable (%)	78	88	(5.2)	0.000
Consumer complaint to WSP (%)	12	18	(3.618)	0.000
Complaint resolved within 2 days (%)	53	36	27.9	0.000
Consumer satisfied with WUSC (%)	77	74	1.291	0.197

( ) = negative, P-value = significance level, T-value = results of T-test (differences are significant at the 5% level for absolute T-values equal to or greater than 2), WSP = water safety plan, WUSC = Water User Sanitation Committee.
Note: Institutional surveys were conducted on 3–14 July and 9–18 October 2017. Household satisfaction as measured by the household survey conducted for the project in June–September 2017.
Source: Asian Development Bank (Independent Evaluation Department). Questionnaire survey of 2,510 households in 20 towns, conducted July–September 2017.

Similarly, households in project towns reported fewer complaints and quicker resolution of complaints than comparison towns. For questions concerning fairness and affordability of tariffs comparison towns expressed higher levels of satisfaction; however, it should be borne in mind that comparison towns have lower tariffs and fewer upward adjustments than project towns (Appendix 6).

72. Overall, the data in Tables 1 and 2 confirm the earlier ADB and government conclusions that institutional sustainability and the levels of service are better in project towns, validating the effectiveness of the cost-shared approach taken to small town community-based WSS, with emphasis on training, public awareness campaigns, and education drives.

C. Contribution of Community Participation to Improved Service Delivery and Sustainability

73. The default model for WSS services in villages and small towns in Nepal is a community-based approach. Therefore, there is no opportunity to examine a with or without community participation scenario. However, a significant difference between the project and comparison towns is that the communities in the project towns contributed upfront to the capital costs for WSS infrastructure. This may reflect better social cohesion, more charismatic leadership, or other intangible factors that are difficult to measure. In addition, while the community contribution was 50% of capital costs, only 5% was typically in the form of upfront cash, the remainder being covered by in-kind contributions, e.g., labor (15%), and by the TDF loan (30%). Based on the project costs and number of households served in each town at project start, this upfront 5% is estimated at approximately NRs2,500 per household on average. Based on the institutional interviews and responses to the household-level questionnaire, some qualitative insights can be identified.

74. The community participation approach taken in the project—once the project towns' water user committees accepted the requirement of cost sharing and operation and maintenance responsibility—promoted further ownership of the water supply schemes by the towns. The approach taken improved participation from the community in operation and maintenance of the system. Consumers were witnessed to assist the utility by reporting leakages and conserving water, more so than the consumers in the comparison towns. The WUSCs have gained a sense of responsibility to the people and have built up good communication with them. These characteristics contribute to improved service delivery. Community participation is difficult to measure directly, but the results reported in Table 2 indicate that about 24% of households in project towns attended the annual meeting of WUSC, higher than the 21% of households in comparison towns.[49] While the attendance of community at the tariff setting meeting was low at 13% in both project and comparison towns, tariffs in project towns were set higher and have been increasing, indicating a greater acceptance of the principle of progressive tariffs.

75. Community involvement in the management of services has also provided more transparency of financial transactions. WUSCs or WUAs have been conducting annual general meetings and presenting audited annual financial reports for approval. The community receives a clear picture of the income and expenditure of the utility from these audit reports, which are approved by the WUA. This has helped the community to make informed decisions and reach a consensus on tariff adjustment (tariff adjustment is still a sensitive issue and requires convincing for its approval). This has contributed to an increased financial sustainability of the water supply systems. Interviews established that some poor performing project towns and many comparison towns alike had a history of delayed annual general meetings and audited financial reports.

76. Out of the 29 WUSCs covering all small towns in the project, eight have repaid all their debt ahead of schedule. Others who had problems during the initial stage of the project had their debt rescheduled. About 90% of debt payments are now made on time after the rescheduling of the loan. Kamalamai and Triyuga are the

[49] The difference in proportions is statistically significant.

remaining two project WUSCs that have had difficulty repaying on time.

D. Summary

77. The fundamental difference between the project model and previous water supply models applied in Nepal was that the project formalized the principle of cost-sharing between government and communities living in small towns, coupled with targeted institutional support and giving the responsibility of operation and maintenance to the community. The viability of the model is most visibly manifest in the fact that the government's own scheme for small towns across Nepal now follows the ADB model, and that small towns applying the approach now have better and more sustainable water supply. The model furthermore relied on providing training to WUSC staff on technical, financial, and administrative issues, and was critical in developing competent institutions with the better capacity to effectively manage and operate their water supply schemes. A weakness of the approach as acknowledged in the completion report was that it lacked sufficient provision for poor communities—this was addressed in the design of subsequent phases.

78. The levels of water supply service provided in project towns outperformed the comparison towns across a range of indicators. Household survey responses to questions on the levels of service corroborated these findings—households in project towns reported higher levels of service than comparison towns concerning the perception of water quality, duration of service, speed of repairs to disruptions, and general satisfaction with the water service provider. Households from project towns had somewhat higher rates of community participation at WUSC meetings compared to comparison towns. Attendance at tariff setting meetings was, however, low at 13% for both project and comparison towns, indicating how difficult this topic remains. Interviews with all stakeholders confirm that the community-based and cost-sharing model promotes ownership, transparency, and accountability, and although tariff increases continue to be a contentious issue, the principle of progressive tariff setting to ensure expected levels of service and sustainability is being adopted. Some small towns' populations have exceeded their design capacity and consideration is needed on identifying the point at which they should transition from community-based schemes to an alternative approach such as a corporate water utility, management board or private model. Similarly, there may be a need to formalize the governance arrangements between the WUSCs and the municipalities. In all, the findings confirm that the cost-sharing approach coupled with significant capacity development, and awareness campaigns has had positive effects on a range of variables.

4

HOUSEHOLD-LEVEL OUTCOMES AND IMPACT

Highlights

Health and education outcomes. The evaluation found lower incidence of diarrhea and improved school attendance among households in project towns.

Households reported an average of 4 hours more per week of time saved because of the project. Time savings are used for household chores, personal leisure, volunteer community work, and other economic activities.

The project did not have an impact on labor force participation rates or work hours. The use of time savings for personal leisure time could partly explain the muted impact on labor market outcomes, especially for women. Households in project towns reported higher total income and per worker wage income, but these could be potentially influenced by many external factors.

Household consumption expenditures were higher in project towns. The project could have plausibly contributed to the change in consumption patterns in project towns through an increase in income-earning potential due to better household health, education, and time savings. However, there is no direct and conclusive evidence for this causal chain from analysis of the household survey data.

79. At the household level, the service delivery outcomes discussed in Chapter 3 reflect the direct effects of the project on access to better quality, quantity, and continuity of piped water supply to household premises. This impact evaluation used household survey data to test the hypotheses regarding the improvement in household welfare that resulted from the implementation of the package of hard and soft investments supported by the ADB project, compared to household welfare in comparison towns that did not receive this package of investments.[50] The findings from FGDs supplement this analysis. The outcomes presented in the TOC (Figure) were assessed using indicators in seven areas: education, health, household and community work, market work, household expenditure, wage income, and time savings.

A. Analytical Results

80. Nearly 89% of households in project towns and 47% in comparison towns had access to piped water on premises. As explained in Chapter 2, this evaluation computed three sets of estimates for the average treatment effects, i.e., the average impact of participation in the project on the entire eligible population. A summary of the impact estimates for indicators for the entire sample is presented in Table 3. Average values of outcomes in treatment and comparison towns are presented first (Appendix 7, Table A7.1).[51] These are followed by estimation results reported in Appendix 7, Tables A.7.2–A7.13. The estimates reported are single differences in outcomes between households in treatment and comparison towns that correspond to the following econometric estimation methods: (i) town matching based on geospatial characteristics only (town pairs), (ii) propensity score matching (PSMatch) using household characteristics in addition to town matching, and (iii) IPWRA, to estimate average treatment effects using household characteristics and town matching. Although Appendix 7 presents results for all three methods as evidence of the consistency of the estimates, only the doubly-robust IPWRA results are discussed in this chapter.

[50] A total of 1,250 households were interviewed in project towns, and 1,260 in comparison towns (10 more than scheduled in the data collection plan), yielding a total sample size of 2,510 households.

[51] These are average values of data collected from households in treatment and comparison towns.

Table 3: Summary of Impacts of the Project on Indicators of Household Welfare

Education	Impact
School Attendance	
All	ns
Female	ns
Male	ns
5–10	ns
11–17	++
18–24	+
Absences	
All	--
Female	ns
Male	-
5–10	ns
11–17	ns
18–24	ns
Health	
Diarrhea	
All	-
Female	ns
Male	-
5 and under	ns
6–10	ns
Above 10	-
Typhoid	
All	ns
Female	ns
Male	ns
5 and under	ns
6-10	ns
Above 10	ns
Jaundice	
All	ns
Female	++
Male	ns
0–10	ns
Above 10	ns
Household and community work	
All	ns
Female	ns
Male	ns
5–10	ns
11–15	ns
16–24	ns
25–34	ns
35–44	ns
45–54	ns
55–64	ns
65 and above	ns

Time savings	Impact
Proportion of households reporting savings	ns
Total time saved per week	
All	+++
Adult, female	+++
Adult, male	+
Female children	+
Male children	+
Labor market outcomes	
In the labor force	
All	ns
Female	ns
Male	ns
15–24	ns
25–34	ns
35–44	ns
45–54	ns
55–64	ns
65 and above	ns
Work hours per week	
All	ns
Female	ns
Male	ns
15–24	ns
25–34	ns
35–44	ns
45–54	ns
55–64	ns
65 and above	ns
Wage income	
Total wages	+++
Wage income per worker	++
Household consumption expenditure	
Food	ns
Food, per capita	ns
Non-food	+++
Non-food, per capita	+++
Total	++
Total, per capita	++

ns = not statistically significant; P = significance level, + = statistically significant positive effect, - = statistically significant negative effect, + or - = $p<0.05$, ++ or -- = $p<0.01$, +++ or --- = $p<0.001$.
Results are based on analysis of data from the household survey conducted from July to September 2017.
Source: Asian Development Bank (Independent Evaluation Department).

81. Since results correspond to single differences in outcomes between treatment and comparison households, the estimated average outcomes for the comparison households are also reported in Appendix 7, Tables A.7.2–A7.13. Following the results chain (Figure), outcome measures that are more closely linked to treatment-induced change are presented first. This

means that health and education outcomes and time savings are discussed first. These are followed by higher-level outcomes (labor force participation and household consumption) that are potentially influenced by many factors external to the intervention and, consequently, may have weaker links to the treatment. Findings from FGDs are integrated into the narrative to provide plausible explanations for some of the estimated results.

B. Health and Education Outcomes

82. **Households in project towns reported a lower incidence of diarrhea than those in comparison towns.** The evaluation assessed three common health indicators that are related to water supply: the incidence of diarrhea, typhoid fever, and jaundice (Appendix 7, Tables A7.2–A7.4) The estimated incidence of diarrhea was 3.2% in comparison towns, and 2.0% in project towns, 1.2 percentage points lower than in comparison towns. However, there was no perceivable impact of the project on the incidence of the two other frequently observed water-borne diseases in Nepal—typhoid and jaundice, except for a slightly higher incidence of jaundice among female household members. The reduction in the incidence of diarrhea in the project towns can be explained partly by the service delivery outcomes of better quantity, quality, and continuity of water supply in project towns (Chapter 3).

83. The sanitation and hygiene education provided through the project is an important part of the package of interventions and is expected to result in higher demand for hygiene and sanitation practices in project towns.[52] This demand should lead to the adoption of sanitary toilets in the household, handwashing practices, and household connections to better waste disposal facilities. High levels of sanitation and hygiene infrastructure and practices were found in both project and comparison towns but were consistently better among households in project towns (Appendix 7, Table A7.5). The most significant differences were in household connection to drains for liquid wastes. These differences provide part of the explanation for the lower incidence of diarrhea in project towns.

84. **School attendance was higher, and school absences were lower among school-age children living in households located in project towns (Table 3).** Education is an important indicator of household welfare. Two indicators are used to measure the impact of the project on education: school attendance and number of absences in the past month. Cohorts of 11–17 and 18–24 years from project towns attended school at rates that were 5 to 7 percentage points higher than in comparison towns. Absence from school was also lower by 0.14 of a day per month in households in project towns (Appendix 7, Table A7.6). The project impact on education outcomes can be explained partly by better health outcomes, and partly by time savings discussed in paras. 85–86.

C. Impact on Time Available and Use of Time

85. **Households in treatment towns reported average time savings of 4 hours more per week compared to households in comparison towns.** Nearly two-thirds of time saved accrued to adult female members of the household, reflecting the gender impact of the project.[53] All cohorts, namely adult females, adult males, female children, and male children reported higher times saved from not having to fetch water (Table 3). The estimated average total time saved among households in treatment towns was 9.3 hours per week, 4 hours more per week than households in comparison towns who reported 5.3 hours of time saved per week (Appendix 7, Table A7.7).[54] Nearly two-thirds of the overall time savings accrued to adult female members of the household, thereby reducing their time poverty (Appendix 7, Table A7.8). Time savings that accrued to school-age children can partly explain the results of higher school attendance and lower absenteeism. Nearly half the

[52] Among households in project towns, 24% attended hygiene and sanitation education sessions, while 19% of households in comparison towns had previously received hygiene and sanitation education through other sources.

[53] Based on self-reported time savings in households that had access to piped water on premises.

[54] Among households that did not have piped water supply on the premises, there were also differences in the following indicators between households in project and comparison towns: frequency of water collection (2 times per week in project towns versus 12 times per week in comparison towns), distance to water sources (0.08 km versus 0.25 km), and average time spent on collecting water (6 hours versus 23 hours per week).

time saved contributed to an increase in personal leisure time, followed by household chores and economic activities. This suggests an increase in discretionary time for women. These results are broadly in line with the findings from the FGDs.

86. **Time saved is used for household and volunteer community work (Table 3).** Household members in comparison towns spent, on average, 17 hours per week on household and community work (Appendix 7, Table A7.9). As expected, women spent more time (24 hours) than men (8 hours). Those in the 25–34 age group contributed the most (28 hours). However, the time spent by households in project towns was not significantly different from comparison town households. Participants in the FGDs reported that the saved time is used for household chores like cleaning, cooking, and preparing children for school, and income-generating activities like operating small retail stores, office jobs, and vegetable farming. Educated FGD participants indicated that they were now able to spend more time helping children with their homework.

D. Impact on Labor Force Participation Rates, Work Hours, and Wages

87. **The project had no significant impact on labor force participation rates or market work hours.** [55] The average overall labor force participation rate in project towns was virtually the same as in comparison towns (Appendix 7, Table A7.10). Participation rates for women (44.6%) and men (61.6%) were also virtually the same in project and comparison towns. Regarding the number of hours worked, there was no significant difference in market work hours among households in project towns compared to comparison towns (Appendix 7, Table A7.11). The use of time savings for personal leisure time could partly explain the muted impact of the project on labor market outcomes, especially for women.

88. **The other impact indicator of the potential impact of improved water supply on the labor market is household wage income.** Households in projects towns had higher total household income and per worker wage income (Table 3). Average total wages per month among households in project towns were 11.1% higher than the average of approximately NRs19,500 in comparison towns (Appendix 7, Table A7.12). Trends were similar for wage income per worker. With no evidence of labor market impact of the project, there is no ready explanation for this effect, except to assume improved water supply services and better health improved productivity. This outcome is also more distant from the intervention, and potentially influenced by many factors external to the intervention, so attribution to the project is more tenuous.

E. Impact on Household Consumption

89. With many aspects of household life impacted by better water supply, household consumption is also often expected to be impacted, as per the TOC.

90. **Among households in project towns, there was an increase in non-food and total consumption expenditure (Table 3).** Total household consumption expenditure in comparison towns was approximately NRs30,600, and NRs8,500 per capita. Total consumption expenditure and expenditure per capita were 13% higher among households in the project towns (Appendix 7, Table A7.13). Better water supply was associated with a 20% increase in non-food expenditure.

91. As with the impact on wage income, there are plausible explanations for this outcome. The lack of water supply infrastructure has complex effects on consumption patterns. These include higher costs of water consumption (buying water from vendors or walking longer distances to get free water), lower consumption of commodities and services, and reduced income-generating opportunities for households due to longer time needed to get water or even longer downtimes due to the higher incidence of diarrhea. It is, however, plausible that the project contributed to the change in consumption patterns in project towns through an increase in income-earning potential because of better household health, education, and time savings, but there is no direct

[55] Similar results were reported in the 2009 impact evaluation study of rural water supply and sanitation in Pakistan (footnote 24).

and conclusive evidence for this chain of causation from the results of the household survey. Anecdotal reports obtained from FGDs indicated that income-generating activities, like small retail stores, office jobs, and vegetable farming, had resulted in part from access to piped water in the household premises, corroborating that better water supply could have increased household income and, hence, consumption patterns.

F. Implications for the Economic Internal Rate of Return

92. Besides the positive impact of water supply on health outcomes reported in the literature, this evaluation estimated the impact of the project on non-health outcomes. These were education outcomes like increased school attendance and reduced absences, increase in personal leisure time due to the reduced time poverty of women, increase in wage income, and an increase in household consumption expenditure. These impacts were not estimated or included in the computation of the economic internal rate of return (EIRR) reported in the report and recommendation of the President or the project completion report. An economic reevaluation which excludes estimates of project impact on wage income generated an EIRR of 16.0% (Appendix 8). If only a quarter of the estimated wage increase is attributed to the project, the EIRR increases to 29.0%. These estimates are higher than the EIRR of 11.7% reported in the project completion report (footnote 16).

G. Summary

93. Evidence from this evaluation indicates that the project approach of cost-shared investments in piped water supply on premises, together with training, awareness campaigns, and education drives, can improve household welfare in health and non-health dimensions in project towns when compared with households in comparison towns. Specifically, the household welfare improvements result from access to greater quantity, better quality, and continuity of water supply services (Chapter 3). The results chain and hypotheses presented in the TOC can be largely confirmed, but the links to the intervention (treatment) are more tenuous for higher-order outcomes like wages and household expenditures. The findings on health outcomes are consistent with the literature, while the positive impact on education estimated for this project is reported less frequently. A key finding is women's use of time savings for personal leisure that suggests an increase in their discretionary time, implying a reduction in time poverty. While there are plausible explanations for the impacts on wage income and consumption expenditures, the evidence must be interpreted cautiously since the chain of causation could not be established conclusively.

5

IMPLICATIONS, LESSONS, AND RECOMMENDATIONS

Highlights

Cost-shared investments in water supply and sanitation services in small towns, coupled with training, awareness campaigns, and institutional development can have an impact on health and non-health outcomes, and should be further tested to service small towns in countries with similar context. The model could be made more inclusive through specific provisions for poor and vulnerable households.

Despite the use of best available methods to mitigate selection bias, there could be residual upward bias in the estimated impact of the project.

Progressive tariffs, which are essential for financial viability, are easier to accept when financial reporting is transparent and there are demonstrable improvements in level of service. Proper technical due diligence is important to avoid technical design flaws concerning availability and quality of source water as these design flaws can affect the sustainability of small town water systems, irrespective of the capacity of the water service provider.

Baseline data collected from project and comparison groups are superior to the approach of generating counterfactual data from ex-post identification of comparison group, and will lead to higher quality impact evaluations.

Strategically plan and implement impact evaluations for future programs or projects that have potential for replication and scale-up as identified by sector and thematic groups.

A. Implications for Knowledge Gaps on the Impacts of Water Supply and Sanitation Interventions in Small Towns

94. The Sustainable Development Goal objective to achieve universal and equitable provision of WSS services by 2030 is far more demanding than the 2015 Millennium Development Goal in this area was and will require a significant ramping up of investment. The Independent Evaluation Group (IEG) estimates that some 43% of the World Bank Group's investments in WSS had significant or high risks to achieving development outcomes largely due to a lack of financial sustainability and inadequate institutional capacity (footnote 5). Likewise, project performance evaluation reports and validation of project completion reports completed by the IED, reported that 55% of ADB supported WSS projects were regarded less than likely sustainable or unsustainable, a higher percentage than for projects in most other sectors.[56] In the context of small towns, this evaluation contributes to addressing some of these issues.

95. Tutusasus and Schwartz emphasize how little research has been undertaken on water services in small towns and argue that a lack of suitable models for water services in such settlements has resulted in poor WSS outcomes (footnote 4). In this evaluation, we highlight that the fundamental difference between this project model and previous models for water supply was that this project formalized the principle of cost-sharing between government and communities living in small towns, vested operation and maintenance responsibilities on the community, and coupled it with targeted institutional support, which resulted in better levels of service and sustainability of water supply systems. Before this project was implemented, most schemes for small towns relied on government grants, which impacted negatively on ownership, efficiency, and ultimately the financial sustainability of the schemes. Only one impact evaluation on water supply in small towns in Ethiopia was identified, and its focus was wholly on household levels of service and not institutional issues. Therefore, the

[56] IED. 2018. *Annual Evaluation Review: The Quality of Project Design and Preparation for Efficiency and Sustainability*. Manila: ADB.

institutional findings of this evaluation represent a new contribution to knowledge on models for water supply provision in small towns. Some small towns' populations, over 100,000 people in two cases, have exceeded their design capacity and consideration is needed on identifying the point at which they should transition from community-based schemes to an alternative approach such as a corporate water utility, management board or private model. For all towns, there may now be a need to clarify the governance arrangements between the water service providers and the municipalities in the light of the recent local elections, after an interlude of almost 20 years, and the new federal structure in Nepal.

96. In the review by IED on sustainability in WSS projects, the main reasons cited for poor sustainability were weak institutional capacity and the inability of these institutions to raise tariffs to cover operation and maintenance (footnote 26). This evaluation examined a range of institutional capacity indicators, including the capacity of water service providers to effectively deal with disruptions in service, on which the project towns outperformed the comparison towns. Collection ratios in both project and comparison towns were very similar, both over 90%, and most connections were metered in both. However, the operational ratios achieved in project towns are much higher. An important difference was the ability of service providers in project towns to convince customers of the need to progressively raise tariffs and to communicate this transparently—support from the TDF is a likely factor, as is the demonstration effect of improved levels of service. This capacity to raise tariffs, coupled with technical and administrative improvements, allows the project town water service providers to service their debt, expand their distribution network, and operate and maintain their system efficiently—all of which culminates in more sustainable water supply systems. The evaluation also showed that cost sharing in water supply projects can work well, although many other factors are necessary to improve the financial sustainability of such projects. The model could have been made more inclusive by refining the degree of cost-sharing and including provisions for targeted support to poor and vulnerable households– measures that have been adopted in later phases of this project.

97. Despite the use of best available methods to mitigate selection bias, there could be residual upward bias in the estimated impact of the project. Towns self-selected and prepared applications to indicate their interest in the project, and the project in turn selected towns from the list of applicants. In the absence of information on selection criteria scores and list of towns that expressed interest in the project, treatment and comparison towns were matched using geospatial characteristics at baseline as a proxy for selection criteria, and households were matched using a small number of characteristics that are not affected by the project. However, residual upward bias due to unobserved characteristics could remain i.e., the project impact could be lower than estimated.

98. To our knowledge, this is the first impact evaluation of water supply projects implemented in small towns in Asia. Evidence from this evaluation suggests that cost-shared investments in water supply and sanitation services in small towns, coupled with training, awareness campaigns, and institutional development, can have an impact on health and non-health outcomes. There is strong evidence of better health outcomes like reductions in the incidence of diarrhea, which is consistent with existing global evidence. Education outcomes like school attendance and reduction in absences from school are less frequently confirmed findings, which suggests that this benefit of the project approach may well be more particular to small-town settings. The key finding of women's use of time savings for personal leisure implies a strong positive effect on reducing time poverty by increasing the discretionary time available; it also shows the limitations of improved water supply services in providing more opportunities for labor market involvement.

B. Lessons

99. This project in Nepal is in its third phase and lessons learnt from the first project, which is the subject of this evaluation, have been documented elsewhere and incorporated in

subsequent phases.[57] Appendix 4 outlines the major changes to subsequent phases that are pertinent to this evaluation. The lessons that follow are derived from the findings of this evaluation.

100. **In small towns, a project approach to water service provision in community-managed systems, relying on cost-sharing with the government, and institutional support and training, is more successful than an approach that is less comprehensive and community-based.** Community-based water supply systems are common in Nepal and it is the default model in villages and small towns. The project introduced the concept of cost-sharing between community and government, together with targeted training programs, and support, which has resulted in water users and sanitation committees (WUSCs) with better sustainability and levels of service than in towns without this support. Better capacity of the water service providers to sustainably operate and manage the built infrastructure has been demonstrated through the timely dealing with major repairs, their efficient operating ratios and their ability to expand their network using their own funds. The government has now adopted this approach for its own small towns water supply program, *Saha lagani*.

101. **Progressive tariffs, which are essential for financial viability, are made easier to accept through transparent reporting of the financial status of the water schemes and demonstrated improvements in the level of service.** Project towns had higher levels of service and the need for tariff increases was explained, with TDF support, through meetings of the WUAs. These are two essential ingredients to bring customers on board. Progressive tariffs allow water service providers to efficiently cover operation and maintenance costs and expand their distribution network, thereby increasing revenue further and improving debt servicing capacity.

102. **Technical design flaws that are not anticipated can impact significantly on the sustainability of water supply systems, irrespective of the capacity of the water service provider. Institutional and household gains are greater if such issues are addressed.** While Nepal is endowed with plentiful water resources, these are not always evenly distributed spatially or temporally due to the country's diverse topography and geology, and monsoon-dominated climate. Design flaws were observed in three project towns concerning source water quality and availability, that could have largely been anticipated through better technical due diligence to develop a robust conceptual understanding of the geohydrological context. These shortcomings impacted on the sustainability of these systems irrespective of the capacity of the water service provider.

103. **Baseline data collected from project and comparison groups are superior to the approach of generating counterfactual data from ex-post identification of comparison group and will lead to higher quality impact evaluations.** Data on outcomes at the town or household level were not available at baseline, so the evaluation could not compare rates of change in outcomes over time. The counterfactual enabled estimation of "with and without" project impact at a point in time, but "before and after" comparisons were not possible.

C. Recommendations for the Asian Development Bank

104. **Further test the model that was the object of this evaluation (cost-shared, community-managed water supply systems with institutional support) in other countries with a similar context to see whether it can be replicated and scaled-up.** The evidence from this impact evaluation indicates that levels of service and sustainability are better in towns where cost-sharing is practiced, and institutional support is provided. Further testing should include refining the degree of cost-sharing with targeted provisions for poor and vulnerable households as appropriate to foster greater inclusion.

105. **Devote more attention to understanding the geohydrological setting when preparing water supply systems in multiple small towns, so that variability in quality and quantity of the source water can be better accommodated in project**

[57] There have been several knowledge products prepared by ADB on this project and its successors, most recently: N. Pokhrel and S. Adhikary. 2017. *Tapping the Unreached Nepal Small Towns Water Supply and Sanitation Sector Projects: A Sustainable Model of Service Delivery.* Manila.

design. Gains in improved water service provider capacity can be undermined if the ex-ante project design does not fully address and anticipate the hydrological and geological setting constraints that can impact on water quality and quantity. This was found to be the case in three of the project towns. Development of a thorough conceptual understanding of the geohydrological context through appropriate investigations would mitigate these risks.

106. **Strategically plan and implement impact evaluations for future programs or projects that have potential for replication and scale-up as identified by sector and thematic groups.** For projects like the Small Towns Water Supply and Sanitation Sector Project, which have the potential for scale-up or replication, baseline and end line data should be collected through beneficiary surveys of project and comparison populations to monitor implementation and estimate development impact.

107. A first step is to make explicit the TOC underlying each project design, to clearly identify outcomes and impact and corresponding indicator variables for which beneficiary-level baseline information can then be collected. The baseline data should enable "with and without project" and "before and after project" comparisons. The difference in changes in the outcome between treatment and comparison groups over time can be computed, resulting in more robust estimates of impact after project completion. These estimates can serve as inputs to compute the stream of benefits for similar interventions in the future.

APPENDIXES

APPENDIX 1: LIST OF TREATMENT AND COMPARISON TOWNS

Table A1.1: Treatment and Comparison Towns for Institutional and Household Surveys

No.	Type	Towns	District	Water Supply Coverage in 2000[a]
Eastern Terai				
1	Project	Surunga (Kankai Municipality)	Jhapa	Poor
2	Comparison	Sanischare Municipality	Jhapa	Good
3	Project	Itahari Municipality	Sunsari	Satisfactory
4	Comparison	Inarwa Municipality	Sunsari	Satisfactory
Eastern Hills				
5	Project	Triyuga Municipality	Udaypur	Satisfactory
6	Comparison	Katari Municipality	Udaypur	Poor
Central Terai				
7	Project	Parsa (Khairahani Municipality)	Chitwan	Poor
8	Comparison	Chitraban (Bharatpur Municipality)	Chitwan	Poor
Central Hill				
9	Project	Kamalamai Municipality	Sindhuli	Good
10	Comparison	Manthali Municipality	Ramechhap	Poor
Western Terai				
11	Project	Bardghat Municipality	Nawalparasi	Good
12	Comparison	Devdaha Municipality	Rupandehi	Poor
Western Hill				
13	Project	Lekhnath (Pokhara Lekhnath Municipality)	Kaski	Satisfactory
14	Comparison	Besishahar Municipality	Lamjung	Satisfactory
Mid-western Terai				
15	Project	Kohalpur Municipality	Banke	Poor
16	Comparison	Neulapur (Babai Municipality)	Bardiya	Poor
Mid-western Hill				
17	Project	Birendranagar (Birendranagar Municipality)	Surkhet	Satisfactory
18	Comparison	Chhinchu (Bheriganga Municipality)	Surkhet	Satisfactory
Far-western Terai				
19	Project	Lamki Municipality	Kailali	Satisfactory
20	Comparison	Jhalari Pipaldi (Sukhalaphata Municipality)	Kanchanpur	Poor

[a] Water supply coverage in the year 2000 (project start) is classified as "Good"–more than 75%, "Satisfactory"–30% to 75%, "Poor"–less than 30%. These estimates are based on (i) interviews with the WUSCs; (ii) pre-project descriptions in ADB. 2012. *Nepal: Strengthening the Town Development Fund Capacity for Public-Private Partnership* (Financed by the TA Special Fund) Technical Assistance Consultant's Report, TA-7669, and; (iii) Government of Nepal. 2009. *Updated Fifteen-Year Development Plan for Small Towns Water Supply and Sanitation Sector*. Kathmandu.

Source: Asian Development Bank (Independent Evaluation Department).

Table A1.2: Treatment and Comparison Towns for Focus Group Discussions

Region	District	Municipality	Type of Town	
			Project	Comparison
Eastern Terai	Jhapa	Surunga	1 FGD with people who had access to piped water in the household 1 FGD with people who did not have access to piped water in the household	
	Jhapa	Sanischare		1 FGD with people who had access to piped water in the household 1 FGD with people who did not have access to piped water in the household
Western Hill	Kaski	Lekhnath	1 FGD with people who had access to piped water in the household 1 FGD with people who did not have access to piped water in the household	
	Lamjung	Besishahar		1 FGD with people who had access to piped water in the household 1 FGD with people who did not have access to piped water in the household
Far-western Terai	Kailai	Lamki	1 FGD with people who had access to piped water in the household 1 FGD with people who did not have access to piped water in the household	
	Kanchanpur	Jhalari Pipaldi		1 FGD with people who had access to piped water in the household 1 FGD with people who did not have access to piped water in the household

FGD = focus group discussion.
Source: Asian Development Bank (Independent Evaluation Department).

APPENDIX 2: SUMMARY OF ECONOMETRIC METHODS IMPLEMENTED

1. Given the data generation process, three econometric estimation procedures were used. The first procedure assumes that the matching of the project and the corresponding comparison towns using geospatial data at the beginning of the project is sufficient to achieve the ignorability or unconfoundedness needed to determine causal impact. This is implemented as a simple comparison of outcomes of interest for households in the project and comparison towns with dummy variables for town pairs as a covariate. Specifically, this means estimating the equation.

$$y = \alpha + \tau * T + \delta + \varepsilon$$

where
y = outcome of interest
T=treatment indicator, 1=treatment community, 0 =control community
δ= treatment-comparison pairing indicator
ε= error

2. The estimate for τ is the estimate of the impact of the project. The choice of the estimating function depends on the nature of the outcomes being estimated. The equation above assumes a continuous outcome such as hours worked. For binary outcomes such as school attendance and incidence of diarrhea, a probit regression is used. For counts such as number of absences, a poisson regression is used. Given the sampling used in the evaluation, the estimation adjusted for clustering of standard errors at the small town level.

3. The second procedure uses propensity score matching (PSMatch) adding household characteristics to the matching of towns to achieve unconfoundedness or ignorability (Rosenbaum and Rubin, 1983). [1] The use of household characteristics recognizes the fact that water connections are decided at the household level. Given the selected set of household characteristics and the town matching indicator, a propensity score is estimated. Specifically, the procedure involves estimating the following equation:

$$P(T = 1) = f(X, \delta)$$

where
X= household characteristics
δ= town pairing dummy variables
f=logistic function

4. The households are then matched using the estimated propensity scores. [2] Given the matched households the treatment effect is given by:

$$\hat{\tau}_{psmatch} = N^{-1} \sum_{N} (\widehat{y_1} - \widehat{y_0})$$

where
y_i = outcomes of group i; 1 for treatment, 0 for comparison.

5. It is not necessary to do this two-step procedure to generate the propensity score matching estimate. In fact, this is not recommended as this will produce wrong estimates of the standard error. The Stata routine *teffects psmatch* does this estimation automatically with a correct estimate of the standard error.

6. Finally, a doubly-robust method combining inverse-probability weighting and regression adjustment (IPWRA) is used. [3] This procedure requires specifying the outcome equation in addition to the propensity score, which is used as weights to generate the missing counterfactual. It is labeled as doubly robust because it requires that only either the outcome equation or the propensity score equation is correctly specified, not both. The impact estimate is given by:

$$\hat{\tau}_{ipwra} = N^{-1} \sum_{N} \left[(\hat{\alpha}_1 + x_i \hat{\beta}_1) - (\hat{\alpha}_o + x_i \hat{\beta}_0) \right]$$

[1] P.R. Rosenbaum and D. B. Rubin. 1983. The Central Role of Propensity Score in Observational Studies. *Biometrika.* Vol. 70 (1). pp. 41–55. http://links.jstor.org/sici?sici=0006-3444%28198304%2970%3A1%3C41%3ATCROTP%3E2.0.CO%3B2-Q

[2] P.R. Rosenbaum and D. B. Rubin (1983) has shown that matching on propensity scores matches the covariates as well.

[3] The average treatment effect is the average impact of treatment on the entire eligible population.

where $\hat{\alpha}_k$ and $\hat{\beta}_k$ are estimates using inverse probability weighting.

7. Given the sampling used in the evaluation, the estimation adjusted for clustering of standard errors at the small town level.

8. Internal validity is achieved if the assumptions of conditional independence and overlap are satisfied. The sampling that considers the salient characteristics of the target population are essential for the external validity of the results.

APPENDIX 3: BALANCE ANALYSIS

A. Introduction

1. This appendix provides the balance analysis of the socioeconomic variables after matching and weighting. The balance of socioeconomic status between treatment and comparison households ensures that near-identical households are compared so that difference in outcomes can be attributed to the treatment. The impact estimation employs three econometric methods: (i) town matching based on geographic characteristics, (ii) propensity score matching (PSMatch) using household characteristics not readily affected by the treatment, and (iii) inverse probability weighting and regression adjustment (IPWRA) using household characteristics not readily affected by treatment in addition to the town matching. The balancing through geographic characteristics utilized physical features rather than respondent characteristics and was taken as given in the estimation. Hence, only the balancing results of the PSMatch and the IPWRA are discussed here. Balancing results are provided using two indicators: (i) the standardized difference, and (ii) the variance ratios.

2. Since matching variables are identical for all impact estimates, only one set need to be shown because the balancing results will be identical for all the other estimates.

B. Balance from Propensity Score Matching

3. The results from propensity score matching are summarized in Appendix 3, Table A3.1. The results show the reduction of standardized differences and the movement of the variance ratios towards 1 or equality after the matching. For instance, the standardized difference of the age of household head declined from 0.103 to 0.029. The variance ratio also moved from 1.11 for raw to 0.96 for matched. Except for the family size, where the standardized difference increased from raw to matched even though the variance ratio approaches 1, the other variables also indicate more balance from raw to matched variables. These indicate a more balanced socioeconomic status between treatment and comparison households after matching.

Table A3.1: Balance Result from Propensity Score Matching

	Standardized Differences		Variance Ratio	
Variable	Raw	Matched	Raw	Matched
Age of household head	0.1034	0.0292	1.1070	0.9632
Sex of household head (Female)	0.0612	(0.0396)	1.0591	0.9637
Education of household head				
Primary	(0.1407)	0.0052	0.7766	1.0091
Secondary	0.1275	(0.0090)	1.0720	0.9953
Beyond Secondary	0.1845	0.0086	1.5259	1.0191
Family size in 2000	0.0229	0.0715	0.9663	0.9700

( ) = negative.
Source: Asian Development Bank (Independent Evaluation Department).

C. Balance from Inverse Probability Weighted Regression Adjustment

4. The IPWRA balances treatment and comparison households using inverse probability weighting (IPW) with the propensity score. The balancing results after IPWRA are shown in Appendix 3, Table A3.2. The results indicate a consistent reduction in the standardized difference for all variables. The variance ratios are also all close to 1. For instance, the standardized

Table A3.2: Balance Result from Inverse Probability Weighted Regression Adjustment

	Standardized Difference		Variance Ratio	
Variables	Raw	Weighted	Raw	Weighted
Age of household head	0.1034	(0.0017)	1.1070	0.9939
Sex of household head (Female)	0.0612	0.0027	1.0591	1.0025
Education of household head				
Primary	(0.1407)	(0.0002)	0.7766	0.9997
Secondary	0.1275	0.0016	1.0720	1.0009
Beyond Secondary	0.1845	0.0003	1.5259	1.0006
Family size in 2000	0.0229	(0.0005)	0.9663	0.9689

( ) = negative.
Source: Asian Development Bank (Independent Evaluation Department).

difference for the age of the household head declined from 0.103 to -0.002 after weighting. The variance ratio, on the other hand, declined from 1.11 to 0.99 after weighting. All other variables show similar patterns indicating more balance after weighting.

5. Based on the indicators, it is noteworthy that the balancing results using IPWRA are better than those derived using propensity score matching.

D. Joint Orthogonality Tests

6. Joint orthogonality tests are recommended as a complement to testing for differences in individual variables to determine the balance between treatment and comparison group characteristics. [1] Results of joint orthogonality tests (after propensity score matching and after IPW, the two methods used in the evaluation to achieve balance in the treatment and comparison households) are presented below. The joint orthogonality tests indicate some remaining imbalances.

1. After Propensity Score Matching

7. Results of the probit regression of the treatment on the household characteristics not readily affected by treatment after propensity score matching are presented in Appendix 3, Table A3.3. The results indicate the variables are not significantly different for treatment and comparison households except for family size in 2000. The joint orthogonality test that all coefficients are jointly zero yielded a Chi-square of 46.67, which is significant at 6 degrees of freedom, indicating some remaining imbalance.

Table A3.3: Joint Orthogonality Test after Propensity Score Matching

Variable	Coeff.	SE	Z-difference	P-value
Age of household head	(0.002)	0.002	(0.85)	0.394
Sex of household head (Female)	(0.067)	0.049	(1.35)	0.176
Education of household head				
Primary	(0.085)	0.068	(1.26)	0.209
Secondary	(0.096)	0.057	(1.68)	0.094
Beyond Secondary	(0.074)	0.072	(1.03)	0.302
Family size in 2000	0.136	0.022	6.23	0.000
Constant	(0.237)	0.126	(1.89)	0.059
Chi-square (6)	46.670			0.000

( ) = negative, Coeff = coefficient, P-value = significance level, SE = standard error, z-difference = test statistic for difference between means.
Source: Asian Development Bank (Independent Evaluation Department).

[1] A World Bank blog dealt with the case of a test of balancing of baseline characteristics in randomized trial. It is applied here in the case of matching and weighting. https://blogs.worldbank.org/impactevaluations/should-we-require-balance-t-tests-baseline-observables-randomized-experiments

2. After Inverse Probability Weighting

8. Results of the probit regression of the treatment on the household characteristics not readily affected by treatment after IPW are presented in Appendix 3, Table A3.4. The results indicate differences in some variables—age of household head, the proportion of female household head, and the proportion of household head with education beyond secondary. The joint orthogonality test yielded a chi-square of 20.38, which is also significant at 6 degrees of freedom, indicating some remaining imbalance. This value, however, is lower than the one produced after the propensity score matching, indicating that the balance is better with the IPW estimation.

Table A3.4: Joint Orthogonality Test after Inverse Probability Weighting

Variable	Coeff.	SE	Z-difference	P-value
Age of household head	(0.002)	0.001	(2.28)	0.022
Sex of household head (Female)	(0.115)	0.031	(3.66)	0.000
Education of household head				
Primary	(0.024)	0.038	(0.64)	0.524
Secondary	(0.037)	0.033	(1.12)	0.263
Beyond Secondary	(0.119)	0.044	(2.74)	0.006
Family size in 2000	0.014	0.013	1.07	0.283
Constant	0.149	0.073	2.05	0.040
Chi-Square (6)	20.380			0.002

( ) = negative, Coeff = coefficient, P-value = significance level, SE = standard error, Z-difference = test statistic for difference between means.

Source: Asian Development Bank (Independent Evaluation Department).

APPENDIX 4: SMALL TOWN WATER SUPPLY AND SANITATION SECTOR PROJECT AND ITS MODIFICATIONS IN SUBSEQUENT PHASES

1. The first phase of Small Town Water Supply and Sanitation Sector Project was assessed to be successful, but it had some weaknesses. The second and third phases of the project have introduced changes based on the lessons from the first phase. These changes focused on the financing and subsidy mechanism, governance and long-term operational sustainability, improvements in technical designs, and strengthening of the sanitation component.

2. The provisions in the first phase of the project and the changes made in subsequent phases of the project are summarized in Table A4.

Table A4: Comparison of Key Provisions of Three Phases of the Small Towns Water Supply and Sanitation Sector Project

No.	Provisions Water Supply	Phase I 2000–2009	Phase II 2009–2018[a]	Phase III 2014–2019[a]
1	**Financing and Subsidy**			
a	Proportion of government grant and community contribution	50:50	50:50	70:30
b	Requirement of community contribution	20% cash or kind with 5% upfront cash and 30% loan from TDF	5–15% cash with 5% upfront cash contribution + 45–35% loan from TDF	5% upfront cash contribution + 25% loan from TDF
c	Maturity period of loan to WUSC	12–15 year including a grace period of 3 years	20 years with grace period of 5 years	25 years with grace period of 5 years
d	Annual interest charged by TDF on loan to WUSC	8% initially and revised to 7% later	5%	5%
e	Subsidy to poor	No provision	Output-based aid subsidy to poor for new water connection and private toilet construction	Output-based aid subsidy to poor for new water connection and private toilet construction
2	**Strengthening Governance and Capacity for O&M**			
a	On the job training of staff and ensuring construction quality		Technical operation for the first year was entrusted to the contractor for ensuring construction quality and training of staff	Technical operation for the first year was entrusted to the contractor for ensuring construction quality and training of staff
b	Technical support to WUSC		Partnership with water utilities for improved management	ISSUA established in DWSS for supporting WUSCs in design and management of O&M of water systems
3	**Strengthening Design (Technical Robustness)**			
a	Design guidelines		Design guidelines developed by DWSS for the project	Revised design guidelines for the project and introduction of distribution network design on DMA basis to optimize system efficiency
b	Project design period	15 years	15 years	20 years

No.	Provisions Water Supply	Phase I 2000–2009	Phase II 2009–2018[a]	Phase III 2014–2019[a]
4	**Sanitation**			
a	Government grant and local government/ community contribution	80:20	80:20	85:15
b	Strengthening of sanitation component	Primary focus on water supply	Primary focus on water supply	Embedded sanitation component including on-site sanitation, decentralized wastewater treatment, storm water drainage, and fecal sludge management in pilot towns

DMA = district metering area, DWSS = Department of Water Supply and Sanitation, ISSUA = Institutional Support and Service Advisory Unit, O&M = operation and maintenance, TDF = Town Development Fund, WUSC = Water Users and Sanitation Committees.

[a] Expected closing year.

Sources: ADB. 2000. *Report and Recommendation of the President to the Board of Directors: Proposed Loan to the Kingdom of Nepal for the Small Towns Water Supply and Sanitation Sector Project*. Manila; ADB. 2009. *Report and Recommendation of the President to the Board of Directors: Proposed Asian Development Fund Grant Nepal: Second Small Towns Water Supply and Sanitation Sector Project*. Manila; ADB. 2014. *Report and Recommendation of the President to the Board of Directors: Proposed Loan and Administration of Loan and Grant Nepal: Third Small Towns Water Supply and Sanitation Sector Project*. Manila; ADB. 2017. *Tapping the Unreached Nepal Small Towns Water Supply and Sanitation Sector Project: A Sustainable Model for Service Delivery*. Manila; ADB. 2015. *Third Small Towns Water Supply and Sanitation Sector Project. Project Implementation Directive*. Manila; Discussions with staff of TDF and WUSCs.

APPENDIX 5: INSTITUTIONAL SUSTAINABILITY AND LEVELS OF SERVICE

Table A5.1: Institutional Study Data–Level of Water Supply Service

Name of Small Town	No. of Connections	Supply Duration (hours)	Water Pressure in Taps	Daily Volume of Supply (m^3)	Metered Connection (%)	Annual Supply Disruption Frequency	WSP Capacity for Major Repair	Water Treatment Plant Status	Water Testing Facilities Available
Surunga (Kankai Municipality)	2,900	24	>6 m	1,000	100	1	yes	WTP in operation	no[a]
Itahari (Itahari Municipality)	13,080	18	>6 m	8,500	99	1	yes	WTP in operation	yes
Triyuga (Triyuga Municipality)	2,000	3.5	0–6 m	770	0[1+]	5	No, low staff capacity	WTP not effective	no[a]
Kamalamai (Kamalamai Municipality)	2,346	2.0	0–10 m	1,300	100	4	yes	WTP not effective	no[a]
Parsa (Khairahani Municipality)	3,365	24	>6 m	2,000	100	1	yes	Only chlorination	yes
Lekhnath (Pokhara Metropolitan City)	10,100	18	3–10 m	7,100	99	4	yes	WTP not fully effective	yes
Bardghat (Bardghat Municipality)	3,120	24	>6 m	1,800	100	1	yes	WTP for surface water	yes
Kohalpur (Kohalpur Municipality)	2,812	6.0	0–6 m	2,750	96	6	yes	WTP not in use	yes
Birendranagar (Birendranagar Sub Metropolitan City)	15,331	2.0	0–6 m	8,986	97	2	yes	WTP in operation	yes
Lamki (Lamkichuha Municipality)	3,214	14	0–10 m	2,200	99	6	yes	WTP not in use	no[a]
Sanischare (Arjundhara Municipality)	1,300	24	>6 m	750	100	4	yes	WTP in operation	no
Inarwa (Inarwa Municipality)	2,337	6.0	0–6 m	1,000	97	12	insufficient staff	WTP in operation	no

Name of Small Town	No. of Connections	Supply Duration (hours)	Water Pressure in Taps	Daily Volume of Supply (m^3)	Metered Connection (%)	Annual Supply Disruption Frequency	WSP Capacity for Major Repair	Water Treatment Plant Status	Water Testing Facilities Available
Katari (Katari Municipality)	673	1.5	0–4 m	200	93	4	no	WTP not in use	no
Manthali (Manthali Municipality)	802	2.0	0–6 m	2,000	95	5	yes, except electric	Manual chlorination	no
Chitraban (Bharatpur Metropolitan City)	537	11	>6 m	175	99	2	No	Manual chlorination	no
Besishahar (Besishahar Municipality)	2,637	4.5	0–10 m	950	100	5	yes	WTP not fully effective[a]	yes
Devdaha (Devdaha Municipality)	2,265	4.0	0–8 m	1,000	98	3	no	WTP only partially effective[b]	no
Neulapur (Babai Municipality)	350	4.0	0–10 m	300	99	5	no	Manual chlorination	no
Chhinchu (Bheriganga Municipality)	912	2.0	0–6 m	700	98	5	no	Manual chlorination	no
Jhalari Pipaldi (Shuklaphat Municipality)	550	24	>6 m	2,000	100	6	yes	Manual chlorination	yes

m^3 = cubic meter, m = meter, WSP = water safety plan, WTP = water treatment plant.
1+ : WSP allowed to take out meter due to turbid water.
[a] WTP in operation but not able to tackle turbidity during rainy season.
[b] WTP in operation but has not been able to solve calcium problem.
Source: Asian Development Bank (Independent Evaluation Department).

Table A5.2: Institutional Sustainability Indicators of Project and Comparison Towns

Name of Town	Staff per 1,000 Connections	Compu-terized Billing System	Collection Ratio (%)	Arrear (Months of Billing)	Operating Ratio (%)	Debt Status	Remarks on Debt Service	Expansion of Network from its Own Fund	Water Connection Charge (NRs)	Tariff for 10 m^3 (NRs)	Tariff for 15 m^3 (NRs)
Surunga (Kankai Municipality)	4.48	Yes	100	0	0.52	Loan paid back by January 2017	Loan paid back ahead of schedule	Yes	17,100	220 (120 for 6 m^3)	360
Itahari (Itahari Municipality)	3.33	yes	100	0	0.78	16.6 % payment remaining	Payments as per revised schedule	Yes	15,525	130	245
Triyuga (Triyuga Municipality)	7.00	no	66	18	1.09[a]	Loan to be repaid fully	Problem in loan payback	No	12,100	150	275
Kamalamai (Kamalamai Municipality)	6.39	yes	96.3	2.2	0.73	Loan to be paid, part interest payment made	default till 2016, now paying as per revised schedule	No	10,420	135	235
Parsa (Khairahani Municipality)	3.88	yes	86.2	1.53	0.69	Loan paid back by September 2014	Loan paid back ahead of schedule	Yes	7,500	130	230
Lekhnath (Pokhara Metropolitan City)	3.00	yes	96.2	NA	0.58	31.5% Payment remaining	Payment as per revised schedule	Yes	21,200	215	335
Bardghat (Bardghat Municipality)	4.17		95	0.92	0.66	Loan paid back by July 2016	Paid back as per schedule	Yes	12,300	120	195
Kohalpur (Kohalpur Municipality)	6.67	Yes	88	1.27	0.96	One installment interest paid	Payment default	Yes	11,150	150	275
Birendranagar (Birendranagar Sub Metropolitan City)	4.02	Yes	96	1.92	0.95	About 26% loan remaining	Payment as per revised schedule	Yes	17,000	114 (90 for 8 m^3)	174

Name of Town	Staff per 1,000 Connections	Compu-terized Billing System	Collection ratio (%)	Arrear (Months of billing)	Operating Ratio (%)	Debt Status	Remarks on Debt Service	Expansion of Network from its Own Fund	Water Connection Charge (NRs)	Tariff for 10 m^3 (NRs)	Tariff for 15 m^3 (NRs)
Lamki (Lamkichuha Municipality)	3.78	Yes	85	0.25	0.74	Interest and part loan paid	Regular Payments from 2016	Yes	11,725	160	260 auto tariff adjust
Sanischare (Arjundhara Municipality)	5.38	No	100	0	0.78	NA	-	No	9,000	157 (125 for 8 m^3)	237
Inarwa (Inarwa Municipality)	3.96	No	75	6.22	1.17[a]	NA	-	No	3,500	100	145
Katari (Katari Municipality)	14.33	No	85	NA	1.12 [a]	NA	-	No	7,500	100	150
Manthali (Manthali Municipality)	11.86	No	85	NA	1.2 [a]	NA	-	No	30,000	500	500
Chitraban (Bharatpur Metropolitan City)	5.66	No	94	0.46	5.08	NA	-	No	7,000	100	145
Besishahar (Besishahar Municipality)	6.83	Yes	100	0	0.8	NA	-	Yes	10,095	80	140
Devdaha (Devdaha Municipality)	3.62	No	100	0	0.77	NA	-	Yes	10,000	75	120
Neulapur (Babai Municipality)	5.85	No	100	0	1.1	NA	-	No	3,500	120	195
Chhinchu (Bheriganga Municipality)	4.44	No	98	NA	2.4 [a]	NA	-	No	14,000	50	100
Jhalari Pipaldi (Shuklaphat Municipality)	7.27	No	100	0	0.9	NA	-	No	2,000	100	175

m^3 = cubic meter, NA = not available, NRs = Nepalese rupees.
[a] WSP has not been able to carry out all required maintenance
Source: Asian Development Bank (Independent Evaluation Department).

APPENDIX 6: CHANGES IN TARIFF IN PROJECT AND COMPARISON TOWNS: PRESENT WATER TARIFF IN SMALL TOWNS AND ITS PAST REVISIONS

No.	Name of Small Town	Present Tariff in NRs and Year of Last Revision	Tariff Applied after Takeover of Project (NRs)	No. of Tariff Adjustments since Operation
1	Surunga (Kankai Municipality)	120 for 6 m^3 (2014)	72 for 6 m^3 (120 for 10 m^3)	2
2	Itahari (Itahari Municipality)	130 for 10 m^3 (2016)	75 for 10 m^3	2
3	Triyuga (Triyuga Municipality)	150 for 10 m^3 (2016)	100 for 10 m^3	2
4	Kamalamai (Kamalamai Municipality)	135 for 10 m^3 (2016)	70 for 10 m^3	1
5	Parsa (Khairahani Municipality)	130 for 10 m^3 (2014)	100 for 8 m^3 (125 for 10 m^3)	1
6	Lekhnath (Pokhara Metropolitan City)	215 for 10 m^3 (2016)	100 for 10 m^3	2
7	Bardaghat (Bardghat Municipality)	120 for 10 m^3 (2010)	80 for 8 m^3 and (100 for 10 m^3)	1
8	Kohalpur (Kohalpur Municipality)	150 for 10 m^3 (2016)	120 for 10 m^3	1
9	Birendranagar (Birendranagar Sub Metropolitan City)	90 for 8 m^3 (2016)	30 for 8 m^3 and (38 for 10 m^3)	2
10	Lamki (Lamkichuha Municipality)	160 for 10 m^3 (2016)	80 for 10 m^3	2
11	Sanischare (Arjundhara Municipality)	125 for 8 m^3 (2015)	100 for 8 m^3 (125 for 10 m^3)	1
12	Inarwa (Inarwa Municipality)	100 for 12 m^3 (2016)		1
13	Katari (Katari Municipality)	100 for 10 m^3 (2009)	No change	1
14	Manthali (Manthali Municipality)	500 for 15 m^3 (2015)		1
15	Chitraban (Bharatpur Metropolitan City)	100 for 12 m^3 (2017)	No Change	0
16	Beshisahar (Besishahar Municipality)	80 for 10 m^3 (2016)	50 for 10 m^3	1
17	Devdaha (Devdaha Municipality)	75 for 10 m^3 (2015)	No change	0
18	Neulapur (Babai Municipality)	120 for 10 m^3 (2016)	No change	0
19	Chhinchu (Bheriganga Municipality)	50 for 10 m^3	No change	0
20	Jhallari (Shuklaphat Municipality)	100 for 10 m^3 (2012)	No change	0

m^3 = cubic meter, No. = number, NRs = Nepalese rupees.
Source: Asian Development Bank (Independent Evaluation Department).

APPENDIX 7: PROJECT (TREATMENT) EFFECTS AT THE HOUSEHOLD LEVEL

A. Average Outcomes

Table A7.1: Average Outcomes in Treatment and Comparison Towns

	Treatment towns		Comparison towns	
Outcomes	Value	N	Value	N
Education				
School attendance, proportion of total				
All	0.822	1,992	0.760	2,137
Female	0.798	1,024	0.736	1,117
Male	0.847	968	0.787	1,020
5–10	0.994	518	0.950	580
11–17	0.974	730	0.911	830
18–24	0.552	744	0.437	727
Absences, number of days in past month				
All	0.398	1,637	0.562	1,625
Female	0.466	817	0.539	822
Male	0.329	820	0.585	803
5–10	0.445	515	0.711	551
11–17	0.371	711	0.443	756
18–24	0.384	411	0.585	318
Health				
Diarrhea, incidence in past 2 weeks				
All	0.016	5,402	0.032	5,460
Female	0.018	2,875	0.036	2,914
Male	0.014	2,527	0.027	2,546
5 and under	0.026	456	0.039	519
6–10	0.020	440	0.028	504
Above 10	0.015	4,506	0.031	4,435
Typhoid, incidence in past month				
All	0.017	5,402	0.020	5,460
Female	0.018	2,875	0.022	2,914
Male	0.017	2,527	0.018	2,546
5 and under	0.018	456	0.033	519
6–10	0.025	440	0.034	504
Above 10	0.016	4,506	0.017	4,435
Jaundice, incidence in past month				
All	0.003	5,402	0.003	5,460
Female	0.002	2,875	0.001	2,914
Male	0.003	2,527	0.004	2,546
5 and under	0.004	456	0.010	519
6–10	0.000	440	0.002	504
Above 10	0.003	4,506	0.002	4,435
Household and community work, hours of work in past week				
All	16.8	5,024	16.6	5,017
Female	24.7	2,719	23.8	2,731
Male	7.4	2,305	8.1	2,286
5–10	0.8	518	1.1	580
11–15	4.8	526	5.7	608
16–24	15.9	946	16.8	949
25–34	28.2	796	27.5	801
35–44	23.9	730	23.3	662
45–54	22.0	637	21.7	601
55–64	18.5	449	20.1	429
65 and above	10.0	422	11.1	385

Outcomes	Treatment towns		Comparison towns	
	Value	N	Value	N
Time savings				
Proportion of households reporting savings	0.743	1,173	0.749	598
Total time saved per week, number of hours				
All	9.6	1,250	5.3	1,260
Adult, female	6.1	1,244	3.4	1,258
Adult, male	3.2	1,113	1.7	1,180
Female children	0.5	769	0.2	1,017
Male children	0.5	847	0.1	1051
Labor market outcomes				
In labor force, proportion of total				
All	0.511	4,092	0.521	3,938
Female	0.434	2,268	0.447	2,219
Male	0.607	1,824	0.616	1,719
15–24	0.264	1,058	0.297	1,058
25–34	0.627	796	0.630	801
35–44	0.695	730	0.734	662
45–54	0.702	637	0.684	601
55–64	0.539	449	0.550	429
65 and above	0.282	422	0.249	385
Work hours per week				
All	15.4	4,984	15.8	5,002
Female	11.0	2,696	12.5	2,727
Male	20.5	2,288	19.7	2,275
15–24	8.3	1,052	10.6	1,054
25–34	23.1	787	25.6	797
35–44	28.8	722	30.8	661
45–54	27.2	630	26.6	596
55–64	19.0	443	18.6	429
65 and above	8.0	420	8.1	384
Wage income per month (NRs)				
Total	25,066	454	19,533	459
Per worker	19,382	454	16,142	459
Household consumption expenditure per month (NRs)				
Food	7,737	1,250	7,381	1,260
Food, per capita	1,970	1,250	1,889	1,260
Non-food	32,483	1,250	23,237	1,260
Non-food, per capita	8,149	1,250	6,578	1,260
Total	40,220	1,250	30,618	1,260
Total, per capita	10,119	1,250	8,467	1,260

N = number of observations.

Source: Asian Development Bank (Independent Evaluation Department). Data collected from a survey of 2,510 households in July–September 2017.

B. Health and Education

Table A7.2: Impact on the Incidence of Diarrhea

	Town Pairs	PSMatch	IPWRA	Comparison
All				0.032
Coeff.	(0.0145)[b]	(0.0104)[b]	(0.0118)[a]	
SE	(0.005)	(0.004)	(0.005)	
N	10,862	10,858	10,858	
Female				0.036
Coeff.	(0.0164)[b]	(0.00920)[a]	(0.0129)	
SE	(0.006)	(0.005)	(0.007)	
N	5,789	5,787	5,787	
Male				0.027
Coeff.	(0.0136)[b]	(0.00525)	(0.0103)[a]	
SE	(0.005)	(0.005)	(0.005)	
N	4,611	5,071	5,071	
5 and under				0.039
Coeff.	(0.0133)	(0.00274)	(0.00766)	
SE	(0.009)	(0.014)	(0.009)	
N	844	975	975	
6-10				0.028
Coeff.	(0.00909)	(0.00212)	(0.00751)	
SE	(0.009)	(0.009)	(0.006)	
N	752	943	943	
Above 10				0.031
Coeff.	(0.0157)[b]	(0.0156)[c]	(0.0129)[b]	
SE	(0.005)	(0.004)	(0.006)	
N	8,941	8,940	8,940	

( ) = negative, Coeff = coefficient, IPWRA = inverse probability weighted regression adjustment, N = number of observations, PSMatch = propensity score matching, SE = standard error.
[a] $p<0.05$.
[b] $p<0.01$.
[c] $p<0.001$.
Source: Asian Development Bank (Independent Evaluation Department). Data collected from a survey of 2,510 households in July–September 2017.

Table A7.3: Impact on the Incidence of Typhoid

	Town Pairs	PSMatch	IPWRA	Comparison
All				0.020
Coeff.	(0.00250)	0.000138	(0.00130)	
SE	(0.003)	(0.003)	(0.003)	
N	10,862	10,858	10,858	
Female				0.022
Coeff.	(0.00419)	0.0000512	(0.00281)	
SE	(0.004)	(0.005)	(0.004)	
N	5,789	5,787	5,787	
Male				0.018
Coeff.	(0.000492)	(0.00115)	0.000501	
SE	(0.003)	(0.004)	(0.003)	
N	5,073	5,071	5,071	
0–10				0.033
Coeff.	(0.0223)	(0.0120)	(0.0110)	
SE	(0.014)	(0.010)	(0.008)	
N	1,187	1,918	1,918	
Above 10				0.017
Coeff.	(0.000119)	0.00317	0.00122	
SE	(0.002)	(0.003)	(0.002)	
N	8,941	8,940	8,940	
All				0.020
Coeff.	(0.00250)	0.000138	(0.00130)	
SE	(0.003)	(0.003)	(0.003)	
N	10,862	10,858	10,858	

( ) = negative, Coeff = coefficient, IPWRA = inverse probability weighted regression adjustment, N = number of observations, PSMatch = propensity score matching, SE = standard error.
Source: Asian Development Bank (Independent Evaluation Department). Data collected from a survey of 2,510 households in July–September 2017.

Table A7.4: Impact on the Incidence of Jaundice

	Town Pairs	PSMatch	IPWRA	Comparison
All				0.003
Coeff.	(0.000106)	0.000487	0.000564	
SE	(0.001)	(0.001)	(0.001)	
N	8,743	10,858	10,858	
Female				0.001
Coeff.	0.00269	0.00244	0.00146[a]	
SE	(0.002)	(0.002)	(0.0006)	
N	2,346	5,787	5,787	
Male				0.004
Coeff.	(0.00155)	(0.00189)	(0.000549)	
SE	(0.002)	(0.002)	(0.002)	
N	4,054	5,071	5,071	
0–10				0.006
Coeff.	(0.00716)	(0.00608)	(0.00227)	
SE	(0.004)	(0.003)	(0.002)	
N	898	1,918	1,918	
Above 10				0.002
Coeff.	0.00107	0.00234	0.00131	
SE	(0.001)	(0.002)	(0.001)	
N	6,258	8,940	8,940	

( ) = negative, Coeff = coefficient, IPWRA = inverse probability weighted regression adjustment, N = number of observations, PSMatch = propensity score matching, SE = standard error.
[a] $p<0.01$.
Source: Asian Development Bank (Independent Evaluation Department). Data collected from a survey of 2,510 households in July–September 2017.

Table A7.5: Impact on Sanitation and Hygiene

	Town Pairs	PSMatch	IPWRA	Comparison
With flush toilet				0.900
Coeff.	0.0538	0.0436[c]	0.0388	
SE	(0.030)	(0.013)	(0.028)	
N	2,510	2,509	2,509	
With own use flush toilet				0.844
Coeff.	0.0738[b]	0.0657[c]	0.0549[a]	
SE	(0.026)	(0.015)	(0.024)	
N	2,510	2,509	2,509	
Use cleansing agent in hand washing				0.988
Coeff.	0.0543[a]	0.00937[a]	0.00948	
SE	(0.023)	(0.004)	(0.008)	
N	502	2,509	2,509	
Connected to drains for liquid wastes				0.363
Coeff.	0.250[c]	0.241[c]	0.236[c]	
SE	(0.053)	(0.021)	(0.056)	
N	2,506	2,505	2,505	
Connected to covered drains for liquid wastes				0.072
Coeff.	0.0393	0.0463 [c]	0.0361	
SE	(0.024)	(0.014)	(0.026)	
N	2,506	2,505	2,505	

( ) = negative, Coesff = coefficient, IPWRA = inverse probability weighted regression adjustment, N = number of observations, PSMatch = propensity score matching, SE = standard error.
[a] p<0.05.
[b] p<0.01.
[c] p<0.001.
Source: Asian Development Bank (Independent Evaluation Department). Data collected from a survey of 2,510 households in July–September 2017.

Table A7.6: Impact on School Attendance

Group	Town Pairs	PSMatch	IPWRA	Comparison
All				0.755
Coeff.	0.0574[a]	0.0299[a]	0.0364	
SE	(0.025)	(0.014)	(0.019)	
N	4,129	4,127	4,127	
Female				0.732
Coeff.	0.0580[a]	0.0223	0.0339	
SE	(0.024)	(0.022)	(0.018)	
N	2,141	2,140	2,140	
Male				0.782
Coeff.	0.0534[a]	0.0320	0.0390	
SE	(0.027)	(0.019)	(0.023)	
N	1,988	1,987	1,987	
5-10				0.958
Coeff.	0.0825[b]	0.0292[c]	0.0285	
SE	(0.029)	(0.009)	(0.023)	
N	497	1,097	1,097	
11-17				0.911
Coeff.	0.0597[c]	0.0403[b]	0.0483[b]	
SE	(0.015)	(0.014)	(0.016)	
N	1,560	1,559	1,559	
18-24				0.437
Coeff.	0.112[b]	0.0490	0.0650[a]	
SE	(0.042)	(0.030)	(0.032)	
N	1,471	1,471	1,471	

( ) = negative, Coeff = coefficient, IPWRA = inverse probability weighted regression adjustment, N = number of observations, PSMatch = propensity score matching, SE = standard error.
[a] p<0.05.
[b] p<0.01.
[c] p<0.001.
Source: Asian Development Bank (Independent Evaluation Department). Data collected from a survey of 2,510 households in July–September 2017.

Table A7.7: Impact on Absences

Group	Town Pairs	PSMatch	IPWRA	Comparison
All				0.541
Coeff.	(0.393)[c]	(0.181)[a]	(0.140)[b]	
SE	(0.116)	(0.072)	(0.054)	
N	3,262	3,260	3,260	
Female				0.535
Coeff.	(0.211)	0.0142	(0.0439)	
SE	(0.156)	(0.097)	(0.067)	
N	1,639	1,638	1,638	
Male				0.547
Coeff.	(0.605)[c]	(0.242)[a]	(0.236)[a]	
SE	(0.179)	(0.104)	(0.098)	
N	1,623	1,622	1,622	
5–10				0.665
Coeff.	(0.438)[b]	(0.156)	(0.174)	
SE	(0.156)	(0.170)	(0.089)	
N	1,066	1,065	1,065	
11–17				0.443
Coeff.	(0.251)	(0.0556)	(0.0556)	
SE	(0.178)	(0.075)	(0.075)	
N	1,467	1,466	1,466	
18–24				0.585
Coeff.	(0.251)	(0.0556)	(0.0403)	
SE	(0.178)	(0.075)	(0.061)	
N	1,467	1,466	1,466	

( ) = negative, Coeff = coefficient, IPWRA = inverse probability weighted regression adjustment, N = number of observations, PSMatch = propensity score matching, SE = standard error.

[a] $p<0.05$.

[b] $p<0.01$.

[c] $p<0.001$.

Source: Asian Development Bank (Independent Evaluation Department). Data collected from a survey of 2,510 households in July–September 2017.

C. Time Savings and Time Use

Table A7.8: Time Savings from Improved Water Source

	Town Pairs	PSMatch	IPWRA	Comparison
Prop. of hh with time saved				0.7
Coeff.	(0.00890)	(0.00659)	(0.00485)	
SE	(0.047)	(0.025)	(0.047)	
N	1,771	1,770	1,770	
Total time saved per week				5.3
Coeff.	4.231[b]	4.109[c]	3.962[c]	
SE	(1.198)	(0.495)	(1.202)	
N	2,510	2,509	2,509	
Adult, female				1.7
Coeff.	2.660[c]	2.719[c]	2.523[c]	
SE	(0.654)	(0.305)	(0.644)	
N	2,502	2,501	2,501	
Adult, male				3.4
Coeff.	1.485[a]	1.441[c]	1.236[a]	
SE	(0.559)	(0.220)	(0.552)	
N	2,293	2,292	2,292	
Female children				0.1
Coeff.	0.284	0.392[c]	0.287[a]	
SE	(0.148)	(0.106)	(0.139)	
N	1,786	1,785	1,785	
Male children				0.2
Coeff.	0.309[a]	0.342[c]	0.339[a]	
SE	(0.133)	(0.093)	(0.133)	
N	1,898	1,897	1,897	

( ) = negative, Coeff = coefficient, hh = household, IPWRA = inverse probability weighted regression adjustment, N = number of observations, PSMatch = propensity score matching, SE = standard error.

[a] $p<0.05$.

[b] $p<0.01$.

[c] $p<0.001$.

Source: Asian Development Bank (Independent Evaluation Department). Data collected from a survey of 2,510 households in July–September 2017.

Table A7.9: Impact on Hours Spent on Household and Community Work per Week

Group	Town Pairs	PSMatch	IPWRA	Comparison
All				17
Coeff.	0.0690	0.416	0.257	
SE	(0.719)	(0.473)	(0.669)	
N	10041	10037	10037	
Female				24
Coeff.	0.890	2.452[b]	1.224	
SE	(0.941)	(0.730)	(0.843)	
N	5450	5448	5448	
Male				8
Coeff.	(0.805)	(0.625)	(0.750)	
SE	(0.617)	(0.439)	(0.563)	
N	4591	4589	4589	
5–10				1
Coeff.	(0.300)	0.0380	(0.120)	
SE	(0.163)	(0.210)	(0.158)	
N	1098	1097	1097	
11–15				6
Coeff.	(1.102)	(1.396)[a]	(0.744)	
SE	(0.546)	(0.494)	(0.577)	
N	1134	1133	1133	
16–24				17
Coeff.	(0.983)	(1.318)	(0.620)	
SE	(1.131)	(1.093)	(1.051)	
N	1895	1895	1895	
25–34				28
Coeff.	0.454	2.402	1.922	
SE	(1.105)	(1.313)	(1.070)	
N	1597	1597	1597	
35–44				23
Coeff.	0.671	0.0713	0.182	
SE	(0.881)	(1.228)	(0.908)	
N	1392	1392	1392	
45–54				22
Coeff.	(0.254)	0.141	0.134	
SE	(1.104)	(1.361)	(1.071)	
N	1238	1238	1238	
55–64				20
Coeff.	(1.368)	(1.977)	(1.202)	
SE	(2.000)	(1.352)	(1.832)	
N	878	878	878	
65 and above				
Coeff.	(1.141)	(1.463)	(1.251)	
SE	(1.071)	(1.068)	(0.954)	
N	807	807	807	

( ) = negative, Coeff = coefficient, IPWRA = inverse probability weighted regression adjustment, N = number of observations, PSMatch = propensity score matching, SE = standard error.

[a] $p<0.01$.

[b] $p<0.001$.

Source: Asian Development Bank (Independent Evaluation Department). Data collected from a survey of 2,510 households in July–September 2017.

D. Labor Force Participation Rates, Work Hours, and Wages

Table A7.10: Impact on Labor Force Participation, 15 Years and Above

	Town Pairs	PSMatch	IPWRA	Comparison
All				0.520
Coeff.	(0.0158)	(0.00889)	(0.00730)	
SE	(0.023)	(0.013)	(0.021)	
N	8030	8028	8028	
Female				0.446
Coeff.	(0.0168)	(0.0122)	(0.0134)	
SE	(0.023)	(0.019)	(0.023)	
N	4487	4486	4486	
Male				0.616
Coeff.	(0.0120)	(0.00585)	0.00438	
SE	(0.028)	(0.021)	(0.024)	
N	3543	3542	3542	
15–24				0.297
Coeff.	(0.0361)	(0.0492)[a]	(0.0181)	
SE	(0.037)	(0.021)	(0.033)	
N	2116	2116	2116	
25–34				0.645
Coeff.	(0.0206)	0.000104	(0.0123)	
SE	(0.024)	(0.029)	(0.024)	
N	1597	1597	1597	
35–44				0.731
Coeff.	(0.0291)	(0.0239)	(0.0144)	
SE	(0.016)	(0.028)	(0.016)	
N	1392	1392	1392	
45–54				0.684
Coeff.	0.000430	(0.0394)	(0.00352)	
SE	(0.027)	(0.028)	(0.028)	
N	1238	1238	1238	
55–64				0.550
Coeff.	(0.0342)	(0.0883)[a]	(0.0364)	
SE	(0.038)	(0.038)	(0.034)	
N	878	878	878	
65 and above				0.249
Coeff.	0.0228	(0.0165)	0.0140	
SE	(0.026)	(0.035)	(0.019)	
N	807	807	807	

( ) = negative, Coeff = coefficient, IPWRA = inverse probability weighted regression adjustment, N = number of observations, PSMatch = propensity score matching, SE = standard error.

[a] $p<0.05$.

Source: Asian Development Bank (Independent Evaluation Department). Data collected from a survey of 2,510 households in July–September 2017.

Table A7.11: Impact on Hours of Market Work, Past 7 Days

Group	Town Pairs	PSMatch	IPWRA	Comparison
All				20
Coeff.	(0.438)	(0.357)	(0.292)	
SE	(0.825)	(0.569)	(0.809)	
N	9986	9982	9982	
Female				15
Coeff.	(1.506)	(1.562)[a]	(1.416)	
SE	(0.765)	(0.657)	(0.722)	
N	5423	5421	5421	
Male				26
Coeff.	0.825	0.739	1.028	
SE	(1.074)	(0.987)	(1.056)	
N	4563	4561	4561	
15–24				11
Coeff.	(2.351)	(1.733)[a]	(1.680)	
SE	(1.486)	(0.884)	(1.296)	
N	2106	2106	2106	
25–34				26
Coeff.	(2.369)	(2.359)	(2.138)	
SE	(1.161)	(1.609)	(1.093)	
N	1584	1584	1584	
35–44				31
Coeff.	(1.849)	(2.084)	(1.370)	
SE	(1.021)	(1.567)	(1.014)	
N	1383	1383	1383	
45–54				27
Coeff.	0.722	0.0954	(0.113)	
SE	(1.822)	(1.618)	(1.781)	
N	1226	1226	1226	
55–64				19
Coeff.	(0.435)	(0.446)	(0.162)	
SE	(1.403)	(1.845)	(1.303)	
N	872	872	872	
65 and above				8
Coeff.	(0.0202)	(0.455)	(0.279)	
SE	(1.382)	(1.299)	(1.160)	
N	804	804	804	

( ) = negative, Coeff = coefficient, IPWRA = inverse probability weighted regression adjustment, N = number of observations, PSMatch = propensity score matching, SE = standard error.
[a] $p<0.05$.
Source: Asian Development Bank (Independent Evaluation Department). Data collected from a survey of 2,510 households in July–September 2017.

Table A7.12: Impact on Household Wage Income per Month

Group	Town Pairs	PSMatch	IPWRA	Comparison
Total wages				19,533
Coeff.	0.175[b]	0.169[b]	0.111[b]	
SE	(0.030)	(0.039)	(0.023)	
N	913	912	912	
Wage income per worker				16,142
Coeff.	0.122[a]	0.119[b]	0.0720[a]	
SE	(0.034)	(0.035)	(0.024)	
N	913	912	912	

( ) = negative, Coeff = coefficient, IPWRA =inverse probability weighted regression adjustment, N = number of observations, PSMatch = propensity score matching, SE = standard error.
Notes: Impacts are in percentage change because the dependent variables are expressed in log form. Comparison data are in Nepalese rupees.
[a] $p<0.01$.
[b] $p<0.001$.
Source: Asian Development Bank (Independent Evaluation Department). Data collected from a survey of 2,510 households in July–September 2017.

E. Household Consumption

Table A7.13: Impact on Household Expenditure per Month

Group	Town Pairs	PSMatch	IPWRA	Comparison
Food				7,381
Coeff.	(0.0170)	(0.0669)[b]	(0.0418)	
SE	(0.035)	(0.024)	(0.033)	
N	2,509	2,508	2,508	
Food per capita				1,889
Coeff.	(0.0243)	(0.0612)[a]	(0.0467)	
SE	(0.045)	(0.024)	(0.038)	
N	2,509	2,508	2,508	
Non-food				23,237
Coeff.	0.284[c]	0.202[c]	0.201[c]	
SE	(0.066)	(0.036)	(0.055)	
N	2,510	2,509	2,509	
Non-food per capita				6,578
Coeff.	0.276[c]	0.217[c]	0.196[c]	
SE	(0.069)	(0.037)	(0.051)	
N	2,510	2,509	2,509	
Total expenditure				30,618
Coeff.	0.199[b]	0.133[c]	0.133[b]	
SE	(0.053)	(0.030)	(0.044)	
N	2,510	2,509	2,509	
Total expenditure per capita				8,467
Coeff.	0.191[b]	0.148[c]	0.128[b]	
SE	(0.056)	(0.031)	(0.041)	
N	2,510	2,509	2,509	

( ) = negative, Coeff = coefficient, IPWRA = inverse probability weighted regression adjustment, N = number of observations, PSMatch = propensity score matching, SE = standard error.
Note: Impacts are in proportional change. Comparison data are in Nepalese rupees.
[a] $p<0.05$.
[b] $p<0.01$.
[c] $p<0.001$.
Source: Asian Development Bank (Independent Evaluation Department). Data collected from a survey of 2,510 households in July–September 2017.

APPENDIX 8: ECONOMIC RE-EVALUATION OF THE SMALL TOWNS WATER SUPPLY AND SANITATION SECTOR PROJECT

1. As recommended in ADB guidelines, the estimated economic internal rates of return (EIRR) computed in this evaluation reflect the incremental benefits and costs of the project.[1] The EIRR is computed for the 10 project towns assuming a benefit period of 25 years starting from 2005, the estimated start year of loan disbursements.

A. Estimated Costs of Providing Better Water Supply Services

2. The costs of providing better water supply services include (i) the initial capital cost, (ii) the recurring operation and maintenance cost (O&M), and (iii) the capital allowance every 10 years. The O&M is computed as proportion of the initial capital cost, at 13.2 %.

3. Total cost of the project in the 10 project towns was estimated using data on loan amounts (excluding interest capitalization) provided by the Town Development Fund. Annual costs of operations and maintenance were estimated using data from annual reports of the WUSCs for the year 2016. The proportion of households with piped water connections in each town was derived from data on total number of households, and number of households with piped water connections as estimated by the WUSCs (Table A8.1).

Table A8.1: Project Costs and Percentage of Households with Piped Water Connections in 10 Project Towns

Name of Small Town	Loan to Towns Excluding Interest Capitalization (NRs)	Total Cost of Water Supply Component Derived from 30% Loan Component Data (NRs)	Annual Costs of Operations and Maintenance in 2016 (NRs)	Ratio of Annual Operations and Maintenance Cost to Total Cost	Number of Connections	Number of Households	Percentage of Households Connected (%)
Surunga (Kankai Municipality)	16,724,618	55,748,726	7,370,000	0.132	2,900	3,250	89.2
Itahari (Itahari Municipality)	64,009,471	213,364,903	49,551,000	0.232	13,080	18,270	71.6
Triyuga (Triyuga Municipality)	32,763,760	109,212,533	3,350,000	0.031	2,000	4,200	47.6
Kamalamai (Kamalamai Municipality)	27,867,566	92,891,886	4,168,000	0.045	2,346	4,500	52.1
Parsa (Khairahani Municipality)	10,094,170	33,647,233	10,325,898	0.307	3,365	3,535	95.2
Lekhnath (Pokhara Metropolitan City)	71,646,517	238,821,723	28,585,000	0.120	10,100	13,100	77.1

[1] ADB. 1998. *Guidelines for the Economic Analysis of Water Supply Projects*. Manila; ADB. 2017. *Guidelines for the Economic Analysis of Projects*. Manila.

Name of Small Town	Loan to Towns Excluding Interest Capitalization (NRs)	Total Cost of Water Supply Component Derived from 30% Loan Component Data (NRs)	Annual Costs of Operations and Maintenance in 2016 (NRs)	Ratio of Annual Operations and Maintenance Cost to Total Cost	Number of Connections	Number of Households	Percentage of Households Connected (%)
Bardghat (Bardghat Municipality)	15,767,142	52,557,140	6,039,000	0.115	3,120	3,300	94.5
Kohalpur (Kohalpur Municipality)	23,269,756	77,565,853	9,311,000	0.120	2,812	5,000	56.2
Birendranagar (Birendranagar Sub Metropolitan City)	92,812,228	309,374,093	24,700,000	0.080	15,331	26,500	57.9
Lamki (Lamkichuha Municipality)	26,206,569	87,355,230	7,932,000	0.091	3,214	3,570	90.0
Total	381,161,797	1,270,539,320	147,981,898	0.116	58,268	85,225	68.4

Sources: Asian Development Bank (Independent Evaluation Department). Personal communication with the Town Development Fund; 2016 Annual Reports of Water User and Sanitation Committees.

B. Estimated Benefits from Better Water Supply Services

4. Benefits of better water services were estimated for (i) non-incremental, incremental and reduced water wastage; (ii) time savings; (iii) health benefits; (iv) education benefits; and (v) wage increases. Outcomes estimated in this evaluation were converted to monetary benefits using assumptions listed in Table A8.2.

5. The benefits from non-incremental water come from the difference in the average price households pay before the project and those paid under the project. Additional water demand due to more convenient source constitutes an important benefit from better water supply. Ten percent of private demand is added to account for demand from other units such as school, hospitals and other institutions. The incremental water demand is the difference between the increased water demand with project and the demand without the project. Savings from water wastage due to poor management is another source of benefits from better water supply. This is assumed to be 10% of household consumption.

6. With better water supply, it is expected that households will save time spent on fetching water. While it is expected that the time saved can be used in market work, the evaluation did not find a significant labor market impact either in labor force participation or in the average hours worked. Nonetheless, the time saved needs to be valued as increase in leisure time.[2]

7. Health benefits are valued by computing the savings on health expenditures from reduction in water-borne diseases such as diarrhea. Estimated health expenditures are derived from the household survey data, and 5% of these expenditures are assumed to be for water-borne diseases.

8. Education benefits are estimated using rates of return for an additional year of schooling, which is 6.5% for South Asia.[3] It is assumed that the additional wage income will be realized 15 years later when children who are currently in school enter the labor market. It is also assumed that half of household wage income will be from children who are currently in school.

9. Even though there is no change in labor force participation and hours of work, the

[2] G. Becker. 1965. "A Theory of the Allocation of Time," Economic Journal, 75(299), pp. 493–517.

[3] C. Montenegro and H. Patrinos. 2013. "Returns to schooling around the world". Background paper for the World Development Report 2013. Washington, DC.

evaluation found an increase in wage income, which could come from availability of better work choices.

Scenarios that attribute 100%, 50% and 25% of the estimated increase in wages to the project yielded EIRR estimates of 52%, 38%, and 29%.

C. Economic Internal Rate of Return

10. The estimated EIRR is 16% when wage increase is not considered in the computations.

Table A8.2: Assumptions for the Estimated Stream of Project Benefits

Indicator	Parameter
Inflation rate (2015=100)	5%
Population growth rate per year	3.3%
Family size (number)	5.6
Households connected to piped water	68%
Pre-project water consumption, liters consumed per day	12.5
Projected incremental demand for water, with project	
Private indoor connections (90% of household connections), liters consumed per day	100
Private yard (10% of household connections), liters consumed per day	65
Additional demand from schools, hospitals, and other institutions	10%
Value of time savings	
Time saved, hours per week	3.9
Opportunity cost of unskilled labor, NRs per day	100
Shadow wage factor	0.7
Non-incremental water	
Pre-project price, minus price with project, NRs	0.0258
Incremental water benefits	
Initial tariff, NRs per liter	0.0142
Tariff increase per year	5%
Non-revenue water	
Proportion of water consumption	0.15
Health benefits	
Health expenditures as a percentage of total household expenditure	12%
Percentage of health expenditure for water-borne diseases	5%
Education benefits	
Increase in wages	6.5%
Proportion of wage increase attributable to children currently in school	0.50
Wage income	
Increase in wage income	11.1%

Source: Asian Development Bank (Independent Evaluation Department).