Impact Evaluation of the FDW Project Sustainable Water Services Project in Harar (SWSH), Ethiopia

SECTION THREE: Report on Rural Households' Baseline and Follow up Surveys (2016 and 2019)

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1. Introduction

Part of the SWSH Project (hereafter 'the Project') had the objective of directly improving access to 'improved' drinking water supply to 25,000 rural people. This rural water supply intervention was not implemented as planned. The Project did not identify intervention target rural areas or households for almost three years after inception. Initially it was thought to enhance rural water supply through three forms of intervention: spring development, sand dam development and rehabilitation of non-functioning hand dug wells. Later the spring development was abandoned and attention shifted to repairing and constructing water points. Three sand dams along with one hand dug well each were constructed in Erer woreda, Hawaye kebele in 2018 to supply water to local rural people. Ten water points were constructed (7 in Sofi, 3 in Dire Tayara woreda)[1] in 2017 and 2018, and more than 60 hand dug wells (15 in Sofi woreda, 12 in Erer woreda and 37 in Dire Tayara woreda) were repaired in 2017 and 2018. In order to have sufficient time between baseline and follow-up surveys, we had to conduct a baseline survey before the interventions were finally identified and ex post allocate household to treatment and control groups.

This evaluation exercise aims to provide empirical evidence about the consequences of improved water supply (due to the Project) on the living condition of rural households. The study specifically compares the wellbeing of those households that have acquired safer drinking water and those who still used drinking water from unprotected sources in 2019 in rural Harari Regional State.

The basic evaluation questions are:

i) Does access to drinking water reduced time spent in fetching water that could leads to improvement in livelihoods of rural people?
ii) Does access to safer water supply brings reduction in school and work absenteeism?
iii) Does using drinking water from protected sources reduce incidence of diarrhea and medical spending?

2. Indicators of Access to Water

Time: Time spent to fetch water is a key indicator of water accessibility. In sub-Saharan Africa, most families have members who take substantial time to fetch water and the mean time needed to fetch water in sub-Saharan Africa is about 30 minutes per trip (UNICEF and WHO, 2012). Accordingly, it is estimated that 40 billion potential working hours are lost each year as a result of collecting water (Blackden and Wodon, 2006). Depending on the household size and water carrying method, multiple trips per day may be required which leads to substantially increasing the total time spent per day (Geere et al., 2010; Sorenson et al., 2011).

Distance: It is also well documented that mostly women and girls travel long distances to fetch water (WHO/UNICEF, 2010). In most rural areas of Ethiopia, the task of fetching water is given to women and adolescent girls which exposes them to different socio-economic pressures with risks of sexual assault and long term physiological damage.

Source of Water*:* source of the water significantly determines the safety of the water that could be used for drinking and cooking purposes. Improved drinking water sources are those which,

[1] These are water points connected with the urban water supply to peri-urban areas and thereby accessible by some rural people (rural water for life).

by nature of their design and construction, have the potential to deliver safe water (Gross et al, 2013). In addition to its safe quality, water should be available when needed, and the water supplied should be free from contamination.

***Quantity/Amount of consumption*:** In order to maintain health of the population, there should be enough quantity of water per person per day collected by or delivered to households. In this regard the amount of water obtained and used should be sufficient for drinking, preparation of food and personal and environmental hygiene of households.

***Affordability of price*:** The affordability of water affects the quantity of use of water used on daily basis and it also influences the selection of water sources. Households with poor access to improved water supply mostly pay more for water as compared to those who are connected to a public sector piped water system (WHO, 2011b). If the cost of accessing water is expensive, the households are forced to use smaller quantities of water and alternatively use water from unprotected sources that represent a greater risk to health.

Continuity/availability of water: Irregularities of water supply affects the day to day consumption of water for different purpose at household level. Interruptions to water service provision, either because of intermittent sources or resulting from seasonality and/or water infrastructure defects, are a major determinant influencing access to and quality of drinking water (WHO, 2011b).

Expected outcomes of providing safer, more accessible water

Utilization of improved water for drinking and cooking purposes is expected to play a positive role on the livelihood of the population. The following are some of the factors that are expected to be changed as a result of interventions aiming at creating access to improved water supply.

Improved Health Status and Reduction in Expenditure on Health Services: access to safe water and maintain personal and environmental hygiene has been recognized as a fundamental factor to improve health status of the population and for socio-economic progress in developing countries. Consumption of improved water reduces the incidence of a variety of waterborne diseases, such as diarrhea, intestinal helminthes, guinea worm, skin diseases, and trachoma (Usman et al., 2016). Such health improvements as a result of using safe water on daily basis can in turn lead to reduced expenditure on health services and better livelihoods.

Improved School Attendance: access to adequate safe water from nearby sources can significantly improve attendance at schools, especially for girls. Water and education are connected with gender equality development agenda as women spend significant time fetching water (Pickering and Davis, 2013). In the presence of accessible safe water, girls would not be forced to spend time collecting water for the family. Hence, provision of improved water supply can help to reduce school dropouts and absenteeism (Chalchisa, 2017).

***Improved Livelihoods*:** The effect of interventions aiming to provide improved water supply is not restricted to creating access to safe water that can be safely used for drinking, washing and cooking. It is widely accepted that time and energy for productive activity and education are central points of livelihoods in any development agenda. Access to safe water in the rural community can play an important role for environmental sustainability, reduced labor, improved nutrition and health status which in general leads to better livelihoods for rural households.

3. Methodology

The study was conducted based on two rounds of rural household panel data. The baseline data was collected in 2016 and the follow up survey was conducted after three years in 2019. The study covers all the three rural woredas (districts) of the Harari People's National Regional State (HPNRS).

The SWSH project had a goal of improving water accessibility for 25,000 rural people. Originally, the Establishing Impact team planned to conduct baseline surveys in 2015/16 but the FDW project was not in a position to identify intervention target areas or households before the baseline data planned collection period in 2016. But, though there was no clear Project design at that time, there were sufficient indications of interventions and locations to design a survey in the three woredas, though this required **ex post** bifurcation into treatment and control groups after the follow up survey in 2019.[2] Household data was collected in eight rural villages - Dire Teyara, Sigicha, Sukul, Awber Kele, Sofi, Awaye, Dodota, and Erer Dodota in the three Harar Region woredas.

Table 1: Sample size from Rural Harar by woreda and survey period

No	Woreda	No of sample households		Sample attrition in the follow up survey
		Baseline survey (2016)	Follow up survey (2019)	
1	Dere Teyera	56	49	7
2	Sofi	140	128	12
3	Erer	112	101	11
Total		308	278	30

The initial plan was to collect two rounds of data from 300 households with approximately 1500 individuals (determined by budgetary and logistical constraints), the baseline study actually covered 308 sample households while the follow up survey found 278 of these households to constitute the final panel (Table 1). Thus, sample attrition after three years between the surveys was about 10%. There were missing households during the follow up survey from all three districts, probably due to emigration. The sample distribution per kebele (can be seen as 'village' in rural Ethiopian context) in and survey year is reported in Table 2. Among the sample villages, broadly proportionate to population sizes, a relatively larger sample was collected from Sofi Kebele (84 households) followed by Erer Dodota Kebele (74 households). On the other hand, the sample sizes taken from Sigicha and Dodota Kebeles were relatively smaller.

Data was collected by two teams of enumerators who had been trained over a period of one and a half days. The questionnaire was completed in Amharic, though the enumerators could work orally in 'Oromifa', the language most used in the rural areas of Harar region. All enumerators and target interviewees were women.

[2] In order to get the more detail about survey design, sampling frame and consideration for study population the baseline repot, please consult the baseline survey report submitted to the Ministry in 2016.

Table 2: Number of sample households by woreda/kebele and year of survey

Woreda	Kebele	No of sample households	
		Baseline survey (2016)	Follow up survey (2019)
Dere Teyera	Dire Teyara	16	16
	Sigicha	12	9
	Sukul	28	24
	Total	56	49
Sofi	Awber Kele	56	49
	Sofi	84	79
	Total	140	128
Erer	Awaye	25	20
	Dodota	13	13
	Erer Dodota	74	68
	Total	112	101
Grand Total		308	278

4. Data analysis

The study employed descriptive statistics to assess the characteristics of sample households and micro econometrics (comparative regression models) to assess the effects of project interventions on different drinking water related variables. Any changes in drinking water access, demographic and socioeconomic conditions of the sample households across survey years by treatment/control intervention status were assessed using frequencies, means, and percentages.

In order to evaluate the differences in the outcomes between treated and control groups, we performed double difference comparison tests. We checked any differences between two means as statistically significant at least at 10% level of confidence. Finally, we run a number of double difference in difference (DID) models to see the impact of protected water on the outcomes using control versus treatment samples. For difference in difference analysis we employed the following regression model.

$$Y_{ht} = \alpha + \beta_1 TS_{ht} + \beta_2 SY_{ht} + \beta_3 (TS_{ht} * SY_{ht}) + \varepsilon_{ht}$$

Where Y_{ht} refers to the outcome variables of the study for household *h* in survey year *t*., which include indicators for water supply, health, education, and sanitation. The outcome variables were regressed after controlling for access to safe drinking water treatment status (TS_{ht}) and survey year (SY_{ht}) as well as the interaction between the two factors ($TS_{ht} * SY_{ht}$). In the model, α and β_i's are coefficients to be estimated and the final term is the error term.

In this analysis, the main coefficient of interest is the interaction between treatment status and survey year (β_3). If the incidence of being exposed to the intervention, that is getting access to drinking water from protected sources, directly influence the outcomes, β_3 should be significant and positive. On the contrary, if the treatment influences the dependent variable perversely, the coefficient of interaction variable should be significant and negative. If the intervention does not affect the outcome, β_3 would be statistically insignificant.

A major concern in conducting such impact evaluation studies is potential bias that could make it difficult to single out the true effect of being exposed to the intervention. In this study, the specified model helps to control for the effect of different unobserved time invariant confounders. However, there could still be bias and the estimated coefficients may not be consistent due to the effects of omitted time variant factors that could correlate with treatment status and influence the outcomes. In order to address such potential bias, we exploited the longitudinal nature of data and conducted alternative sensitivity tests using single difference and double difference analysis.

It should be noted that, for the collection of baseline data in 2016, intervention treatment households were not clearly known and in this analysis we had to use proxy indicators for possible exposure to treatment. Actual division between treatment and control groups was made after the follow-up survey in 2019 on the basis of households' reporting whether their access to water had been changed by a Project intervention. All those households who reported changed access to water due to Project interventions are placed in the treatment group while other households were placed in the control group.

Characteristics of households

The age distribution of individuals included in the follow up survey based on gender and woreda is reported in Table 3. The baseline survey consists of 1,628 people (805 females and 823 males). Across the sample districts, relatively more individuals were from Sofi woreda (692 individuals) followed by Erer woreda (615 people). In terms of age groups, there are 299 girls and 317 boys between the ages of 6 and 15 years. The survey also contains 371 children (179 females and 192 males) who are less than or equal to 5 years old.

Table 3: Sample individuals by woreda and age groups in 2019

Woreda	Female				Male				Total
	Age 0-5	Age 6-15	Age 16-59	Age60+	Age0-5	Age 6-15	Age 16-59	Age60+	
Dire Teyara	27	64	63	5	28	63	68	3	321
Sofi	77	118	147	6	75	133	130	6	692
Erer	75	117	103	3	89	121	102	5	615
Total	179	299	313	14	192	317	300	14	1,628

Source: HH survey 2019.

The number of sample individuals found in 2019 is reduced by 5% (94 people) as compared to the baseline survey (Table 4), though the number of households fell by ten percent. Among different age groups, a larger reduction is observed in the 'productive' age group (age 16-59) which is 38 females and 27 males. This may be due to emigration of adult household members for education and work.

Table 4: Sample individuals by survey year and age groups in the panel

Survey year	Female				Male				Total
	Age 0-5	Age 6-15	Age 16-59	Age 60+	Age 0-5	Age 6-15	Age 16-59	Age 60+	
2016	199	317	351	30	176	299	327	23	1,722
2019	179	299	313	14	192	317	300	14	1,628
Difference (2019-2016)	-20	-18	-38	-16	16	18	-27	-9	-94

Source: HH surveys, conducted in 2016 and 2019

Among different age group, individuals under 16 constitute the major share that is 58% during the baseline study and 60% in the follow up survey. On the other hand, the lowest proportion of individuals is elderly group which is 3% in baseline and 2% in the follow up (Table 5). The share of children under 16 years to some extent increased while the adult and elderly shares reduced. The mean household size in 2016 was 5.59 and rose to 5.86 in 2019.

Table 5: Summary figures for age groups by proportions and mean HH size

	2016	2019
Less than 16 years proportion	0.58	0.60
16-59 years proportion	0.39	0.38
60 and over years proportion	0.03	0.02
Female proportion	0.52	0.49
HH size (mean)	5.59	5.86

Source: Computed from Table 3.

Source and level of cash income

Table 6 shows main sources of cash income in three months before the survey time based on three ranks. As the study was conducted in rural areas, farming was the most frequent first ranked source of income for most households. It is found that 210 out of 278 households are dependent primarily on agriculture for their livelihood. Trade is the first source of income for 39 households and overall second in sources of income. Working as daily labourer for others is not found to be a common source of cash income in rural Harari.

Table 6: Main sources of cash income in the last three months (number of respondents)

Main source of cash income	1st rank	2nd rank	3rd rank
Agriculture (farming)	210	25	1
Livestock	1	16	4
Both agriculture and livestock	17	20	0
Trader (food/non-food items)	39	64	8
Daily labourer	2	7	1
Other	9	10	3
Total	278	142	17

Source: HH survey 2019.

The number of sample households with broadly categorised differing cash incomes per month is reported in Table 7. In all three sample woredas, a majority of the sample households earned between Birr 1000 to 4999 cash income per month. Only 5 out of 278 household had monthly cash income of Birr 5000 plus.

Table 7: Monthly household cash income by woreda

Last month cash income	Woreda			Total
	Dire Teyara	Sofi	Erer	
Birr 0-499	8	37	30	75
Birr 500-999	18	43	32	93
Birr 1000-4999	19	48	38	105
Birr 5000 or more	4	0	1	5
Total	49	128	101	278

Source: HH survey 2019

As shown in Table 8, treatment households look poorer as compared to control households. For instance, 35% of households in the intervention group obtained less than Birr 500 per month while about 25% of households in the comparison group fell in this category of income.

Table 8: Last month cash income by treatment status (in %)

Last month cash income	Treatment	Control
Birr 0-499	35.0	24.6
Birr 500-999	36.3	31.2
Birr 1000-4999	28.8	43.2
Birr 5000 or more	0.0	1.1

Source: Computed from Table 7.

Water supply and quality

The study assessed the main considerations given by rural people when deciding how to obtain water from alternative sources. Out of the total 277 household respondents, 183 (66%) households gave cleanliness as a top priority while 72 (28%) took distance as the most important issue (see Table 9). Cost of the water was given the least attention by the respondents, but most households did not pay cash for water.

Table 9: Ranking main considerations when obtaining drinking water (number of respondents)[3]

Main consideration	1st rank			2nd rank			3rd rank			4th rank		
	Treatment	Control	Total	Treatment	Control	Total	Treatment	Control	Total	Treatment	Control	Total
Cleanliness	112	61	183	17	11	29	14	8	22	4	0	4
Time	16	2	18	48	13	65	31	12	44	4	1	5
Distance	52	18	72	65	43	108	12	5	18	3	0	3
Cost	4	0	4	14	0	14	9	1	10	12	8	20
Total	184	81	277	144	67	216	66	26	94	23	9	32

Source: HH survey 2019.

[3] Rank is in order of importance from 1 to 4. For some of the results in the table, the sum of treatment and control respondents may be less than total respondents because there are some sample households who were categorized neither in treatment nor in control group.

In the total sample, over 60% of households used water from protected sources as their first ranked source, whereas 31% of the households used higher risk sources (that is from river, pond, lake, unprotected well and unprotected spring). The data suggests that just under ten percent of households use higher risk sources when their first ranked sources ‘fail’ in terms of water availability for seasonal or technical reasons. Very few households (3 out of 372 respondents) used bottled water as a primary source of drinking water (Table 10).

Table 10: Sources of drinking water in rural area (number of respondents)

Source	1st rank	2nd rank	Total
Own hand pump/borehole	15	1	16
Unprotected well	3	8	11
Protected well	15	17	32
Collective hand pump/borehole	108	16	124
River/pond/lake/unprotected spring	77	26	103
Packed water	0	3	3
Tanker	2	23	25
Communal tap/Bono	49	0	49
Protected spring	9	0	9
Total	278	94	372

Source: HH survey 2019

To assess the comparative impact of Project interventions, we allocated all households using safer drinking water sources to the ‘treatment’ group and households using higher risk sources to the control group. This division gave us 183 treatment households using water from protected sources and 80 control households using unprotected water sources (Table 11). This division is sub-optimal in terms of a bias towards over-estimating the impact of the Project intervention as it includes some households using protected water sources before the Project intervention and others that have been beneficiaries of interventions funded from non-Project sources during the life of the Project. But the division will provide valid estimates of the effect of using safer water sources in rural areas of Harar Region with possible implications for wider rural Ethiopia.

Table 11: First main source of drinking water (number of respondents)

Treated group	Freq.	Control group	Freq.
Protected well	15	Unprotected well	3
Collective hand pump/borehole	108	River/pond/lake/unprotected spring	77
Tanker	2		
Communal tap/Bono	49		
Protected spring	9		
Total	183	Total	80

Source: HH survey 2019

In the baseline responses, 30% of households were not affected by the seasonal variations in the availability of water and this increased to 39% in the follow up survey (Table 12). However, a majority of households (62%) still experienced changes in availability of water due to seasonal fluctuation in 2019. This suggests that continuity of the available water is a continuing concern in rural Harar, though decreasing during the Project lifetime.

Table 12: Change in the availability of water depends on the season (total sample)

Is there change in availability of water with the seasons?	2016		2019	
	Freq.	Percent	Freq.	Percent
No seasonal differences	90	29.90	104	38.52
Availability significantly changes depends on the seasons	211	70.10	166	61.48
Total	301	100.00	270	100.0

Source: HH surveys, conducted in 2016 and 2019

It is found that in both survey years, seasonal factors in accessing water is more common among control households. In 2019, half of the treated households reported seasonal variations in water availability, while, in the same period of time, 86% of control households were affected by seasonality of water availability (Table 13). For treatment group, the share of households who faced seasonal variations in obtaining water reduced by 14.4 percentage points over time (that is from 64.1% in 2016 to 49.1% in 2019), while, the share of control households affected with seasonality variations increased by about 10 percentage points. Thus, making water safer appears to be associated with making water supplies more reliable. Though such interventions do not remove issues of reliability which needs to be independently factored into future interventions.

Table 13: Change in the availability of water depends on the season (percent of the households)

Is there change in availability of water with the seasons?	Treatment		Control	
	2016	2019	2016	2019
No seasonal differences	35.9	50.3	24.0	14.1
Availability significantly changes depends on the seasons	64.1	49.7	76.0	85.9

Source: HH surveys, conducted in 2016 and 2019

During the 2016 baseline survey, more than 60% of households faced irregularities in the supply of water. Three years after the baseline survey, households which faced irregularities only reduced by 5% (Table 14). This indicates that though there was improvement in continuity of getting water, more than half of the households still experienced irregularity problem in 2019. This provides further evidence that unreliability of water supply is a factor that needs explicit attention in drinking water interventions in rural Ethiopia.

Table 14: Has your household faced irregularities in the supply of water in the past year (total sample)

Effect of irregularities	2016		2019	
	Freq.	Percent	Freq.	Percent
Not at all	117	38.49	98	42.98
Sometimes	125	41.12	112	49.12
A lot	62	20.39	18	7.89

Total	304	100.00	228	100.00

Source: HH surveys, conducted in 2016 and 2019

For the treatment group, the share of households facing a lot of irregularities in the supply of water reduced from 24% in 2016 to 10% in 2019 (Table 15). In the same period, the share of control households who did not face any problem of irregularities in accessing water increased by 42.9 percentage points. Table 15 shows treated households faced irregularities in the supply of water more than control households. Higher rainfall may explain the improved performance for the control group often using surface or near-surface water, but this positive effect is muted for the treatment group as their safer sources are less surface water dependent.

Table 15: Has your household faced irregularities in the supply of water in the past year (% of households)

Effect of irregularities	Treatment		Control	
	2016	2019	2016	2019
Not at all	29.6	27.4	54.5	97.4
Sometimes	49.4	62.3	31.3	2.6
A lot	24.0	10.3	14.2	0.0

Source: HH surveys, conducted in 2016 and 2019

5. The effect of access to protected water on welfare of rural households

Daily drinking water use amounted to 11.6 litres for treatment group while it was 10.4 litres for control group at the baseline in 2016 (see Table 16). In a two-month recall period, treatment households made about 21 trips to collect water while control households made 23 trips. Average travel time and in line waiting time to fetch drinking water are found to be higher for those in the treatment group in 2016. The treatment and control groups in access to water in 2016 were comparable with a slight advantage to the control group in terms of ease of access to a little less water.

Table 16: Difference between treated and control households in access to water supply in 2016

	Treatment (a)	Control (b)	Diff.	
			(a)-(b)	p-value
Average amount of drinking water consumed in a day (in litres)	11.6	10.4	1.2	0.2169
Average number of trips to collect drinking water in the last two months	20.5	22.8	-2.3	0.0912
Average travel time to fetch drinking water from the primary source (in minutes)	39.8	32.7	7.1	0.0799
Average in line waiting time for getting drinking water from the primary source (in minutes)	58	44.2	13.8	0.0147
Percentage of households that faced difficulties to obtain drinking water in the last four weeks for:				

zero day	47.4	64.4	-17	0.041
1 to 4 days	20.5	15..2	5.3	
5 to 9 days	17.3	12.9	4.4	
10 to 19 days	11.5	4.6	6.9	
20 or above days	3.2	3	0.2	

Source: HH survey 2016

But households in the treatment group have better access to water supply in 2019. Average daily consumption of water for treated group was 15.7 liters while the corresponding amount for control group was 9.7 litters (see Table 17). This difference in water consumption size between the two groups is statistically significant at 1% level of significance. This is a significant change as compared to the baseline survey. Moreover, after the intervention the number of trips made to fetch water from the main source is found to be less for those households in the intervention category. To fetch water from the primary source, people in the treatment group had to travel for about 37 minutes and those in the comparison group travel for around 44 minutes. The difference in travel time between the two groups is statistically significant (p=0.0432). This was not the case for the baseline survey. On the other hand, the average in line waiting time to collect water from the sources is found to be higher for treatment group but this is not found to be statistically significant even at 10% level of significance.

Table 17: Difference between treated and control households in access to water supply in 2019

	Treatment (a)	Control (b)	Diff.	
			(a)-(b)	p-value
Average size of drinking water consumed in a day (in litres)	15.7	9.7	6	0
Average number of trips to collect drinking water in the last two months[4]	15.4	15.8	-0.44	0.5325
Average travel time to fetch drinking water from the primary source (in minutes)	36.8	43.7	-6.9	0.0432
Average in line waiting time for getting drinking water from the primary source (in minutes)	62.7	50.9	11.8	0.1686
Percentage of households that faced difficulties to obtain drinking water in the last four weeks for:				
zero day	57.9	87.5	-29.6	0
1 to 4 days	21.3	10	11.3	
5 to 9 days	8.2	0	8.2	
10 to 19 days	12	1.3	10.7	

[4] Outlier values of reporting more than 50 times of collecting drinking water in the last two weeks are excluded. An independent samples t-test was used to compare the average outcomes between treatment and control households while a chi-square test was used to see if there is a relationship between the number of days the households faced difficulties in obtaining water and treatment states.

20 or above days	0.6	1.3	-0.7	

Source: HH survey 2019

One of the measures of access to water supply is lack of water when it is in need. The study shows that households in the intervention group faced more challenges in obtaining drinking water as compared to control households. In 2019, 87.5% of households in the control group did not face any difficulties to obtain drinking water in a one-month recall period. The corresponding figure for households in the treatment category was 58% (Table 18). The variations in the distribution of number of days with difficulties in accessing water is statistically significant between treatment and control group (p=0.000). This is the same as that of the baseline result with significant increase during the follow up survey. The possible reason for a greater challenge among the treatment group is that households in this category used protected drinking water which requires adequate water reservoir, distribution network and capacity. Thus reliability of water supply is again found to be negatively correlated with water safety.

Table 18: Difference in difference effects on access to water supply outcomes, 2016 and 2019

	Diff-in-diff estimate	Robust Stand Error	P-values
Average size of drinking water actually use in a day (in liter)	4.865545	1.261175	0
Average number of trips to collect drinking water in the last two months	-4.821688	2.512494	0.059
Average travel time to fetch drinking water from the primary source (in minutes)	-13.9765	5.026315	0.006
Average in line waiting time for getting drinking water from the primary source (in minutes)	-2.123291	8.079884	0.793

Source: HH surveys, conducted in 2016 and 2019

The difference in difference analysis based on the panel data indicates significant variations in water supply between treatment and control groups. For instance, treatment households consumed 4 litres more water per day as compared to those in the control group. Households in the intervention group also travelled 4 trips less to collect water in two months (p=0.000). It also took for them 13 minutes less time to fetch water from primary sources (Table 18). However, waiting time to get drinking water does not significantly differ between the two groups. This evidence in general indicates that interventions which increase provision of protected water sources may increase average consumption and reduce water collection travel time, though reliability of supply may diminish.

Effect on health indicators

Unsafe water is a risk factor for diarrhea occurrence. This study compares episode of diarrhea between treatment and control groups. In 2016, about 5% of sample individuals faced episode of diarrhea in 2-week recall periods (see Table 19). Among household members, experience of diarrhea episode was relatively more common among children under 5 years. For instance, 13% of children from control households suffered from diarrhea. This indicates that water borne disease is significant in rural Harar Region. In the baseline survey, there was no significant difference in prevalence of diarrhea episode based on access to safer drinking water.

Table 19: Experience of diarrhea episodes and treatment costs 2016

Percentage of household members experienced episode of diarrhea in the last two weeks by age and gender

	Treatment (a)	Control (b)	Diff.	
			(a)-(b)	p-value
Females aged 0-5	10.9	8.7	2.2	0.6438
Females aged 6-15	2.1	1.3	0.8	0.6964
Females aged 16-59	2.7	4.6	1.9	0.3947
Females aged 60 and above	0	0	--	--
Total female household members	*6.5*	*4.9*	*1.6*	*0.5666*
Males aged 0-5	6.9	12.9	-6	0.2546
Males aged 6-15	2.5	1.3	1.2	0.491
Males aged 16-59	0.7	2.6	-1.9	0.2258
Males aged 60 and above[5]	46.7	0	46.7	0.5638
Total male household members	*4.8*	*5.4*	*-0.6*	*0.8165*
Total household members	4.9	5.2	-0.3	0.856
Average water treatment cost in the last month (in Birr)	0.82	0.21	0.61	0.0951
Average amount spent on medical treatment for diarrhea in the last two weeks (in Birr)	104.8	106.8	-2	0.7976

Source: HH survey 2016

In 2019, occurrence of diarrhea episode was higher among household members in the control group as compared to those in the treatment group. For instance, about 28% of under-five males from control group were sick due to diarrhea whereas the corresponding figure for those in the treatment status was 11%. The difference in the share of illness due to diarrhea between the two groups is statistically significant at 1% level of significance (see Table 20). In the same period, diarrhea affected 21% of females aged below five in the comparison group but only 8% of females in the intervention group were suffered from this sickness.

Similarly, there is significantly more prevalence of diarrhea among females aged 16 to 59 years in the control group (p=0.0151). In general, episode of diarrhea affected 5% of household members in the intervention group and 14% of control individuals. Thus, access to safer drinking water has a significant effect assuming that substantial numbers of households received access to safer water in the Project period.

[5] Since the number of males aged 60 plus is 4 from treatment group and 15 from treatment group, the difference in prevalence of diarrhea is not statistically significant.

Table 20: Experience of diarrhea episodes and treatment costs 2019 Percentage of household members experienced episode of diarrhea in the last two weeks by age and gender				
	Treatment (a)	Control (b)	Diff.	
			(a)-(b)	p-value
Females aged 0-5	8	20.6	-12.6	0.0311
Females aged 6-15	4.5	7.8	-3.3	0.3161
Females aged 16-59	2.8	9.6	-6.8	0.0151
Females aged 60 and above	0	0	--	--
Total female household members	*5.4*	*13*	*-7.6*	*0.0052*
Males aged 0-5	10.5	27.6	-17.1	0.0048
Males aged 6-15	4.7	7.1	-2.4	0.5173
Males aged 16-59	0.9	3.6	-2.7	0.1254
Males aged 60 and above	8.3	--	--	--
Total male household members	*4.4*	*11.3*	*-6.9*	*0.0014*
Total household members	4.7	13.8	-9.1	0
Average water treatment cost in the last month (in Birr)[6]	6.27	45	-38.73	--
Average amount spent on medical treatment for diarrhea in the last two weeks (in Birr)	121.83	132.91	-11.08	0.5176

Source: HH survey 2019

Households were also asked how much money was paid for water treatment. It is found out that the average treatment cost for intervention group was Birr 6.3 while for the control group it was Birr 45 in 2019 (see Table 21). This implies treatment cost is smaller for households which use drinking water from protected sources. It should be also noted that only one household from treatment group reported payment for water treatment while 26 households reported payments in the control group. Treatment households also paid Birr 11 less for medical treatment of diarrhea as compared to control group.

Table 21: Difference in difference effects on health spending, 2016 and 2019

	Diff-in-diff estimate	Robust Stand Error	P-values
Average water treatment cost in the last month (in Birr)	-39.33994	2.010642	0
Average amount spent on medical treatment for diarrhea in the last two weeks (in Birr)	-9.030557	18.81828	0.632

Source: HH surveys, conducted in 2016 and 2019

The analysis based on longitudinal data indicates that not only episodes of illness but also treatment costs had reduced for those households using water from protected sources in 2019. It is found that the average water treatment cost in one-month recall period was less by Birr 39

[6] p-values for treatment cost is not predicted because only one household from the intervention group reported paying for water purification and, hence, standard error could not be estimated.

for treated group as compared to those in control group (see Table 21). Moreover, households in the intervention treatment group spent Birr 9 less on medical treatment for diarrhea.

Effect on education and work

This study also evaluates the effect of suffering from diarrhea on schooling and work times lost. The baseline study indicates that diarrhea prevented members of 1.6% of treatment households from going to work while the corresponding figure for those in the control group was 9.3% (see Table 22). The difference between the two groups that are affected by diarrhea is statistically significant (p=0.0645). However, it is found that the effect of diarrhea on absence from school and work on mean differences are not statistically significant, suggesting strong heterogeneity within the two groups.

Table 22: The difference between treated and control households in terms of absence from school and work in 2016

	Treatment (a)	Control (b)	Diff. (a)-(b)	Diff. p-value
Percentage of the households that diarrhea prevent members of the family from attending education	9.4	6.7	2.7	0.5835
If diarrhea affected attending school, how many days of education were lost in total in the last two weeks?	5.8	4.3	1.5	0.4838
Percentage of the households that diarrhea prevent members of the family working for cash in the last two weeks	1.6	9.3	-7.7	0.0645
If diarrhea prevents members of the family working for cash, how many days of work were on average lost in total in the last two weeks? [7]	4	3.3	0.7	--

Source: HH survey 2016

In 2019, the effect of diarrhea on missing classes for children and absence from work are less prevalent for those in the treatment group. The share of households in which diarrhea prevented their members from attending school is less by 19.5 percentage points for the treatment group (see Table 23). Similarly, the share of sample households whose family members were absent from work due to diarrhea was smaller by about 20 percentage points for treatment group. However, mean differences between treatment and control group are not statistically significant and therefore we cannot claim that the treatment group as a whole is better off in education and work outcomes.

[7] p-values for difference on the number of working days lost due to diarrhea is not predicted because only one household from treatment group reported lost of working days.

Table 23: The difference between treated and control households in terms of absence from schooling and work in 2019

	Treatment (a)	Control (b)	Diff.	
			(a)-(b)	p-value
Percentage of the households that diarrhea prevent members of the family from attending education	37	56.5	-19.5	0.1751
If diarrhea affected attending school, how many days of education were lost in total in the last two weeks?	4.3	4.1	0.2	0.8363
Percentage of the households that diarrhea prevent members of the family working for cash in the last two weeks	19.2	38.9	-19.7	0.1571
If diarrhea prevents members of the family working for cash, how many days of work were lost in total in the last two weeks?	2	4.1	-2.1	0.2413

Source: HH survey 2019

The panel data analysis using difference in difference approach does not show significant variations between control and treatment groups on several education and labour outcomes. It is found that, among those households affected by episodes of diarrhea, school absenteeism among treatment children was more by 10 days as compared to those from the control group (see Table 24). This could imply that once children suffer from diarrhea in intervention treatment households they suffer more seriously and access to improved water may not reduce illness duration and absent days from school.

Table 24: Difference in difference effects on education and work, 2016 and 2019

	Diff-in-diff estimate	Robust Stand Error	P-values
Percentage of the households that diarrhea prevent members of the family from attending education	-0.22193	0.148984	0.138
If diarrhea affected attending school, how many days of education were lost in total in the two weeks?	10.0899	4.65586	0.031
Percentage of the households that diarrhea prevent members of the family working for cash in the last two weeks	-0.12012	0.146721	0.414
If diarrhea prevent members of the family working for cash, how	4.159666	3.809031	0.275

many days of work were lost in total in the two weeks?			

Source: HH surveys, conducted in 2016 and 2019

6. Conclusion

This evaluation exercise attempts to understand the effect of improved water supply interventions on access to water, education, health, and financial outcomes in rural Harar Region. In order to do so, we used two rounds of panel data collected in 2016 (baseline survey) and in 2019 (follow up survey). These surveys cover 308 sample households and 90% of the households were re—surveyed during the follow up study. Access to drinking water from protected sources was used as proxy for exposure to the intervention. For analysis, the study used both descriptive statistics and difference in difference regression techniques.

The main sources of safe water in rural Harari region are collective hand pumps, communal taps and protected wells and households with these sources in 2019 were put in the intervention treatment group. Households put in the control group used unprotected water from rivers, ponds, unprotected springs, and a lake in 2019.

About 70% of the households faced seasonal variations in the availability of water in 2016. The share of households reported seasonal variations reduced to by 10 percentage points after three years in 2019. The problem of seasonal variation in 2019 is found to be more common among control households who relied on unprotected water sources.

The regression analysis indicates that households in the treatment group on average gets 4 litters more water as compared to those in the control group. Treatment households also made 5 trips less and 13 minutes less time per two-weeks to fetch water from the main sources for treatment households. This implies that those households not only get safe drinking water but also get water from closer sources. Access to water from closer sources is expected to improve people's well-being through increasing discretionary time available for other activities.

It is found that episodes of diarrhea are common, especially among children under 5 years old in rural Harar. The evaluation exercise suggests that access to safe water helps to reduce incidence of diarrhea among family members. The follow up survey indicates that about 4.7% of sample individuals from treated group suffered from diarrhea, while the corresponding figure for control group was 13.8%. The analysis indicates not only episodes of diarrhea, but also associated medical costs were less for those who used water from protected sources. On average, households in the intervention group also paid less for treatment as compared to control households.

The interpretation of this survey of rural households in Harar Region is challenging as the delay in design and implementation of Project activities forced us into a sub-optimal design in which locations and forms of Project interventions were unclear for a baseline survey. In the end, we were forced to view all households that had access to improved water supplies in 2019 as being 'treated'. This increased inaccuracy in our estimates of impact due to both a few households having improved water supplies before the baseline plus the possibility that some households received improvements in their water supply between 2016 and 2019 not due to Project activities.

Nevertheless, a tentative conclusion can be drawn that there had been improvements in access to safer drinking water with some gains in freed time for schooling and productive activity, and some financial benefits during the time of the Project interventions. Thus, there was a qualitative shift suggesting some positive value-added though the quantitative impact is uncertain. If only the cost of rural household interventions is considered then the case could be made that long term sustainable value added can be credited to the Netherlands' government FDW subsidy.

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