Basic Research for Impact Evaluation Trial on Grant Aid: A Case from Rural Groundwater Development Project in Zambia

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Contents

Executive Summary

With the growing interest in the results of development interventions, the importance of credible evidence produced by rigorous impact evaluations has been recognized. While several impact evaluations have been conducted in JICA, no impact evaluations targeting grant aid projects have been conducted. Therefore, this study aims to fill in this gap by attempting to conduct an impact evaluation on a grant aid project implemented in rural Zambia (The Project for Groundwater Development in Luapula Province Phase 2) in order to understand the causal effects (impacts) of the Project in a reliable manner and to extract insights and implications for the implementation of impact evaluations.

The project constructed 216 borehole water facilities with the objective of reducing water-related diseases (especially diarrhea) and the burden of fetching water by ensuring access to safe drinking water in districts of Luapula Province. In addition, soft component activities were conducted, such as the promotion of hygiene practice and the establishment of community-based operation and maintenance systems. This study collected data on 635 households from 64 project sites where the facilities were constructed and 30 control sites where the facilities were not constructed before and after the Project. A difference-in-differences (DID) approach, which combines before/after and with/without comparison, is employed to estimate the causal effects of the Project.

The estimation results show a positive and statistically significant impact of the Project on reducing the incidence of diarrhea (1.0–1.7% reduction) and that the magnitude of the impact is larger among children under five years old (3.7–6.2% reduction), among whom diarrhea is more prevalent. The results also show that the magnitude of the project impact depends on the distance to the borehole and diminishes as distance from the borehole increases. The results also show that the distance to the nearest water source is reduced with the Project compared to control sites where no intervention was implemented. On the other hand, we cannot find a significant impact on time spent fetching water. Although water-fetching time is reduced in the project sites, somehow it is also reduced in the control sites, resulting in non-significant DID estimation results. Further investigation is needed to clarify this point.

This impact evaluation trial provides several lessons learned. First, it is important to examine the causal effects (impacts) of a project with an appropriate evaluation design. While this evaluation provides concrete evidence of the impact of the Project on the incidence of diarrhea, if a simple approach were used to estimate this impact, we would reach an incorrect conclusion that the Project has no impact. The evaluation result produced with an appropriate design allows us to avoid such an incorrect understanding and make decisions based on reliable evidence, which can contribute to more effective and efficient implementation. Second, since substantial resources (budget, time, and human resources) are required to implement impact evaluations, it is important to strategically focus on impact evaluations with larger benefits, that is, those that are expected to produce more useful and policy-relevant evidence, such as impact evaluations on JICA's flagship projects, which are required to show results in a credible way, or on interventions whose impact is unknown or controversial. Finally, it is important to incorporate impact evaluations into project design at an early stage of project formulation, which allows us to employ evaluation designs that can produce more rigorous and policy-relevant evidence. Considering the relatively longer time required to carry out the necessary procedures from the request to the commencement of a project than is involved in other schemes, it is particularly important to consider the possibility of conducting impact evaluation at an earlier stage.

要旨

効果的な事業実施への要求が高まりを見せている中、精緻なインパクト評価によって事業効果の検証を行い、その結果（エビデンス）に基づいた意思決定を行なっていくことの重要性が広く認識されてきている。JICAにおいても近年インパクト評価の取り組みが進んできているものの、無償資金協力事業を対象とするインパクト評価はこれまで実施されてこなかった。このような背景の下、本基礎研究ではザンビアにおいて実施された「第2次ルアプラ州地下水開発計画」を対象とし、事業の効果について正確な理解を得るとともに、今後の無償資金協力事業におけるインパクト評価の実施に向けた教訓を得ることを目的としてインパクト評価を試行的に実施した。

本プロジェクトでは、ザンビアの北部に位置するルアプラ州の4郡において、安全な水へのアクセスの改善を通じた水因性疾患（特に下痢症）の減少、および水汲み労働の軽減を目的として、216か所のハンドポンプ付深井戸給水施設の建設が行われた。また施設建設に加えて、啓発活動や維持管理体制の整備などのソフトコンポーネント活動も実施された。本評価では、施設建設の対象となった64コミュニティと施設建設対象の候補となりながらも実際には建設が行われなかった30コミュニティの計635世帯から、施設設置前後のデータを収集し、「二階差分法（Difference-in-Differences：DID）[1]」と呼ばれる手法を用いて事業の因果的効果の検証を行った。

分析の結果、施設建設が行われなかったコミュニティでは下痢症の増加傾向が観察された一方で、施設建設が行われたコミュニティでは下痢の減少傾向が見られた。その結果、DID推計値では1.0~1.7ポイントの統計的に有意な下痢症の減少が確認された。また、分析の対象を5歳未満の子どもに限ると、上記の傾向はより顕著であり、DID推計値で3.7~6.2ポイントの減少が確認された。また、距離によるインパクトの違いを検証したところ、給水施設建設によるインパクトは施設と世帯との距離に依存することが確認され、施設との距離が近いほど、より大きな効果が見られることが明らかになった。水汲み労働の軽減という点に関しては、水源への距離には有意な減少が確認された一方で、水汲み時間については施設が建設されなかったコミュニティでも減少傾向が観察されたため、統計的に有意な減少は確認されなかった。

教訓としては、適切な手法を用いた効果検証の重要性が挙げられる。従来の効果検証で用いられている簡易な方法では、事業の効果を正確に把握することができず、誤った結論に基づいた意思決定がなされてしまう可能性がある。適切な手法を用いた検証を行うことで、正確なエビデンスに基づく効果的な事業実施が可能となると考えられる。他方で、インパクト評価の実施には予算・時間・人的リソースなど一定のコストが必要とされるため、インパクト評価実施に当たっては、フラッグシップとなっている案件や効果の有無について明確なコンセンサスが得られていない介入など、より大きな付加価値が見込めるものに対し戦略的にリソースを配分することが重要となろう。また、そのためには、早い段階からインパクト評価の実施を事業デザインの中に組み込むことが重要となる。そうすることによって、厳密性の高い手法や付加価値の高い評価デザインを用いることが可能となり、効果的な事業実施のためのより有意義な知識を得ることが可能となると考えられる。特に無償資金協力では、要請から事業実施までに長い準備期間が必要とされるため、より早い段階でインパクト評価実施の検討を行うことが重要である。

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[1] 評価の対象となる指標について、プロジェクト実施前後と、プロジェクト裨益者・非裨益者間の双方の差分を取ることで効果を推計する手法。

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1. Introduction

With the growing interest in the results of development interventions, the importance of credible evidence produced by rigorous impact evaluations has been recognized.[2] Rigorous impact evaluation provides reliable knowledge about whether an intervention works or not, and, if it works, the extent to which it does so. This kind of knowledge can contribute to effective and efficient implementation by allowing policymakers and practitioners to make decisions on the selection, scaling-up, remediation, or cancelation of interventions based on credible evidence.

Aligning with this trend, JICA has also promoted impact evaluations for more than a decade so as to maximize the effectiveness of its work and demonstrate the results in a reliable manner. Approximately 10 completed impact evaluations have already been produced,[3] and including those that are ongoing and being prepared, there are more than 30 impact evaluations on the list. However, the existing impact evaluations have covered only technical cooperation and loan projects, and no impact evaluations targeting grant aid projects have been conducted. While conventional ex-post evaluations are also conducted on all grant aid projects that satisfy certain criteria,[4] these tend to focus on the confirmation of outputs and processes, and the assessment of effectiveness and impact tends to lack an appropriate counterfactual. As a result, little is known about whether a project really has a causal effect on intended outcomes, and anecdotal evidence is likely to be utilized for decision-making, which does not necessarily guarantee expected results. Therefore, this study aims to help fill in this gap by attempting to conduct an impact evaluation on a JICA grant aid project.

This study examines the impact of a grant aid project in which groundwater supply facilities are constructed in rural Zambia (The Project for Groundwater Development in Luapula Province Phase 2, hereafter referred as “the Project”). Rural water development projects are one of the typical types of intervention in the grant aid scheme, and a number of projects have been conducted in various countries, especially in Sub-Saharan Africa, aiming at the reduction of water-related diseases and the time burden for fetching water. They are, of course, subject to ex-post evaluation. However, since these evaluations mostly employ simplified methods, such as simple before/after comparison or simple with/without comparison, for the assessment of effectiveness and impact, the causal effect of these projects cannot be clearly confirmed. In recognition of this, this study examines the causal effects (impacts) of the Project by employing a rigorous evaluation design (a combination of with/without comparison and before/after comparison) with two objectives: (1) to understand the causal effects (impacts) of the Project in a reliable manner by using a rigorous evaluation design; and (2) to extract insights and implications for the implementation of impact evaluations in JICA’s grant aid projects.[5]

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[2] Rigorous impact evaluation can be defined as an assessment of “the causal effects (impacts) attributable to specific interventions, where the outcomes of interest are compared with a counterfactual situation－that is, with what would have happened without the program” (IEG 2012, 14). For further explanation, see Gertler et al. (2011) or Khandker et al. (2010).

[3] For the existing completed impact evaluations on JICA projects, see JICA’s website. (http://www.jica.go.jp/english/our_work/evaluation/tech_and_grant/impact/index.html)

[4] Ex-post evaluations are conducted for all projects over 200 million yen under all schemes (ODA loan, technical cooperation, and grant aid) three years after project completion in principal. Ex-post evaluations assess the relevance, effectiveness, efficiency, impacts, and sustainability of each project.

[5] There are also a number of practical reasons why this Project was selected as a subject of this study.

The rest of this report is organized as follows. The next section describes the background of the study area, and the details of the Project to be assessed are shown in Section 3. Section 4 then explains the methodology and data used in this study. The results are presented in Section 5. Section 6 summarizes the findings and presents conclusions.

First, as impact evaluations usually employ statistical methods for analysis, for practical purposes, a certain sample size is required. Second, since this impact evaluation is being conducted as a trial, it is necessary for the results to be obtained within a short term. This Project, in which water facilities are constructed at more than 200 sites and where impacts are expected to emerge within a relatively short term, is suitable with regard to these conditions. Finally, it was possible to prepare and conduct a prospective impact evaluation.

2. Background of Study Area

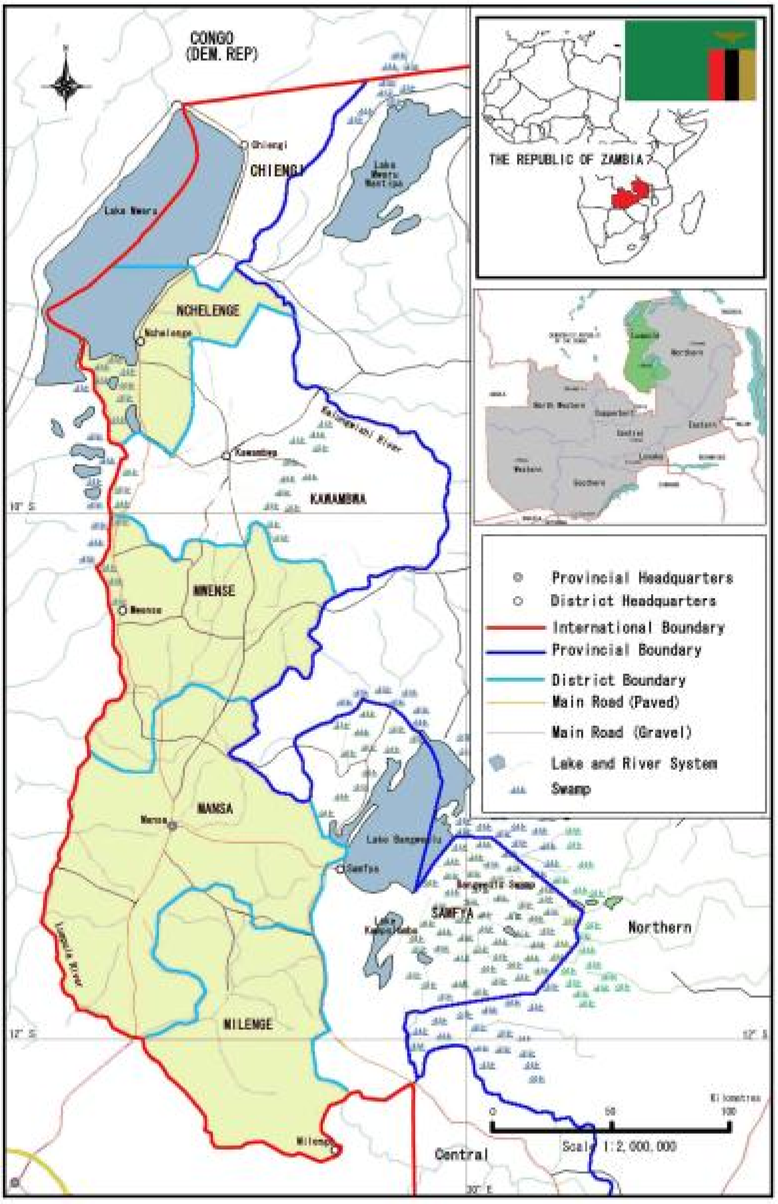
2.1. General Information

Zambia is a landlocked country in southern Africa with a tropical climate, and consists mostly of high plateaus, with some hills and mountains, dissected by river valleys. It shares borders with the Democratic Republic of the Congo, Tanzania, Malawi, Mozambique, Zimbabwe, Botswana, Namibia, and Angola. The estimated population is 13,046,508, in an area of 752,614 km^2, and 61% reside in rural areas (Central Statistical Office 2011). Administratively, it consists of nine provinces and 72 districts.

Zambia's per capita GDP in 2012 was US$1,445, and as the average growth rate between 2003 and 2012 (6.76%) shows, its economy has shown robust growth for several years, led by strong performance in agriculture, manufacturing, and services (World Bank 2012). However, the strong economic growth has not necessarily led to significant reduction of poverty. As of 2006, 64% of the population was counted as living as poverty, and the figure showed only a modest decline from 68% as of 2004. More severely, in rural areas, the situation even worsened, with an increase in rural poverty from 78% in 2004 to 80% in 2006 (UNDP 2011). This inequality between urban and rural areas is high, with a Gini coefficient for consumption of 52 in 2010, making Zambia one of the most unequal countries in the world (World Bank 2012). Not only the monetary dimension, but also the improvement of social indicators is stagnant. Zambia is still positioned in the low human development category in the UNDP's Human Development Index 2012, at 163 out of 187 counties and territories (UNDP 2013).

Luapula Province, where the Project is implemented, is situated the northern part of Zambia, with a population of 958,976 in 2010 in an area of 30,600 km^2, approximately 8% and 25% of the national totals, respectively (Central Statistical Office 2011). Since 43.5% of its surface area is covered by lake and wetland areas (JICA 2010), it has access to relatively abundant water resources. The major bodies of water are Lake Bangweulu in the southeastern corner of the Province, Lake Mweru in the northwestern corner, and the Luapula River, which flows between them. Its administration is divided into seven districts, including the four districts targeted by the Project: Mansa, Nchelenge, Mwense, and Milenge.

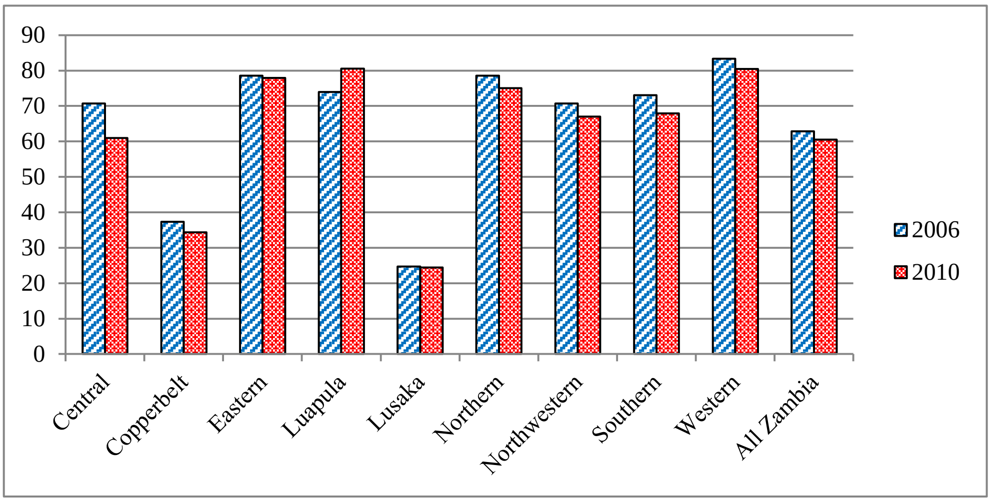
Figure 1: Map of Luapula Province



Source: Completion Report of the Project

Economically, Luapula Province is positioned at the economic bottom of Zambia, because it is relatively isolated and lags behind the rest of county. According to a survey conducted by the Central Statistical Office (2011), the poverty rate in Luapula Province in 2010 (80.5%) was the highest in the country's nine provinces. Moreover, as Figure 2 shows, while the poverty rate decreased in the other eight provinces between 2006 and 2010, only Luapula Province experienced an increase in the poverty rate during the same period. For other indicators, such as health and education, Luapula shows one of the poorest levels of performance in Zambia, ranking seventh out of the nine provinces in terms of the HDI (UNDP 2011).

Figure 2: Poverty Status by Province (%)



Source: Central Statistical Office (2011)

According to a preparatory survey conducted prior to the formulation of the Project in the candidate villages for the Project, more than 90% of the population is engaged in agriculture, and produces maize, millet, sorghum, cassava, beans, and so forth. In the areas that face lakes or rivers, fishing is also actively practiced, although it is banned from December to March for resource conservation (JICA 2010).

2-2. Current Situation in the Water Sector

Zambia is still struggling to expand water supply coverage, although the overall coverage has been continuously increasing over the past several years. As Table 1 indicates, the overall proportion of people with access to improved water has reached more than 60% (Central Statistical Office 2011). However, approximately 40% of the population still has difficulty in getting safe water, and significant efforts are needed to achieve the target under the MDGs[6] (UNDP 2013). In particular, lack of access to safe water is a serious problem in rural areas, with more than half living without access to safe water, while 87% of the urban population has such access (WHO/UNICEF 2012). The lack of access to safe water sources also imposes burdens for fetching water. The proportion of the rural population who can get drinking water on their premises is only 8.4%, and 30% spend more than 30 minutes to get drinking water, compared to 8.3% in urban areas (UNDP 2011).

Table 1: Access to Safe Water Supply in Zambia 2000–2010

	2006		2010	
	Population ('000)	Coverage (%)	Population ('000)	Coverage (%)
Zambia	11,711	56.6	13,064	61.6
Urban	4,099	86.6	4,533	83.6
Rural	7,612	40.6	8,531	49.2

(Source) Central Statistical Office (2011)

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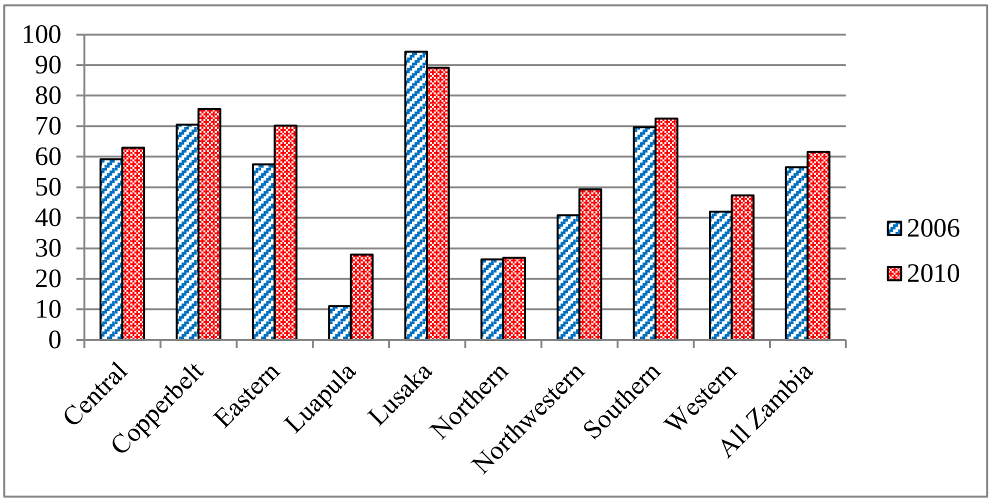
[6] The target is to reduce the proportion of the population without sustainable access to safe drinking water to 25.5%.

Luapula is a province with limited water supply coverage. Although there was a significant increase in water coverage from 2006 to 2010, as shown in Figure 3, only 28.0% as of 2010 have access to safe water, which forces people to rely on unsafe water sources, such as unprotected shallow wells, hand-dug wells, steams, rivers, and lakes, for their livelihood (Central Statistical Office 2011). The result of the preparatory survey conducted prior to the formulation of the Project also shows that more than 90% of households use water from rivers, lakes, springs, or unprotected shallow wells for drinking and daily activities, and most of them expresses dissatisfaction with the water sources they are using. It also reports that the households who rely on rivers, lakes, and springs as their sources of water have to travel long distances to get water, which imposes large burdens on women and children (JICA 2011).

Figure 3: Percentage of Population with Access to Safe Water in 2006 and 2010 by Province



Source: Central Statistical Office (2011)

To tackle to this situation, JICA and other donors have implemented several projects in this province to improve access to safe water. Between 2008 and 2010, JICA provided the Government of Zambia with grant aid assistance for the construction of 200 water facilities with hand pumps in all seven districts in Luapula Province (The Project for Groundwater Development in Luapula Province Phase 1). Technical cooperation projects have also been conducted to strengthen local capacity for the operation and maintenance of existing water facilities. Similar interventions, such as the construction of water facilities and training for personnel in charge of the operation and maintenance of facilities, are also conducted by the United Nations Children's Fund (UNICEF), African Development Bank, Water Aid, and Plan International. As a result of these interventions, the proportion of the population with access to safe water doubled between 2006 and 2010 (11.1% to 28.0%), although the figure is still poor (Central Statistical Office 2011).

2-3. Current Situation of Water-Related Diseases

There are concerns that a lack of safe water, together with poor hygiene, can be a contributing factor to the high prevalence of diarrhea and other waterborne diseases. Zambia has in fact faced a situation of stagnation in the improvement of water-related health status. Table 2 shows that the incidence of diarrhea increased from 69 per 1,000 population in 2008 to 79 per 1,000 population in 2010 (Ministry of Health 2012). In addition, hospital case fatality rates for diarrhea also increased from 70 deaths per 1,000 admissions in 2008 to 74 deaths per 1,000 admissions (Ministry of Health 2012).

Table 2: Incidence of Diarrhea per 1,000 Population

	2008	2009	2010
Central	69	74	88
Copperbelt	73	79	86
Eastern	66	69	83
Luapula	72	77	60
Lusaka	71	53	62
Northern	57	36	61
North-Western	62	78	91
Southern	85	96	99
Western	65	79	82
Zambia	69	72	79

Source: Ministry of Health (2011)

Note: Incidence of diarrhea is defined as the number of new cases of diarrhea (non-bloody) per 1,000 catchment population.

The causes of the currently observed trend of diarrhea cases may be diverse. According to a descriptive survey targeting program officers at the provincial, district, and facility levels, there were several hypotheses for the increase, such as poor access to protected water sources, under-utilization of chlorine for water treatment, poor hygiene, and the use of unsafe water from unconventional water sources especially in rural areas, although it could be partly attributable to improvement in reporting in the existing health information system (Ministry of Health 2012).

According to the explanation of Ministry of Health staff, Luapula Province is historically recognized as a high-risk area for water-related diseases because it is a remote province with plentiful water resources due to the large number of rivers, streams, and lakes. In such circumstances, the main water sources for households have been untreated and easily contaminated. Poor hygiene, particularly around fish markets along the Luapula River, has long been regarded as a problem. While a reduction in the incidence of diarrhea can be observed in Luapula, presumably due in part to the interventions by donors mentioned above, the preparatory survey conducted at Project candidate sites reveals that diarrhea was recognized as one of the major health issues in about 50% of the candidate sites (JICA 2010).

3. Project Description

The Project is conducted in four districts of Luapula Province—Nchelenge, Mwense, Mansa, and Milenge districts—and consists mainly of two components, the construction of borehole water supply facilities and a soft component, with the objective of improving the living standard of the rural population by providing safe drinking water. More specifically, this project aims to reduce water-related diseases, especially diarrhea, and to lessen the burden of fetching water by assuring reasonable access to safe and stable water sources. The outline of the Project is shown in Table 3.

Table 3: Project Outline

Project Name	The Project for Groundwater Development in Luapula Province Phase 2 in the Republic of Zambia
Exchange of Notes Date	2 June 2011
Project Completion Date	10 May 2013
Grant Limit/Actual Grant Amount	712 million yen/688 million yen
Executing Agency	Department of Housing and Infrastructure Development Ministry of Local Government and Housing

3-1. Facility Construction

Facility construction included the construction of borehole and appurtenant facilities and the installation of hand pumps at 216 sites. Each facility was designed to provide 250 people with 30 liters/day of water. In total, the Project was expected to benefit more than 54,000 people in the four districts. The construction started in February 2012, and was completed in May 2013. The first facilities were handed over and started to be used by residents in October 2012. One of the characteristics of this project is the depth of the boreholes. The minimum and average depth of boreholes are designed to be 30 m and 63 m, respectively, which allows water to be free from contaminants from the ground. In addition, water quality testing was conducted before each facility was handed over to the residents to check if the water quality satisfied the standards of Zambia, which also ensures that water is uncontaminated at a source, at least at the time of completion.[7]

3-2. Soft Component

The soft component aimed at encouraging the establishment of community-based operation and maintenance systems.[8] At the village level, the Village Water, Sanitation and Health Education (V-WASHE) Committee is responsible for general and daily operations and maintenance including minor repairs, the collection of maintenance fees, and communication

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[7] The water quality testing conducted before handing-over examines electrical conductivity, pH, and the content of iron, manganese, fluorine, and *E. coli*. The testing was conducted on-site, and when further examination was needed, samples were reexamined at the laboratory of the University of Zambia in Lusaka. In three sites where the iron content exceeded the reference value, iron remover was installed to reduce the iron content. (By chance, these three sites were not included in our sample.)

[8] Soft component activities were conducted at all of the target sites (including the site where the facility was not constructed due to drilling failure) and alternative sites that actually replaced target sites.

with the administration or Area Pump Menders (APMs).[9] The soft component facilitated the (re-) organization of the V-WASHE Committees and conducted capacity development activities to enhance their knowledge and techniques for the operation and maintenance of the facilities and organization management. In addition, training of district officers, WASHE facilitators, and APMs was also conducted at the district level so that they can provide the V-WASHE with necessary administrative and technical support.[10]

The soft component had also activities to raise awareness and to promote water and sanitation practices in the target sites. These activities involved the provision of knowledge on health and sanitation, such as proper water treatment, promotion of hand washing, and the use of latrines. Proper understanding of health and sanitation was also expected to facilitate resident ownership of the facilities and their commitment to maintenance activities including the payment of maintenance fees.

Residents also participated in the determination of drilling points where the facilities were constructed through the soft component activities. While the drilling points at each site were selected in accordance with the hydrogeological conditions through careful field reconnaissance and geophysical sounding, priority was given to the local residents' demands with careful consideration of the possibility of groundwater contamination.

3-3. Site Selection

Figure 4 shows the selection process of the sites that the Project targeted. First, 320 sites in the four districts were specified by the Zambian Government in the request for Grant Aid. Each site was then examined using seven criteria to consider the feasibility and relevance of the project implementation.[11] As a result of the examination, 291 sites that satisfied the above criteria were identified as candidate sites. However, considering the project capacity within the project period (two years), it emerged that only 216 facilities could be constructed. Thus, the number of sites for each district was determined by using the same proportion per district for the originally requested number such that the total number would be 216, and in each district, the target sites for the Project were finally selected based on their population size.

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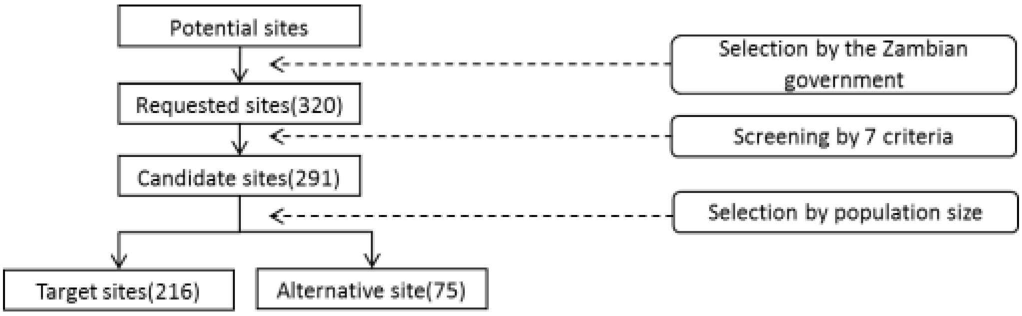
[9] One or two people are assigned as APMs assigned in each ward, and are responsible, on a charge basis, for hand pump maintenance and repairs which communities cannot handle.

[10] The Rural Water Supply and Sanitation (RWSS) Unit takes administrative responsibility in the planning and implementation of rural water supply and sanitation projects within a district, and the District Water, Sanitation and Health Education (D-WASHE) Committee provides the RWSS Unit with technical advice.

[11] The 320 sites were screened using the following seven criteria: (1) the demand for a safe and stable water supply; (2) accessibility to the site; (3) the hydrogeological conditions; (4) the availability of existing water supply facilities; (5) overlap with other related projects; (6) the possibility of forming a V-WASHE Committee; and (7) the residents' willingness to pay the operation and maintenance costs of the facilities.

Figure 4: Process of Site Selection



The remaining 75 sites were reserved as alternative sites that would replace target sites if drilling was unsuccessful at the target sites. Although the drilling point was determined through careful examination, the possibility of failing to find underground water remained, because it was technically impossible to precisely identify the points where ground water was available, and whether drilling was successful or not depended on chance, even with careful examination.[12] In this Project, a maximum of two drillings were attempted, and if the second drilling was unsuccessful, the site was to be cancelled and replaced with one of the alternative sites.

Ultimately, the project constructed 216 boreholes at 214 sites; 31 target sites were replaced because it was impossible to obtain water even after two drillings. In Milenge district, since the number of unsuccessful sites exceeded the number of alternative sites, two facilities were constructed at two sites.[13]

Table 4: The Number of Sites

District	Number of requested sites	Proportion per district	Number of candidates sites	Number of target sites	Number of alternative sites
Nchelenge	95	29.7%	93	64	29
Mwense	65	20.3%	59	44	15
Mansa	90	28.1%	79	61	18
Milenge	70	21.9%	60	47	13
Total	320	100.0%	291	216	75

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[12] In this project, the possibility of success is assumed as being 75.5% based on the experience of the Phase 1 project.

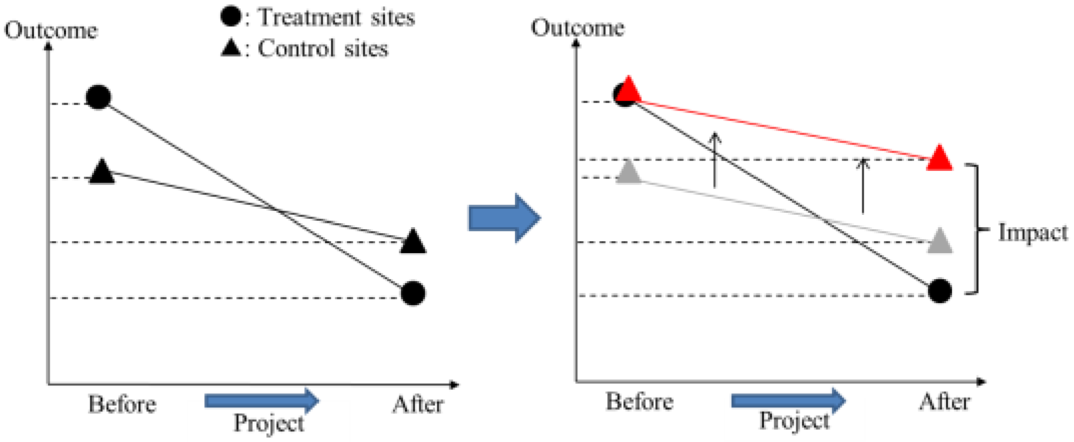
[13] By chance, these two sites are not included in our sample.

4. Methodology

4-1. Approach

In JICA's conventional evaluations, simple before/after comparison or with/without comparison tend to be employed for the assessment of a project's effectiveness. However, these approaches cannot necessarily detect the real project effects, because a change before/after the intervention might be explained by factors other than the project, and with/without comparison might suffer from selection biases (e.g., only worse-off people might be targeted as a project beneficiary group or only motivated people might participate in a project) (Ravallion 2001). In recognition of these problems, this study employs a difference-in-differences (DID) approach to control these potential biases and estimate the causal effects (impacts) of the Project. The DID methodology combines before/after comparison and with/without comparison, and is popularly used for project impact evaluations, as shown Figure 5.[14]

Figure 5: Differnce-in-Differences (DID)



The central assumption for the DID methodology to be valid is called a "parallel trend" assumption. It assumes that a change (without the intervention) during the baseline and end-line survey period is common between the treatment and control sites. Under this assumption, the DID methodology, by subtracting the common trend in the treatment sites, can identify the causal effects of the project.[15]

4-2. Data

Data used for this study were collected in two rounds of original surveys. The first round (baseline) was implemented during July–August 2012, and the second round (end-line) was also conducted during July–August, in 2013.[16] The surveys were conducted by an independent local

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[14] This methodology also may not be free from biases, although it is better than either with/without comparison or before/after comparison. Randomized control trials (RCTs) are regarded as the gold standard for impact evaluation. Reasons why we could not employ an RCT design for this study and more arguments on this issue will be provided in the Conclusion section.

[15] A more detailed empirical model is presented in Appendix A.

[16] This period falls in the dry season (from April to October) with almost no rain at all in June, July, and August. Since it is practically impossible to travel in the project area in the rainy season due to bad road

consulting firm hired by JICA Zambia Office.

Each round of the survey involved both household and community questionnaires and the collection of a variety of socio-economic variables of individuals, households, and communities. The questionnaires were tested twice to validate the contents and revised prior to the first-round survey. In the second-round survey, the same questionnaires were used with minor revisions after another pretest of the questionnaires.

With respect to access to water outside the home, the community questionnaire confirmed the presence of various types of water sources in the community and also their accessibility from the community, whereas the household questionnaire asked respondents to provide information about the distance from the household to each water source.

Regarding health conditions, the household questionnaire collected information about episodes of illness/injury for individual family members over the past 30 days. With respect to water-related diseases, the household questionnaire focused on diarrhea symptoms over the past two weeks and also asked about diarrhea symptoms over the past 30 days. In addition to these general health conditions of individuals, the enumerator conducted a simple test of the quality of drinking water stored at each household by drawing a cup of water from a storage container and utilizing a test sheet. The test sheet examined whether or not the drinking water contained a certain amount of *Escherichia coli* (*E. coli*, one of the indicators of water quality). The appearance of spots on the test sheet indicated that the drinking water of the household was contaminated.[17]

Figure 6: Water Stored at Home and Examined by the Test

Another notable feature of this study was that the respondent family was asked to fill in a timetable for a whole day from 5:00 a.m. to 10:00 p.m. This exercise was requested for a weekday and a holiday separately, and when an individual was absent the most knowledgeable person, in most cases the female spouse, was asked to provide such information. Based on this information, we measured the hours spent fetching water, and also the time spent for other

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conditions, the survey was conducted in the dry season.

[17] The test results were independently judged by an enumerator and a supervisor, and when there was discordance between them, the project manager made a final judgment.

purposes. This methodology has an advantage over a simple question on being involved in fetching water or on hours spent fetching water.

4-3. Sample

Table 5 summarizes the number of sample sites and sample households used for the impact study of the Project. The sample size was determined considering the results of power calculation and budget constraints. Project sites were selected in three districts (Milenge, Mwense, and Nchelenge) in Luapula Province. Although the Project was implemented in four districts, Mansa district was excluded from this study because the facility construction had already started before the baseline survey began. In Milenge district, at time of the baseline survey, 14 target sites[18] were randomly selected from the list of the villages where the Project was to be implemented. Control sites (12) were then selected from the list of the villages where the Project was *not* to be implemented by carefully examining a number of fundamental characteristics of the village so that we would be able to have appropriate comparison groups.[19] In the same manner, 19 target sites and 17 control sites were randomly chosen in Mwense district, and 17 target sites and 15 control sites were chosen in Nchelenge district. The sampled sites totaled 94.[20]

The procedure described above does not indicate that we had the intended number of project sites and control sites at the time of the end-line survey. At some target sites, the JICA groundwater project could not obtain water from the new boreholes, and they were regarded as control sites at the time of the end-line survey. In contrast, as a result of failures at some target sites, some control sites were converted into alternative target sites and water was successfully obtained from the new boreholes the Project constructed. It was in fact technically very difficult to predict the possibility of successfully obtaining water from deep boreholes by examining observable characteristics on the ground, and thus some failures were inevitable. For this reason, we ended up with 21 project sites and five control sites in Milenge, 25 project sites and 11 control sites in Mwense, and 18 project sites and 14 control sites in Nchelenge.[21]

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[18] "Target sites" are defined as sites where the construction of facilities was initially planned (including those where water was not available and facilities were not actually constructed). "Project sites" are defined as sites where facilities were actually constructed (including those which replaced target sites).

[19] To be a candidate for the JICA groundwater project, a higher priority was placed on villages with a higher demand for water, which was primarily determined by population.

[20] At the time of the end-line survey, we discovered that other donors had unexpectedly constructed water facilities (boreholes) at our control sites. These interventions have the potential to cause bias in our estimates of the Project's impact with the DID methodology. Because we expect that these interventions would reduce the incidence of diarrhea and the time spent fetching water by providing better access to safe water in our control sites, the DID methodology could underestimate the JICA Project's impact. Thus, the empirical findings shown in this report should be interpreted as a conservative estimate of the Project's impact. In fact, this report can present a significant reduction of the incidence of diarrhea as even a conservative estimate of the Project's impact, whereas only ambiguous impacts are detected regarding time spent fetching water. The failure to find any significant reduction in hours spent fetching water is highly likely to be attributable to the interventions by the other donors, which unfortunately was not under our control.

[21] The end-line survey found that other donors had unexpectedly constructed water facilities at our control sites. This fact, however, does not affect the validity of the evaluation design, although it slightly changes the evaluation question. Precisely speaking, we examine the impact of the Project compared to those of other donors. However, considering the actual situation, in which it is impossible to completely exclude interventions by other donors, this comparison can be regarded as more realistic.

Table 5: Sample Sites and Sampled Households

District	No. of Sample Sites			No. of Sampled Households		
	All	Project	Control	All	Project	Control
Milenge	26	21	5	185	150	35
Mwense	36	25	11	236	156	80
Nchelenge	32	18	14	214	128	86
Total	94	64	30	635	434	201

Table 5 also shows the number of sampled households used for this study. At the time of the baseline survey, eight households were randomly chosen in each village, and thus 752 households in total were interviewed (Table A1). However, 117 households (15.6% of the total households) moved away after the baseline survey and could not be visited at the end-line survey, and therefore the total number of sampled households used for the study became 635. Because the attrition rate was relatively high, we conducted an analysis of factors associated with attrition (Table A2). The estimation results show that households with fewer family members were more likely to move away, although this attrition pattern did not significantly differ between project and control sites. This fact must be borne in mind and caution is required whenever we interpret the estimation results based on the DID methodology. Causal effects of the Project on smaller households are less likely to be taken into account.

4-4. Comparison between Project and Control Sites

Before we apply the DID methodology to our data for impact evaluation, Table 6 compares socio-economic characteristics between the project and control sites before the implementation of the Project. Circumstances in which people in the Project and control sites lived under similar conditions before the Project are a desirable requirement for the parallel trend assumption to hold, although the DID methodology allows for level differences in the outcome variables at time of the baseline survey.

We find that, while the proportion of children under 10 in the project sites was lower by 4.1% than that in the control sites, the proportion of teenagers in the project sites was higher by 4.9% than that in in the control sites. Also, residents of the project sites achieved higher levels of education by 0.327 years and the highest level of education achieved by female family members was higher by 0.628 years compared to residents of the control sites. Although we find that there were slight differences in population structure below 20 and education levels, we conclude that most individual and household characteristics were similar before the Project, and thus these differences do not significantly affect the validity of the application of the DID methodology to our data.

Another concern is that, because one of the most important criteria for a village to be a Project target site is its population, which determines the demand for water, the project sites might have larger populations than the control sites. Due to unpredictable failures of the Project in some target sites, however, we do not find a significant difference in population between the project sites and control sites. Additionally, based on the information collected by the community questionnaire, we can confirm that residents in the project and control sites had similar access to natural resources such as water and firewood. We can also confirm that their communities had similar infrastructure conditions such as roads, irrigation, and electricity. They also had similar access to shops/markets, schools, and health facilities at time of the baseline survey.

Table 6: Comparison of Socio-economic Characteristics in 2012

	All	Project	Control	Diff.
	(A)	(B)	(C)	(B)-(C)
Individual characteristics (no. of observations)	3303	2268	1035	
Female (= 1)	0.509	0.513	0.500	0.012
Age	20.85	20.92	20.69	0.23
Age group [10-] (= 1)	0.328	0.315	0.357	-0.041**
Age group [10+ & 20-] (= 1)	0.253	0.269	0.219	0.049***
Age group [20+ & 30-] (= 1)	0.138	0.135	0.146	-0.011
Age group [30+ & 40-] (= 1)	0.111	0.112	0.109	0.003
Age group [40+ & 50-] (= 1)	0.091	0.094	0.084	0.010
Age group [50+ & 60-] (= 1)	0.041	0.037	0.050	-0.013
Age group [60+] (= 1)	0.037	0.037	0.035	0.003
Education level	3.875	3.977	3.650	0.327***
Household characteristics (no. of observations)	635	434	201	
Female headed household (= 1)	0.206	0.207	0.204	0.003
Age of the household head	43.06	43.43	42.25	1.18
Education level of male members	6.793	6.889	6.576	0.314
Education level of female members	5.170	5.368	4.741	0.628**
Household size	5.202	5.226	5.149	0.077
Ratio of dependents to household size	0.452	0.453	0.451	0.002
Monthly consumption per capita [ZMK]	174843	163219	199940	-36721
Village characteristics (no. of observations)	94	64	30	
Population	414	446	346	100

Note: *t*-test results are shown; * significant at 10%; ** significant at 5%; *** significant at 1%.

5. Results

5-1. Water Quality (Existence of *E. coli* in Water Stored at Home)

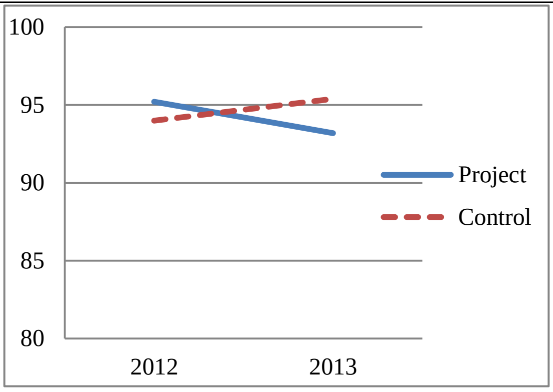
Our impact study begins with an investigation into the effect on water quality measured by the test sheet for *E. coli*. Table 7 presents a descriptive analysis and the analytical results from the simple DID estimation. Drinking water contained *E. coli* at 95.2% of households in the project sites and 94.0% of households in the control sites in 2012. The difference between the project sites and the control sites was 1.1%, which was not statistically significant at any conventional levels. After the implementation of the Project in 2013, *E. coli* was found at 93.2% of the households in the project sites and 95.4% of the households in the control sites. While there was a decrease of 1.9% in the rate of *E. coli* content in the project sites, the rate increased by 1.4% in the control sites. These figures lead to a 3.3% decline as a DID estimate for the casual effect of the Project, although this is not statistically significant at any conventional levels. As mentioned in Section 3, the water test conducted at the time of handing-over confirmed that *E. coli* was not detected at any boreholes constructed by the Project. Since the water test examines water stored at home at the time of the interview, the water might have been contaminated during transport and/or storage.

Table 7: Existence of *E. coli* in Water Stored at Home (%)

Year	Project		Control		Diff.
	(A)	(B)	(C)	(D)	(B)-(D)
	Obs.	Mean	Obs.	Mean	
2012	434	95.2	201	94.0	1.1
2013	428	93.2	197	95.4	-2.2
Change		-1.9		1.4	-3.3

Note: Statistical test results are shown; * significant at 10%; ** significant at 5%; *** significant at 1%.

Figure 7: Existence of *E. coli* in Water Stored at Home (%)



5-2. Diarrhea

We next examine the impact of the Project on incidence of diarrhea symptoms during the past two weeks. In 2012, 2.5% of individuals in the project sites self-reported an experience of having a symptom of diarrhea and 2.2% of individuals in the control sites reported such symptoms (Table 8). The difference between the project and control sites was 0.3% and not statistically significant at any conventional levels. After the Project, in contrast, while 1.7% of individuals in the project sites self-reported diarrhea, 3.0% of individuals in the control sites reported diarrhea symptoms. The difference became 1.4% and statistically significant at the 5% level. These figures indicate that, while the rate of incidence of diarrhea declined by 0.8% in the control sites, the rate was improved by 0.8% in the project sites. Thus, the simple DID estimation suggests that the causal Project impact is a 1.7% decline, which is statistically significant at the 10% level.

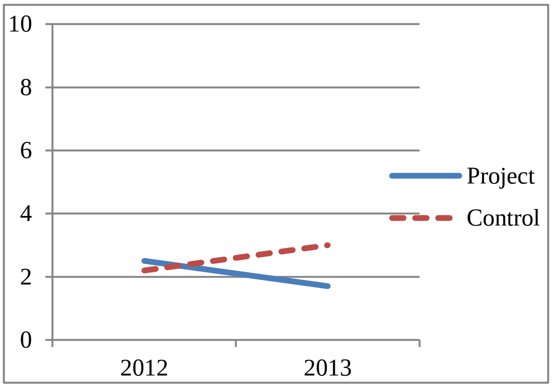
Because the simple DID estimate may be biased by differential changes in covariates of the project sites and control sites, additional analyses with explicit control of some covariates are also estimated.[22] Table A4 summarizes the estimation results from three different regression models. While the coefficient becomes smaller, the overall result does not substantially change even after controlling for covariates. The estimation results of the model with both individual and household covariates indicate that the Project decreased the rate of incidence of diarrhea by 1.08%, which is statistically significant at the 5% level (Column C).

Table 8: Incidence of Diarrhea Symptoms (All Individuals: %)

Year	Project		Control		Diff.
	(A)	(B)	(C)	(D)	(B)-(D)
	Obs.	Mean	Obs.	Mean	
2012	2268	2.5	1035	2.2	0.3
2013	2155	1.7	989	3.0	-1.4**
Change		-0.8		0.8	-1.7*

Note: Statistical test results are shown; * significant at 10%; ** significant at 5%; *** significant at 1%.

Figure 8: Incidence of Diarrhea Symptoms (All Individuals)



5-3. Diarrhea among Children under Five

Because diarrheal diseases are more serious health problems among children under five, we placed a particular focus on the impact of the Project for such children. When we restrict our sample to children under five, the incidence of diarrhea over the past two weeks was more prevalent: in 2012, 6.0% of children under five in the project sites reported diarrhea symptoms and 5.1% did so in the control sites (Table 9). The difference was 0.9% and not statistically significant at any conventional levels. After the Project, 4.1% of children under five in the project sites reported diarrhea symptoms, whereas 9.4% did so in the control sites. The difference became 5.3% and statistically significant at the 5% level. These figures indicate that, while the rate of incidence of diarrhea worsened by 4.3% in the control sites, the rate was improved by 1.9% in the project sites. The simple DID estimation indicates that the impact of the Project was a 6.2% reduction, which is statistically significant at the 1% level.

Table A5 summarizes the estimation results of regression models with control covariates.[23] The estimation results of the model with both individual and household covariates in addition to district dummy variables indicate that the JICA groundwater project reduced the rate of incidence of diarrhea by 3.77% (Column C in Table A5), which is statistically significant at the 5% level.

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[22] Summary statistics of the covariates are shown in Table A3.

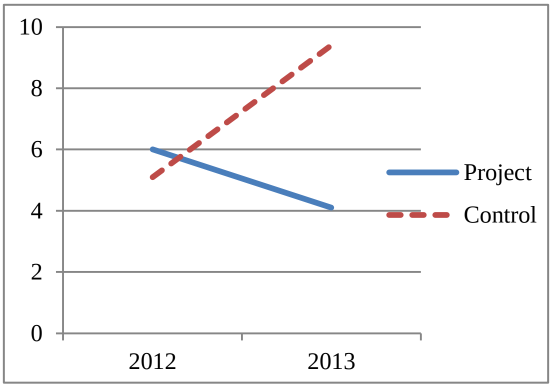
[23] Summary statistics of the covariates are shown in Table A6.

Table 9: Incidence of Diarrhea Symptoms (Children under Five Years Old: %)

Year	Project		Control		Diff.
	(A)	(B)	(C)	(D)	(B)-(D)
	Obs.	Mean	Obs.	Mean	
2012	385	6.0	197	5.1	0.9
2013	317	4.1	160	9.4	-5.3**
Change		-1.9		4.3	-6.2*

Note: Statistical test results are shown; * significant at 10%; ** significant at 5%; *** significant at 1%.

Figure 9: Incidence of Diarrhea Symptoms (Children under Five Years Old: %)



5-4. Impact of Usage and Heterogeneity of Impact

Thus far, we have estimated the so-called intention-to-treat (ITT) impact of the Project at the village level (in other words, the impact of constructing water facilities in the village). However, because some households in the project sites did not report that they used the new borehole constructed by the Project, we try to distinguish the impact of the usage of the new borehole from that of the construction of the borehole in the same village. The former can be interpreted as a more direct impact of the Project and the latter may involve a spillover effect. For the former, furthermore, we explicitly investigate heterogeneous impacts of the Project by distance to the new borehole. Because we expect that as distance to the borehole is farther the magnitude of the impact of the Project becomes smaller, we test this hypothesis. Our data in fact suggest that 86.6% of households in the project sites used the borehole and the average distance to the new borehole among user households is 0.221 kilometers. The estimation results are shown in Table A7.[24] We find that the direct impact is more evident and the magnitude diminishes as the distance becomes farther from the borehole. The estimation result is illustrated in Figure 10, showing that the effect of the Project is concentrated within a radius of 1.3 kilometers away from a borehole.

As for children under five years old, the investigation into the effect of the usage of the new borehole shows that the average magnitude of the effect is 3.69% (statistically significant at the 5% level). Moreover, further analysis reveals that the magnitude is the largest (4.13%) near a borehole and diminishes as the distance from the borehole becomes longer (Column B in Table A8). Heterogeneous impacts of the Project by distance to a new borehole are illustrated in Figure A1.

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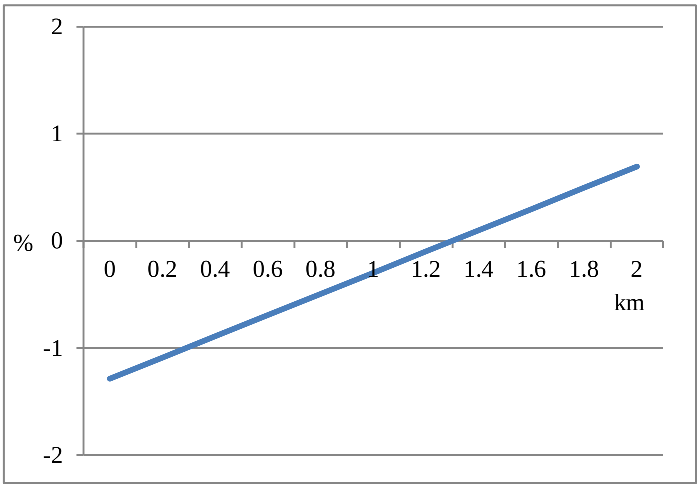
[24] The regression results with two dummy variables for users and non-users separately instead of the dummy variable for the project sites suggest that there was no significant selection problem between users and non-users in 2012.

Figure 10: Heterogeneous Impacts by Distance to JICA Borehole (Incidence of Diarrhea among All Individuals)



5-5. Distance to the Nearest Water Source

In addition to the improvement of water quality, better physical access to water sources brought by the Project, and especially the shorter distance to water sources, would be expected to reduce the burden of fetching water and enhance more productive activities. Before the implementation of the Project, the major water sources were shallow wells, hand-dug wells, and natural resources such as streams, rivers and lakes. Table 10 shows the distance to the nearest water sources from home and examines whether the Project has in fact brought better access to water sources. Because it was discovered that other donors such as UNICEF and Water Aid constructed a number of new boreholes even in our control sites, we divide our sample into three categories: our project sites; control sites with intervention by other donors; and genuine control sites without any intervention.[25]

We find that before the Project the average distance to the nearest water sources in our project sites was 0.463 kilometers and 0.455 kilometers in the genuine control sites. The difference was 0.008 kilometers and not statistically significant at any conventional levels. The average distance to the nearest water sources in the other project sites was 0.592 kilometers, which was a little longer than that in the genuine control sites. As expected, the distance to the nearest water sources was shortened in both our project sites and other project sites in 2013. The average distance became 0.168 kilometers in our project sites and 0.334 kilometers in other project sites, whereas the distance remained almost unchanged in the genuine control sites. Therefore, the simple DID estimation compared to the genuine control sites reveals that the JICA Project reduced the distance by 0.286 kilometers and the other projects reduced the distance by 0.259 kilometers, which are both statistically significant at the 1% level.

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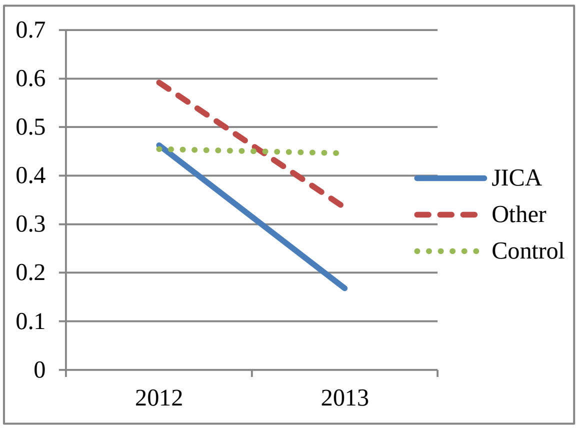
[25] Even in the control sites without any intervention, some hand-dug wells were newly constructed during the period between 2012 and 2013.

Table 10: Distance to the Nearest Water Source (km)

Year	JICA Project		Diff.	Other Projects		Diff.	Control	
	(A)	(B)	(B)-(F)	(C)	(D)	(D)-(F)	(E)	(F)
	Obs.	Mean		Obs.	Mean		Obs.	Mean
2012	434	0.463	0.008	109	0.592	0.138*	92	0.455
2013	434	0.168	-0.278***	109	0.334	-0.112*	92	0.446
Change		-0.295	-0.286***		-0.259	-0.250***		-0.009

Note: Statistical test results are shown; * significant at 10%; ** significant at 5%; *** significant at 1%.

Figure 11: Distance to the Nearest Water Source (km)



5-6. Hours Spent Fetching Water among Women over 18

To examine if the reduction in the distance to the nearest water sources leads to a reduced time burden for fetching water, we focus on the change in hours spent fetching water among women over 18. We expect that a lower water-hauling burden for women would improve their standard of living. This study thus examines if the reduction in the distance to the nearest water sources leads to a reduction in hours spent fetching water among women over 18.

Table 11 presents a descriptive analysis and the analytical results of the simple DID estimation. Hours spent fetching water was 1.566 hours per person in our project sites and 1.525 hours per person in the genuine control sites in 2012. The difference between our project sites and the genuine control sites was 0.041 hours per person, which was not statistically significant at any conventional levels. After the implementation of the Project, hours spent fetching water was 0.551 hours per person in our project sites and 0.737 hours per person in the genuine control sites. The difference between our project sites and the genuine control sites became -0.186 hours per person in 2003, which is statistically significant at the 10% level. Over the survey period, there was a 1.015-hour reduction in hours spent fetching water in our project sites, and there was also a 0.787-hour reduction in the genuine control sites. These figures lead to a 0.288 hour reduction per person as a DID estimate for the casual effect of the Project, although this estimate is not statistically significant at any conventional levels. The magnitude of the reduction in hours spent fetching water in the other project sites is almost identical to the change in the genuine control sites, despite the fact that some new boreholes were constructed in the other project sites and the distance to the nearest water sources was actually shortened. These findings cast doubt on our expectation that a large part of the reduction in hours spent fetching water can be explained by the construction of the new boreholes. The changes seem to be caused by other reasons.

Table 11: Hours Spent Fetching Water (Women over 18)

Year	JICA Project		Diff.	Other Projects		Diff.	Control	
	(A)	(B)	(B)-(F)	(C)	(D)	(D)-(F)	(E)	(F)
	Obs.	Mean		Obs.	Mean		Obs.	Mean
2012	509	1.566	0.041	130	1.385	-0.140	101	1.525
2013	501	0.551	-0.186*	129	0.632	-0.106	99	0.737
Change		-1.015	-0.228		-0.753	0.035		-0.787

Note: Hours spent fetching water on a weekday.
Statistical test results are shown; * significant at 10%; ** significant at 5%; *** significant at 1%.

Figure 12: Hours Spent Fetching Water (Women over 18)

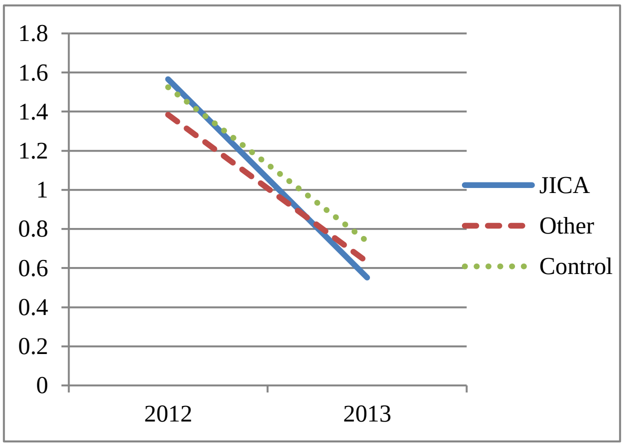


Table A10 shows the estimation results of regression models with control covariates (summary statistics of the covariates are shown in Table A9). Unfortunately, we do not find any significant results from these regressions. We conducted further analysis with information about households that actually use a borehole (user households) and those that do not use a borehole (non-user households) along with the distance to the new borehole. It reveals that the JICA groundwater project reduced hours spent fetching water per person significantly only for user households residing near a new borehole and also for non-user households residing in our project sites (Table A11).

6. Conclusion

6-1. Summary of Findings and Discussion

This study has examined the impact of the construction of groundwater supply facilities on four outcomes: water quality, incidence of diarrhea, distance to water source, and time spent fetching water. Regarding water quality (existence of *E. coli*) measured at home, we cannot find statistically significant improvement by the Project. On the other hand, the Project is seen to contribute to reducing the incidence of diarrhea, which is not consistently supported by the estimation result regarding water quality. One possible explanation for this inconsistency is that contamination is in fact eased to some extent by the Project but this is not detected by the simple water test. Since the outcome of the water test is binary (whether *E. coli* is detected or not), the test cannot capture the degree of contamination.[26] Another possibility is that the soft component activities facilitate appropriate hygiene practice and/or water treatment, such as washing hands, using chlorine, or boiling water before drinking it. If water is being properly treated before drinking, it is understandable that diarrhea symptoms are reduced even if the tested water stored in the dwelling is contaminated. This hypothesis is consistent with the existing literature, which shows the importance of point-of-use intervention relative to water source intervention (Waddington et al. 2009). In any case, however, further investigation is required to reach a credible conclusion.

Regarding the incidence of diarrhea, the results show a positive and statistically significant impact of the Project (1.0–1.7% reduction) and that the magnitude of this impact is larger among children under five years old (3.7–6.2% reduction), among whom diarrhea is more prevalent. The results also show that the magnitude of the impact of the Project depends on the distance to the borehole and that it diminishes as the distance from the borehole increases. This finding has implications for the selection of a borehole location since the location critically affects who enjoys larger benefits from the borehole.

The results also show that the distance to the nearest water source is reduced by the Project compared to the genuine control sites where no interventions were implemented, including those provided by other donors. On the other hand, we cannot find a significant impact on time spent fetching water. Although water-fetching time decreased in the project sites, somehow it also decreased in the control sites, resulting in a non-significant DID estimation result. Thus, we cannot draw a clear conclusion on whether the Project contributes to people’s wellbeing by reducing their burden for fetching water. Further investigation is needed to clarify this point.

6-2. Limitations

Any evaluation conducted in a real-world setting under time, budget, and other constraints cannot be free from limitations, and this study is no exception. First, this evaluation cannot employ RCTs, which would provide the most rigorous results. As explained in this report, since the selection of target and alternative sites was already determined based on the population size prior to the start of the evaluation, it was impossible to randomly select the target and alternative sites. Although we tried to minimize the unbalance in population size, it is still possible for the

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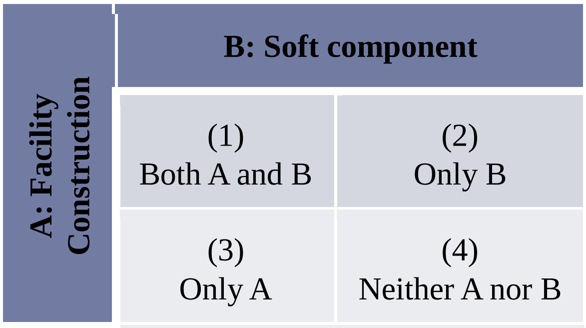
[26] Since the primary outcome of this evaluation is diarrhea, we used a very simple test kit for the examination of water quality. However, it would be practically very difficult to conduct detailed water testing in the survey area, and even if it were possible, it would be very costly.

results to be influenced by it. It is worth noting, however, that unpredictable failures of the drilling in the target sites yielded an experimental setting that resembles what it would have been if RCTs had been employed in each district.

Second, since the intervention evaluated in this study is a package of the construction of water facilities and a soft component, it is impossible to decompose the impact of the package into that of each component. In order to decompose the impact, it would be necessary to employ a factorial design (Figure 13). Although we could not do this because of the given project design, it would be a more policy-relevant question to understand the impact of each component and their synergy.

Figure 13: Factorial Design



	B: Soft component	
A: Facility Construction	(1) Both A and B	(2) Only B
	(3) Only A	(4) Neither A nor B

–Comparison (1) and (4) yields the impact of the package.
–Comparison (2)/(3) and (4) yields the impact of each component.
–Comparison (1) and (2)/(3) yields the synergy effect of A and B

Third, caveats are necessary in interpreting the outcome indicators. As mentioned above, to examine water quality, we use a simple water test kit with a binary outcome (whether or not *E. coli* is detected). Thus, even if there is no change in the binary outcome, it is still possible for contamination to be eased to some extent. Regarding the data on the incidence of diarrhea, we collect data on the past two weeks to minimize recall bias. As diarrhea occurring before this period is omitted, the frequency of diarrhea could be underreported, although two weeks is a period commonly used in this kind of survey, such as the Demographic and Health Surveys.

Fourth, this study examines the impact within a relatively short term. Thus, it is necessary to conduct another follow-up survey to investigate the long-term impact of the Project.

Finally, this study focuses on an examination of causal effect of the Project (i.e., whether or not the Project has the intended impact and the magnitude of its impact). Thus, although it is of course important to examine the reasons and mechanism why the Project has (or does not have) the intended impact, this is beyond the scope of the present study.[27] In order to examine these reasons and mechanisms, another investigation is required, employing an appropriate methodology suitable for its purpose.[28]

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[27] However, it is impossible to question why an intervention has (or does not have) an impact without understanding whether an intervention actually has (or does not have) an impact. In this sense, one of the contributions of this study is to provide a base for further investigation.

[28] Program evaluation consists of several sub-evaluations, and one of these sub-evaluations is impact evaluation, which focuses on the examination of the causal effects of an intervention. Other sub-evaluations, such as process evaluation, have different purposes and usually require different methodologies. For further explanation, see Rossi et al. (2004).

Despite these limitations, this evaluation employs as rigorous an evaluation design as possible under the given conditions, and the findings provide reliable information on the impact of this groundwater development project.

6-3. Lesson and Implications

In addition to the specific results on the Project's impact, there are some general lessons learned through conducting this impact evaluation. First, it is important to examine the causal effect (impact) of a project with an appropriate evaluation design. This evaluation provides concrete evidence on the impact of the Project on the incidence of diarrhea by employing a rigorous evaluation design. However, if a simple approach were used to estimate this impact, we would reach an incorrect conclusion that the Project has no impact, because a simple before/after comparison at the project sites does not show a statistically significant reduction in the incidence of diarrhea at any conventional levels, as shown in Tables 8 and 9. The evaluation results produced with an appropriate design allow us to avoid such an incorrect understanding and make decisions based on reliable evidence, which can contribute to more effective and efficient implementation. Furthermore, such rigorous evidence on a project's impact can facilitate accountability to stakeholders.

However, while the benefits of impact evaluations are evident, substantial resources (budget, time, and human resources) are required to implement them. In conducting this impact evaluation, for instance, it took more than two years from the planning of the evaluation to the completion of the evaluation report, and it has involved various inputs including local consultants, Japanese consultants, and JICA staff. Thus, it is important to consider the balance between the costs and benefits of conducting impact evaluations. On the cost side, as impact evaluations usually require originally-collected data, analytical skills, and intensive input for data processing and analysis, it is not easy to substantially reduce costs. Thus, it is important to strategically focus on impact evaluations with larger benefits, that is, those that are expected to produce more useful and policy-relevant evidence. Possible options include impact evaluations on JICA's flagship projects, which are required to show results in a credible way, or those on interventions whose impact is unknown or controversial.

Finally, in order to conduct impact evaluations with larger benefits, it is important to incorporate impact evaluations into the project design at an early stage of project formulation. In the present case, it was possible to collect baseline data and use a DID approach because this evaluation started before the handing-over of the facilities, but the contents, design, and target sites of the Project had already been determined before this evaluation began. As a result, we could not employ RCTs or a factorial design. In order to incorporate these evaluation designs into grant aid projects, it is important to have a consensus among stakeholders on conducting an impact evaluation when grant aid is requested from recipient governments. Since a relatively longer time is required to carry out the necessary procedures from the request to the commencement of the project than it is in other schemes, it is particularly important to consider the possibility of conducting an impact evaluation at an earlier stage. Such proper planning of both the project design and the evaluation design allows us to have an opportunity to produce more rigorous and policy-relevant evidence which can facilitate the effective design and implementation of projects.

Appendix

A. Related Literature

-Water supply and health (diarrhea)

Water is a serious issue related to human life, and there are still 780 million people without access to an improved drinking water sources as of 2008 (UNICEF/WHO 2012). It has also been reported that there are huge disparities in access to improved water sources among regions and between a country's urban and rural areas (UNICEF/WHO 2012). Every year about 1.5 million children under five years old lose their lives due to diarrhea caused by a lack of safe water and basic sanitation facilities, which is the second-most common cause of the death of children (UNICEF/WHO 2009).

Governments, international organizations, and academic researchers have been tackling this issue. Their experience and knowledge have been accumulated, and systematic reviews have been published to examine the impact of the relevant interventions to improve water quality (Clasen et al. 2006, Esrey et al. 1991, Fewtrell et al. 2005, Waddington et al. 2009). Most of these studies have focused on direct health outcomes such as the prevalence of diarrhea.

An intervention is usually defined as a means to protect against the infection of water by microbial contaminants or to treat water for the removal of microbial contaminants at source, at storage or at the point of use. Interventions can be grouped into five categories: water supply improvement, and water quality, sanitation, hygiene and multiple interventions (Waddington et al. 2009).

The results of these systematic reviews indicate that point-of-use water quality interventions may have the highest effectiveness, while water source treatment has less impact in reducing the incidence of diarrhea. In addition, multiple interventions comprising a mix of several interventions have a larger impact than single approaches (Clasen et al. 2006, Waddington et al. 2009). This is explained as being due to the reduction of the risk of transmission of pathogens in the pathways of water use from the water sources at the point of use to the mouths of users. The nearer the intervention is to the point of use or the more the intervention is implemented, the less chance there is that pathogen (re-) contamination can be reduced. There are several possibilities for where water can easily be (re-) contaminated between sources and points-of-use in unhygienic environments in the process of transport and storage or at points-of-use.

- Fetching water and time use

Generally, in developing countries, rural women and their children often devote a considerable amount of their time to collecting water. For example, survey results from 45 developing countries show that women are more than two times as likely as men to collect drinking water for the household, and that girls are twice as likely as boys to be responsible for collecting water (UNICEF/WHO 2010). Other studies show similar results in South Asia (Loughran and Pritchett 1997, Research Foundation for Science, Technology and Ecology 2005, World Bank 2005a), and in countries across North Africa and the Middle East (World Bank 2005b, AfDB 2006).

Although lessening the burden of collecting water has potential to enable women and children to engage in more productive activities, such as income generation activities and education, this issue has not been intensively examined based on rigorous empirical evidence, and the existing evidence is mixed.

The study by Costa et al. (2009) in Ghana showed that women's total working hours are shorter in communities with access to water, and shorter for those living closer to the water source. It has also been reported that poor access to water in rural Pakistan reduces the time for women to devote to market-oriented activities (Ilahi and Grimard 2000). Koolwal and van de Walle (2013) found evidence that both boys' and girls' school enrollment is higher when access to water is ensured, from cross-sectional surveys from Madagascar, Malawi, Rwanda, Uganda, India, Nepal, Pakistan, Morocco, and Yemen, although access to water comes with greater off-farm work for women. Nauges and Strand's cross-sectional study in Ghana (2013) showed similar findings, of a significant negative relation between girls' school attendance and water-hauling activity. In addition, Ndiritu and Nyangena (2010) found that being involved in resource collection reduces the likelihood of a child attending school. Other studies show that water infrastructure facilitates women's participation and changes of time use in market-based work, or time spent on child care or children's schooling (Barsell 1996, Ilahi and Grimard 2000, UNDP 2006, Koolwal and van de Walle 2013).

On the other hand, Nankhunni and Findeis (2004) found no direct impacts of time spent collecting water on school participation, while there was a significant relationship between time spent collecting fuel wood and school attendance. In addition, Lokshin and Yemstov (2005) showed that a water infrastructure rehabilitation project had no significant impact on women's employment, using propensity score matching and DID methods.

B. Empirical Model

Let y_{ijt} be an outcome variable of an individual *i* residing in site *j* surveyed at time *t* ($t = 0$ for baseline and $t = 1$ for end-line). Using these settings, the simplest version of our empirical model can be shown as follows:

$$y_{ijt} = \gamma_0 + \gamma_1 \cdot S_j + \gamma_2 \cdot t + \gamma_3 \cdot S_j \times t + u_{ijt} \tag{1}$$

where S_j takes the value of 1 when the site *j* has a successful borehole, and 0 otherwise. γ_0, γ_1, γ_2, and γ_3 are the parameters to be estimated, and γ_3 is the parameter of interest that measures the causal effect of the project. u_{ijt} is an error term.

In addition to the simplest version of the DID model, we also employ an empirical model with some covariates. The parallel trend assumption can be violated if changes in covariates are not common between Project and control sites, and thus we need to examine if this is the case by explicitly controlling for some observable covariates. Let X_{ijt} be a set of individual *i*'s characteristics and X_{jt} be a set of site *j*'s characteristics other than the results of borehole construction. With these observable covariates, another version of our empirical model can be written as follows:

$$y_{ijt} = \gamma_0 + \gamma_1 \cdot S_j + \gamma_2 \cdot t + \gamma_3 \cdot S_j \times t + X_{ijt}\beta_1 + X_{jt}\beta_2 + u_{ijt}\ . \tag{2}$$

We employ logistic regression when the outcome variable is a binary variable such as the incidence of diarrhea. The Tobit model is utilized when the outcome variable is censored.

C. Tables

Table A1: Sample Sites and Sample Households (All Households)

District	No. of Sample Sites			No. of Sample Households		
	All	Project	Control	All	Project	Control
Milenge	26	21	5	208	168	40
Mwense	36	25	11	288	200	88
Nchelenge	32	18	14	256	144	112
Total	94	64	30	752	512	240

Table A2: Factors Associated with Attrition – Logit Model

Dependent variable (attrition = 1)	Individuals		Households	
	(A)	(B)	(C)	(D)
Project variable				
Control (= 1)	0.0199	0.0010	0.0102	-0.0031
	(0.0313)	(0.0329)	(0.0319)	(0.0307)
Individual characteristics in 2012				
Female (= 1)		0.0098		
		(0.0116)		
Age		0.0002		
		(0.0016)		
Age squared		-0.0452*		
[× 10^{-3}]		(0.0257)		
Education level		-0.0001		
		(0.0034)		
Household characteristics in 2012				
Female headed household (= 1)		0.0247		0.0069
		(0.0413)		(0.0449)
Age of the household head		-0.0143**		-0.0006
		(0.0072)		(0.0062)
Age squared		0.1590**		-0.0168
[× 10^{-3}]		(0.0727)		(0.0653)
Education level of male members		0.0046		-0.0012
		(0.0063)		(0.0054)
Education level of female members		-0.0097*		-0.0044
		(0.00498)		(0.0056)
log (household size)		-0.0482		-0.1030***
		(0.0485)		(0.0391)
Ratio of dependents (15- and 65+)		-0.0077		0.1020
to household size		(0.0915)		(0.0745)
log (monthly consumption per capita)		-0.0165		-0.0212
		(0.0236)		(0.0169)
District dummy variables				
Mwense district (= 1)		0.0929*		0.0866*
		(0.0479)		(0.0481)
Nchelenge district (= 1)		0.0785		0.0734
		(0.0481)		(0.0472)
Pseudo R-sq.	0.0004	0.0250	0.0002	0.0349
No. of observations	3840	3840	752	752

Note: Coefficients on continuous variables indicate marginal changes in the probability of attrition evaluated at the mean values, and coefficients on dummy variables indicate changes in the probability of attrition when the value of the dummy variable changes from zero to one. Household-level cluster-robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.

Table A3: Summary Statistics of Explanatory Variables (All Individuals)

2012	**Mean**	**S.D.**	**Min.**	**Max.**
Individual characteristics		n = 3303		
Female (= 1)	0.509	(0.500)	0	1
Age	20.9	(17.6)	0	88
Household characteristics		n = 635		
Project site (= 1)	0.683	(0.465)	0	1
Female headed household (= 1)	0.206	(0.405)	0	1
Age of the head	43.1	(13.6)	18	84
Highest education among females	5.177	(2.943)	0	13
Highest education among males	6.813	(2.834)	0	13
log (household size)	1.528	(0.526)	0	2.708
Ratio of dependents to household size	0.452	(0.246)	0	1
log (monthly consumption per capita)	11.66	(0.74)	9.68	16.23
2013	**Mean**	**S.D.**	**Min.**	**Max.**
Individual characteristics		n = 3144		
Female (= 1)	0.509	(0.500)	0	1
Age	21.8	(17.9)	0	89
Household characteristics		n = 635		
Project site (= 1)	0.683	(0.465)	0	1
Project site * Borehole user (= 1)	0.592	(0.492)	0	1
Distance to new borehole (km)	0.151	(0.290)	0	3
Project site * Borehole non-user (= 1)	0.091	(0.288)	0	1
Female headed household (= 1)	0.198	(0.399)	0	1
Age of the head	43.9	(13.7)	17	85
Highest education among females	5.015	(2.936)	0	13
Highest education among males	6.751	(2.872)	0	13
log (household size)	1.475	(0.534)	0	2.708
Ratio of dependents to household size	0.450	(0.248)	0	1
log (monthly consumption per capita)	11.65	(1.00)	8.37	15.38

Table A4: Impact on Incidence of Diarrhea Symptoms (All Individuals)

Dependent variable: Incidence of diarrhea (= 1)	Logit	Logit	Logit
	(A)	(B)	(C)
Project and year dummy variables			
Project site (= 1)	0.0029	0.0035	0.0029
	(0.0060)	(0.0050)	(0.0043)
Year 2013 (= 1)	0.0068	0.0062	0.0043
	(0.0062)	(0.0053)	(0.0045)
Project site * Year 2013 (= 1)	-0.0143**	-0.0122**	-0.0108**
	(0.0064)	(0.0054)	(0.0047)
Individual characteristics	No	Yes	Yes
Household characteristics	No	No	Yes
District dummy variables	Yes	Yes	Yes
Pseudo R sq.	0.0069	0.0421	0.0748
No. of observations	6447	6447	6447

Note: Coefficients indicate changes in the probability of having a diarrhea symptom over the past two weeks when the value of the dummy variable changes from zero to one. Full estimation results are available upon request.

Household-level cluster-robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.

Table A5: Impact on Incidence of Diarrhea Symptoms (Children under Five)

Dependent variable: Incidence of diarrhea (= 1)	Logit	Logit	Logit
	(A)	(B)	(C)
Project and year dummy variables			
Project site (= 1)	0.0090	0.0070	0.0057
	(0.0192)	(0.0173)	(0.0149)
Year 2013 (= 1)	0.0342	0.0348	0.0284
	(0.0229)	(0.0213)	(0.0187)
Project site * Year 2013 (= 1)	-0.0451**	-0.0408**	-0.0377**
	(0.0208)	(0.0191)	(0.0165)
Individual characteristics	No	Yes	Yes
Household characteristics	No	No	Yes
District dummy variables	Yes	Yes	Yes
Pseudo R sq.	0.0235	0.0606	0.1010
No. of observations	1059	1059	1059

Note: Coefficients indicate changes in the probability of having a diarrhea symptom over the past two weeks when the value of the dummy variable changes from zero to one. Full estimation results are available upon request.

Household-level cluster-robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.

Table A6: Summary Statistics of Explanatory Variables (Children under Five)

2012	**Mean**	**S.D.**	**Min.**	**Max.**
Individual characteristics		n = 582		
Female (= 1)	0.495	(0.500)	0	1
Age	2.232	(1.320)	0	4
Household characteristics		n = 377		
Project site (= 1)	0.666	(0.472)	0	1
Female headed household (= 1)	0.164	(0.371)	0	1
Age of the head	38.45	(10.82)	19	80
Highest education among females	5.122	(2.931)	0	12
Highest education among males	6.665	(2.809)	0	13
log (household size)	1.743	(0.369)	1	2.708
Ratio of dependents to household size	0.559	(0.144)	0	1
log (monthly consumption per capita)	11.59	(0.71)	9.68	16.23
2013	**Mean**	**S.D.**	**Min.**	**Max.**
Individual characteristics		n = 477		
Female (= 1)	0.512	(0.500)	0	1
Age	2.499	(1.217)	0	4
Household characteristics		n = 345		
Project site (= 1)	0.678	(0.468)	0	1
Project site * Borehole user (= 1)	0.591	(0.492)	0	1
Distance to new borehole (km)	0.148	(0.271)	0	3
Project site * Borehole non-user (= 1)	0.087	(0.282)	0	1
Female headed household (= 1)	0.157	(0.364)	0	1
Age of the head	38.72	(10.48)	18	75
Highest education among females	4.976	(2.973)	0	12
Highest education among males	6.550	(2.797)	0	13
log (household size)	1.703	(0.363)	1	2.708
Ratio of dependents to household size	0.553	(0.144)	0	1
log (monthly consumption per capita)	11.60	(1.08)	8.37	15.38

Table A7: Impact on Incidence of Diarrhea Symptoms (All Individuals)

Dependent variable: Incidence of diarrhea (= 1)	Logit	Logit
	(A)	(B)
Project and year dummy variables		
Project site (= 1)	0.0029	0.0029
	(0.0043)	(0.0043)
Year 2013 (= 1)	0.0043	0.0043
	(0.0045)	(0.0045)
Project site * Borehole user	-0.0106**	-0.0128***
* Year 2013 (= 1)	(0.0044)	(0.0042)
Project site * Borehole user		0.0099**
* Year 2013 * Distance (km)		(0.0045)
Project site * Borehole non-user	-0.0079*	-0.0078*
* Year 2013 (= 1)	(0.0046)	(0.0046)
Individual characteristics	Yes	Yes
Household characteristics	Yes	Yes
District dummy variables	Yes	Yes
Pseudo R sq.	0.0749	0.0768
No. of observations	6447	6447

Note: Coefficients on continuous variables indicate marginal changes in the probability of having a diarrhea symptom evaluated at the mean values, and coefficients on dummy variables indicate changes in the probability of having a diarrhea symptom when the value of the dummy variable changes from zero to one. Full estimation results are available upon request.

Household-level cluster-robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.

Table A8: Impact on Incidence of Diarrhea Symptoms (Children under Five)

Dependent variable: Incidence of diarrhea (= 1)	Logit	Logit
	(A)	(B)
Project and year dummy variables		
Project site (= 1)	0.0057	0.0057
	(0.0149)	(0.0148)
Year 2013 (= 1)	0.0284	0.0282
	(0.0187)	(0.0186)
Project site * Borehole user	-0.0369**	-0.0413***
* Year 2013 (= 1)	(0.0152)	(0.0149)
Project site * Borehole user		0.0249
* Year 2013 * Distance (km)		(0.0186)
Project site * Borehole non-user	-0.0250	-0.0249
* Year 2013 (= 1)	(0.0157)	(0.0155)
Individual characteristics	Yes	Yes
Household characteristics	Yes	Yes
District dummy variables	Yes	Yes
Pseudo R sq.	0.1010	0.1030
No. of observations	1059	1059

Note: Coefficients on continuous variables indicate marginal changes in the probability of having a diarrhea symptom evaluated at the mean values, and coefficients on dummy variables indicate changes in the probability of having a diarrhea symptom when the value of the dummy variable changes from zero to one. Full estimation results are available upon request.

Household-level cluster-robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.

Table A9: Summary Statistics of Explanatory Variables (Women over 18)

2012	**Mean**	**S.D.**	**Min.**	**Max.**
Individual characteristics		n = 740		
Age	36.5	(14.0)	19	88
Education	5.049	(2.989)	0	13
Household characteristics		n = 608		
JICA Project site (= 1)	0.688	(0.464)	0	1
Other project site (= 1)	0.169	(0.375)	0	1
Female headed household (= 1)	0.214	(0.410)	0	1
Age of the head	43.21	(13.55)	19	84
Highest education among females	5.180	(3.006)	0	13
Highest education among males	6.857	(2.812)	0	13
log (household size)	1.567	(0.489)	0	2.708
Ratio of females (0–6) to household size	0.108	(0.141)	0	0.667
Ratio of males (0–6) to household size	0.111	(0.142)	0	0.667
Ratio of females (7–18) to household size	0.104	(0.132)	0	0.667
Ratio of males (7–18) to household size	0.101	(0.131)	0	0.750
Ratio of females (19–65) to household size	0.237	(0.159)	0	0.750
Ratio of males (19–65) to household size	0.303	(0.190)	0	1.000
Ratio of females (65+) to household size	0.019	(0.081)	0	0.500
Ratio of males (65+) to household size	0.017	(0.083)	0	1.000
log (monthly consumption per capita)	11.639	(0.734)	9.681	16.229
2013	**Mean**	**S.D.**	**Min.**	**Max.**
Individual characteristics		n = 729		
Age	37.1	(14.2)	19	89
Education	4.832	(3.025)	0	13
Household characteristics		n = 595		
JICA Project site (= 1)	0.689	(0.463)	0	1
Other project site (= 1)	0.171	(0.377)	0	1
Female headed household (= 1)	0.208	(0.407)	0	1
Age of the head	43.95	(13.58)	17	85
Highest education among females	5.035	(3.019)	0	13
Highest education among males	6.843	(2.853)	0	13
log (household size)	1.522	(0.484)	0	2.708
Ratio of females (0–6) to household size	0.097	(0.137)	0	0.667
Ratio of males (0–6) to household size	0.106	(0.142)	0	0.667
Ratio of females (7–18) to household size	0.101	(0.133)	0	0.600
Ratio of males (7–18) to household size	0.107	(0.137)	0	0.667
Ratio of females (19–65) to household size	0.240	(0.173)	0	1.000
Ratio of males (19–65) to household size	0.302	(0.181)	0	1.000
Ratio of females (65+) to household size	0.025	(0.106)	0	1.000
Ratio of males (65+) to household size	0.022	(0.101)	0	1.000
log (monthly consumption per capita)	11.634	(0.995)	8.367	15.384

Table A10: Impact on Hours Spent Fetching Water (Women over 18)

Dependent variable: Hours spent fetching water per day	Logit	Logit	Logit
	(A)	(B)	(C)
Project and year dummy variables			
JICA project site (= 1)	0.0523	0.0623	0.0963
	(0.2170)	(0.2180)	(0.2030)
Year 2013 (= 1)	-1.236***	-1.239***	-1.272***
	(0.2090)	(0.2060)	(0.2070)
JICA Project site * Year 2013 (= 1)	-0.3630	-0.3470	-0.3120
	(0.2380)	(0.2350)	(0.2350)
Individual characteristics	No	No	Yes
Household characteristics	No	Yes	Yes
R-sq.	0.052	0.057	0.073
No. of observations	1469	1469	1469

Note: Coefficients indicate changes in hours spent fetching water on a weekday evaluated at the mean values when the value of the dummy variable changes from zero to one. Full estimation results are available upon request. Household-level cluster-robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.

Table A11: Impact on Hours Spent Fetching Water (Women over 18)

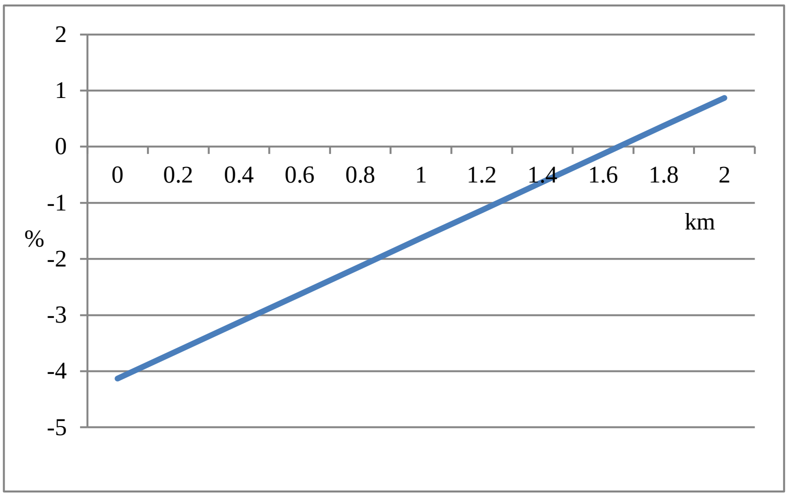
Dependent variable: Hours spent fetching water per day	Tobit	Tobit
	(A)	(B)
Project and year dummy variables		
JICA Project site (= 1)	0.1200	0.1230
	(0.2010)	(0.2010)
Year 2013 (= 1)	-1.223***	-1.221***
	(0.1900)	(0.1900)
JICA Project site * Borehole user	-0.3400	-0.424*
* Year 2013 (= 1)	(0.2290)	(0.2400)
JICA Project site * Borehole user		0.2840
* Year 2013 * Distance (km)		(0.2270)
JICA Project site * Borehole non-user	-0.559**	-0.561**
* Year 2013 (= 1)	(0.2850)	(0.2850)
Other project site (= 1)	-0.0507	-0.0491
	(0.2180)	(0.2170)
Other project site * User	0.1060	0.1010
* Year 2013 (= 1)	(0.2580)	(0.2580)
Other project site * Non-user	-0.0350	-0.0344
* Year 2013 (= 1)	(0.3160)	(0.3160)
Individual characteristics	Yes	Yes
Household characteristics	Yes	Yes
District dummy variables	Yes	Yes
Pseudo R sq.	0.4500	0.0733
No. of left-censored observations	517	517
No. of observations	1469	1469

Note: Coefficients on continuous variables indicate marginal changes in hours spent fetching water on a weekday evaluated at the mean values, and coefficients on dummy variables indicate changes in hours spent fetching water on a weekday when the value of the dummy variable changes from zero to one. Full estimation results are available upon request.

Household-level cluster-robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.

D. Figure

Figure A1: Heterogeneous Impacts by Distance to JICA Borehole
(Incidence of Diarrhea among Children under Five)



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