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Keyword list: water supply, control and treatment, rural development and regression analysis

Abstract

Clean water provision is challenging for Afghanistan as a post-conflict country. Afghanistan has suffered long term economic and political instabilities as a result its infrastructures has been severely impaired. Fortunately, international aid assisting in Afghanistan's redevelopment has included investment projects for rehabilitating the water supply system in order to provide safe and clean water. This quantitative research assesses the impact of the water supply project in Fayzabad city of Badakhshan province. Data was collected with two questionnaires developed for treatment and control groups. The treatment group included households that benefited from the project and households that still relied on unfiltered water sources made up the control. 500 questionnaires were distributed with 250 in each group. We used regression to analysis the data in four models which assessed project impact using health, education, time spend collecting water and savings as dependent variables. The data was statistically analyzed using SPSS version 25. The results indicate that, program intervention decreased school absences as indicator of the project effect on education, additionally the analysis showed a decrease in sickness and hospital visits. The time-saving effects and financial savings also showed a positive change as result of project intervention in the treatment group. It was found that program intervention positively impacts the welfare and quality of life for residents in Fayzabad.

Description of the Data

Fayzabad is the capital of Badakhshan province, located within 700 Km of Kabul. Its population is currently living with a shortage of safe and healthy water. Fayzabad residents rely on water from a number of sources such as streams, river, rainwater, tanker truck and reservoirs. Despite the Kokcha River's passage through the city, local government has not been able to facilitate filtered water. As part of international aid, potable water project has been established to help the local government provide clean water to beneficiaries' homes at a low cost per liter. This project is financially supported by KfW and, aims to build a water supply system for approximately 20000 households. This study considers the effects of the irrigation project's intervention and analysis the living standards of the beneficiaries in comparison to the unaffected population. The water supply is an initiative and therefore this research required primary data collection. The data was gathered through a questionnaire surveying 500 households in two parts of the target city. According to the urban development plan of the local government, there is water supply infrastructure currently operating in Fayzabad. 20000 households allocated for the new clean water program, 5000 are connected to the metered water supplying system. The program plans to connect the rest of the beneficiaries to a potable tap in their house by 2022. In this study those who have already received the program are assigned as the treatment group and households who are still accessing water through traditional practices such as wells and the Kokcha River or who buy water from tanker trucks are assigned as the control group using purposive sampling. The questionnaire consisted of two parts. The survey was designed to evaluate the comfort of the program's beneficiaries compared to non-recipient and used questions that address, demographic and exploratory variables derived from existing literature. Since the program is not limited to any specific city district, it is possible to identify respondents belonging to the treatment and control groups in each district. Respondents in Fayzabad are not familiar with the practice of data collection for academic research and so, it was necessary for the data collectors to carefully describe the questionnaire to respondents in order to avoid data collection bias.

Research Questions/Theoretical Contextualization

Afghanistan is a landlocked country in central Asia that has 75000 million cubic meters water. This country uses only one third of its water potential and the rest flows in to neighboring countries (Habib, 2014). For many years, potable water for household use has been challenge for Afghans and this water shortage has directly affected citizen's life and social development (Abdul Halim Zaryab, 2017). Traditional practices for collecting water continue to be used in urban areas and as well as suburban areas. The water sources for daily use are streams, rain water reservoirs, canals, public water tap and wells as well as the Kokcha River, none of which offer a reliable source of drinking water (Abobakar Himat, 2019). After the collapse of the Taliban regime, numerous financial corporation of international aid flowed in to Afghanistan to fund vital projects (Popal, 2014; Johnson, 2010). Despite the high the rate of financial corporations and water potential water supply and sanitation remained weak and has not garnered much assistance from international aid. Improvements for water supply systems in urban areas has received a relatively low percentage of funds from the influx of donation despite the fact that many victims of the water crisis reside in cities and suburbs (Bartram & Cairncross, 2010). Afghanistan is not the only country with insufficient water and sanitation infrastructure and there are examples of successful redevelopment projects improving of water supply systems in other countries. Recent studies have assessed the impact of clean water supply projects on the quality of life in different continents. For instance, Boone and Glick investigated how poor water infrastructure was related to community life. They found that lack of infrastructure necessities time-consuming routines for collecting water from taps. They evaluated the effects of poor water supply from a gendered perspective and found that women and girls were mainly responsible for water collection. (Boone, 2011). There is also a strong relationship between water contamination and health. Studies have shown that improved drinking-water has a positive impact on children's health too (Jalan & Ravallion, 2003).

Contaminated water is a common cause of illness, specially diarrhea and sore throat. Recent research by Sandy and others investigated the role of contaminated water on the incident rate of diarrhea. Findings from the study by Sandy indicate that low water quality and poor hygiene cause diarrhea (Sandy Cairncross, 2010). Additionally, a study based in Morocco by Aziz et.al (2017), found that contaminated waters in reservoirs, filled by rain-water or directly from rivers can causes high rate of illness when in use without a reliable filtration system. They concluded that there is a strong relationship between bacterial contamination of water sources and public health. Another study by Shrestha et.al (2017) assessed the effect of improvement to drinking-water on incidents diarrhea in the Kathmandu valley of Nepal. In this study the families with clean drinking-water and improved sanitation, were less likely to develop diarrhea than their counterparts without water and sanitation upgrades. Moreover, in countries suffering from insufficient secure and sanitary water infrastructure, children are most often responsible for collecting water for daily use which compromise their school attendance. A study conducted in Cambodia showed that a lack of clean drinking water results in a high rate of absenteeism among children and adults in school. For children in these areas, this is due to time consuming task of collecting water (Paul R. Hunter, 2015). Access to affordable clean water also increases the monthly savings of impoverished families. A study in Nepal showed that access to reliable metered water system improved the households' savings, which afforded residents more opportunities to buy necessities such as high quality food, and even some luxury goods for their home. Moreover, the study found that metered household water taps reduce potential healthcare costs for illnesses caused by contaminated water (Nicholas Fielmua, 2018). Despite concerns about the impact and sustainability of donor-funded projects' the literature demonstrates that such projects have had positive effects on millions of through, improved water and sanitation, especially in decreasing the incidence of diseases from contaminated water (Kwangware, Mayo, & Hoko, 2014). As previously stated, Fayzabad does have water resources, but due to poor infrastructure and sanitation, it is unsuitable and unhygienic for daily activities. This research aims to assess out the real impact the metered infrastructure that has recently been established by KfW and Afghanistan's Ministry of Energy and water. For this analysis, we considered dependent variables such as education, time-saving, health, savings in order to evaluate the changes beneficiaries' quality of life as a result of accessing clean water inside their houses. This research has the following aims,

- To evaluate the project's impact on decreasing the waterborne diseases.
- To estimate the time-saving effects of improved water infrastructure and the related economic impact?
- To examine the effects of the project on education, especially children's school attendance.

We have developed the following hypothesis, which we will test with statistical analysis,

Hypothesis 1:

H0: The program has no effect on schooling

H1: The program intervention has significant effect on schooling

Hypothesis 2:

H0: The program has no effect on time-saving and savings

H1: The program intervention has a statistically significant impact on time-saving and savings

Hypothesis 3:

H0: There is no significant relationship between program intervention and health (e.g. decrease in incidences of waterborne diseases)

H1: There is a significant relationship between program intervention and health (e.g. decrease in incidences of waterborne diseases)

Field Research Design/ Methods of Data Gathering

The population under analysis is that of Fayzabad city and the data was gathered from part of the city. The research was designed based on questionnaires used in (Global-Epidemiology-Team, 2014) and (Löwenstein, Shakya, Hansen, & Gorkhali, 2015). However, the research method for these previous studies was experimental, whereas our research is semi-experimental. The survey was designed to compare households with piped water supply to households accessing water from unstandardized local sources. The data is divided in-to treatment and control groups. The methodology is coefficient comparison between treatment and control groups. The water supply project is funded by KfW and covers 60 % of Fayzabad households. The remaining 40% of households have limited access to potable water. A questionnaire used to collect primary data. Interviews used purposive sampling to select respondents and interviewed respondents in their homes. Two types of questionnaires were designed, one with questions for respondents about their water supply facilities and one for respondents with less access to potable water. The aim was to evaluate the effect of the water supply project on living conditions, specifically to access potential effects relating to the health, time spent collecting water and financial savings of beneficiaries. In order to discern any changes, we evaluated four key independent variables, education, time saved, health and financial savings. In many families collecting water is the responsibility of school-aged children, and so, for the education variable, we evaluated school absences for children 8-16 years old. The variable of time savings refers to the amount of time a child or family member spends on retrieving water from public taps. The health variable is measured in the number of hospital visits in month and incidence of water-related health issue such as sore throat and diarrhea. The project's cost-saving effects are evaluated in relation to the high cost of purchasing water from local water trucks for daily usage. The below regression models ran on data obtained from two groups,

1. **Education** =β0+ β1age+ β2gender+β3marital status+ β4family member + β5family income+ β6timespend for water collection+ β7number of children collecting water+ β8studyhours+e
2. **Time saving**= β0+ β1age +β2gender+β3marital status+ β4family member + β5family income+ β6water cost per liter+ β7time for allocates for water collection+e
3. **Health**= β0+ β1age +β2gender+β3marital status+ β4family member+β5family income+ β6sickness+ β6numberofhospital visits + β7hygienic use+ β8 water source+e
4. **Savings**=β0+ β1age +β2gender+β3marital status+ β4family member+β5family income+ β6sickness+ β7sickness+ β8amount of money spend on health treatment+ β9water cost per liter+e

Results

This study aims to find the impact of water supply projects. The questionnaires developed with two parts: the first part gathered demographic information and second part addressed exploratory variables. The demographic section asked respondents' age, marital status, education and family at them interviewed.

Table 1: Gender composition of the respondents

Gender	Frequency	Percentage
Male	243	54
Female	207	46
	450	100

Source: Field research Aug-Nov 2019

Table 2: Marital status of the respondents

Marital Status	Frequency	Percentage
Single	394	88
Married	56	12
	450	100

Source: Field research Aug-Nov 2019

One of the demographic variable was education. It was expected the findings to record respondents with education at the secondary level. Table 3 shows the education level of the respondents,

Table 3: Respondents education level

Education levels	**Frequency**	**Percentage**
Illiterate	54	12
Primary School	94	21
Secondary School	49	11
High School	126	28
Bachelor	113	25
Master	14	3
	450	100

Source: Field research Aug-Nov 2019

Data Analysis

An impact evaluation of the water supply project requires taking into account several exploratory variables. Although there are many variables that influence the impact and sustainability of a development projects, this research specifically address education, time used for water collection, health and cost as exploratory variables. The first variable expected to be affected by the water supply project is education. In many impoverished communities, collecting water for daily usage is the responsibility of school-aged children. Table 4 shows how the project impacted education in the treatment group.

Table 4: Analysis of the water supply project on education in treatment group,

Model	Unstandardized B	Coefficient Std.Error	Standard Coefficient Beta	Sig
Age	.005	.003	.070	0.152
Gender	.009	.048	.009	0.857
Marital Status	-.003	.007	-.026	0.600
Family Size	.026	.027	.048	0.334
Water collecting hours	.208	.000	.003	0.945
Study Hours	.072	.005	.750	0.450

Dependent Variable: Education

A regression model was applied on education data obtained from families in the treatment group who were beneficiaries of project. Table 4 describes the education status of households with metered water with variables of water collecting hours and study hours. In the treatment group the coefficient for water collecting hours and education is .003, while the relation between study hour and education is with coefficient of 0.750. The same regression was applied to families in the control group who were not beneficiaries of the project. Table 5 shows the effect of water supply on education for the control group.

Table 5: Regression analysis of the water supply project and education in control group

Model	Unstandardized B	Coefficient Std.Error	Standard Coefficient Beta
Age	.015	.008	.001
Gender	.097	.122	.058
Marital Status	.060	.182	.024
Family Size	-.392	.317	-.233
Water collecting hours	-.130	.089	-.268
Study Hours	-.399	.000	-.012

Dependent Variable: Education

The same regression model was applied on the control group to assess the impact of water supply projects on beneficiaries' education. The result indicates that water collecting hours and education in families with no metered water has a negative impact on education with coefficients of -0.268. Furthermore, study hours in households not include in the development program also negatively affected education with coefficient of -0.012. Following the education liner regression model, time saving was considered as another indicator of the water supply project's impact. Both groups reported the amount of time used for collecting water. Table 6 shows the time-saving data attitude of the treatment group.

Table 6: Time saving as an indicator for impact of water supply redevelopment in treatment group,

Model	Unstandardized B	Coefficient Std.Error	Standard Coefficient Beta	Sig
Age	-.006	.008	-.051	.462
Gender	.135	.126	.076	.287
Marital Status	.067	.185	.025	.720
Family Size	.019	.046	.029	.677
Family income	.000	.000	.264	.000
Water cost per liter	-.182	.074	-.211	.015
Time for water collecting	-.007	.006	-.094	.275

Dependent variable: time saving

Given the result of this analysis, time-saving only describes -0.094 of the families' time, while water cost per litter has a coefficient -0.211. The time-saving linear regression model was applied on control data as well and, table 7 gives the coefficients.

Table 7: Time-saving as an indicator for impact water supply redevelopment in control group,

Model	Unstandardized B	Coefficient Std.Error	Standard Coefficient Beta
Age	-.003	.008	-.380
Gender	.123	.126	.981
Marital Status	.038	.188	.203
Family Size	.008	.018	.426
Family income	.956	.000	.182
Water cost per liter	.000	.000	.426
Time for water collecting	-.099	.127	-.783

Dependent variable: time saving

The control group has the same variables assessed on the treatment group's data. The coefficient of water cost per liter is 0.426 and time for water collecting is -0.783. Another key variables in this study was health. As discussed above the daily use of contaminated can cause serious health problems. The target population in Fayzabad mostly uses water from unstandardized sources. The health linear regression evaluates the impact of water the supply project in control and treatment groups. Table 8 describes respondents' health status in the treatment group,

Table 8: Health linear regression model in treatment group,

Model	Unstandardized B	Coefficient Std.Error	Standard Coefficient Beta	Sig
Age	.021	.081	.024	.000
Gender	-.003	.002	-.053	.058
Marital Status	.030	.028	.031	.288
Family Size	-.018	.042	-.012	.663
Family income	-.002	.004	-.015	.592
Sickness	.781	.000	.008	.774
Number of hospital visits	-.255	.009	-.883	.016
Hygienic use	.012	.010	.034	.237
Water Source	.435	.000	-.073	.015

Dependent variable: Health

The research considers three variables to assess the health impact of the project, sickness, number of hospital visits and hygienic use. Sickness the health status of the respondents in the treatment group and has a coefficient 0.008. The number hospital visits -0.883 coefficient has a negative relation with health. Hygienic use received 0.034 compared to other variables. Table 9 shows the result of the health regression model on control group data

Table 9: Health linear regression model in control group,

Model	Unstandardized B	Coefficient Std.Error	Standard Coefficient Beta
Age		.347	
Gender	-.007	.006	-.030
Marital Status	.059	.101	.017
Family Size	.007	.148	.001
Family income	-.001	.014	-.002
Sickness	.445	.000	-.012
Hospital visits	.042	.037	.033
Hygienic Use	.981	.000	-.003
Water Source	-.212	.110	-.926

Dependent variable: Health

Sickness related to contaminated water usage has -0.012. In Fayzabad, the cost of water is high and therefore, it was important to assess financial savings as an indicator of the water redevelopment project's impact. Table 10 shows the relationship between daily water usage and savings.

Table 10: Saving impact of water supply project on treatment group.

Model	Unstandardized B	Coefficient Std.Error	Standard Coefficient Beta	Sig
Age	-.279	.687	-.057	.400
Gender	.916	.246	.051	.450
Marital Status	-.968	.024	-.033	.627
Family Income	-.001	.003	-.030	.671
Sickness	.049	.127	.027	.700
Health Expenditure	-.185	.619	-.398	.022
Water Cost per litter	.709	.583	.015	.931
Water Source	-.322	.699	-.055	.431

Dependent variable: Saving

Total savings was evaluated as the amount of money a household pays for per water liter and expenses incurred for healthcare related to waterborne illness. It was found that health expenditure has -0.398 coefficient, following water cost per liter which has 0.015.

Table 11: Saving impact of water supply project on control group.

Model	Unstandardized B	Coefficient Std.Error	Standard Coefficient Beta
Age	-.357	.553	-.046
Gender	.433	.704	.107
Marital Status	-.341	.108	-.074
Family income	.107	.509	.094
Sickness	-.873	.404	-.047
Health expenditure	.786	.632	.020
Water cost per litter	-.757	.779	-.032
Water Source	.483	.035	.226

Dependent variable: saving

Control groups data analysis indicates that health expenditure has 0.020 coefficient, while water cost per liter has a negative relationship with -0.032.

Discussion

This research relies on primary data gathered through questionnaires designed to evaluate the water supply redevelopment established in city of Fayzabad in Afghanistan's Badakhshan province. We identified four dependent variables for assessing the impact of the project. The variables are education, health, time used collecting water and savings. Water collection for daily use is often the responsibility of school-aged children. Thus when they are required to collect water from public taps their school attendance is affected. Based on the education linear regression model, it was found that the variable of study hours has 0.003 coefficient in the treatment group, whereas the variables coefficients in the control group is -0.012. This means the project intervention decreased students' school absenteeism. The second variable evaluated was time-saving, or the reduction of time used collecting water. The coefficient for this variable in the treatment group is 0.275 compared to the -0.783 coefficient in the control group. Thus the program intervention positively affected the time-saving of the beneficiaries by reducing the time spent collecting water. Another key variable of the analysis was health. Health was measured with reference to incidence of waterborne illness, the number of hospital visits, hygienic use and water source. Each of the variables has coefficients in the treatment group as seen in Table 8, but for the control group the coefficient are mostly negative as shown in table 9. Due to the high cost of water, part of households' income in Fayzabad is allocated to providing water. Thus cost saving was considered as an indicator of the water supply project's impact through analysis of beneficiaries' saving according to the cost per liter for water. It reduced as result of program intervention as shown in table 10 and 11.

Conclusion

This research studied the impact of the water supply redevelopment project in Fayzabad, specifically the effect on beneficiaries' education, time, health and saving. A total 500 questionnaires were distributed in to treatment and control groups. The treatment group included households who benefited from program intervention, while the control comprised households those who relying on unstandardized water sources. Our analysis measured the effect on education resulting from school-aged children who were responsible for collecting water. The findings of the education regression analysis indicates that project intervention positively affected education and decreased the number of school absence by increasing study hours of children who collected water at least 3 days a week. The lack of easily accessible and potable water means that families spend a high proportion of their working hours for collecting water. Taking this into account, we assessed time-saving as a dependent variable in this study. The water supply program positively affected the time loss of beneficiaries in treatment group and the implementation of clean, filtered water systems reduced time spent collecting water. Contaminated water can cause several waterborne illnesses and so this research addressed health as a key variable to assess the impact of the redevelopment program. Our findings showed that clean water provisions decreased sickness and hospital visits and the results confirmed the alternative hypothesis with 0.05 significance level. The last variable was financial saving, it was found that project decreased amount of money families' pays for water to facilitator like, water tanker trucks and reservoirs, therefore part of households' income in Fayzabad is allocated to providing water. By establishing potable water taps in homes they are not obliged to pay high amount of money for collecting water, because the project supplies low cost water per liter.

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