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Abstract

This paper combines geocoded subnational data on the location of water, sanitation and hygiene (WASH) aid projects in Uganda with nationally representative household-level panel survey data to evaluate the impact of WASH aid on access to water and on the burden of water collection. Specifically, it examines whether proximity to aid-funded WASH projects improves household access to improved water sources and reduces the time burden of water collection. Our results suggest that while aid-funded WASH projects increase household access to improved sources of water, households may also see the time burden of water collection increase, as they may need to travel longer distances and also experience longer wait times due to congestion at water service points. This is an indication that the supply of improved water sources is still insufficient relative to demand as measured by the population density.

Keywords

Aid

Water and sanitation

Africa

Uganda

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1. Introduction

Globally, 785 million people lack access to basic improved drinking water sources; 8 out of 10 of these live in rural areas and nearly half live in least developed countries.[4] Sub-Saharan Africa lags behind other developing regions in terms of access to basic water and sanitation: the region is home to half of those living without access to basic drinking water, and the number of people without access to safely managed drinking water increased from 531 million in 2015 to 747 million in 2017 (UN, 2021). The burden of water collection in terms of the time spent collecting water remains high for many: in 2017, 207 million people spent over 30 minutes a day collecting water; two-thirds of that number live in sub-Saharan Africa.[5] In most countries, this burden falls primarily on women and girls. Achieving Sustainable Development Goal 6 (SDG 6) of universal access to safe and affordable drinking water, adequate sanitation and hygiene by 2030 will require a four-fold increase in the current rate of progress (UN-Water, 2021).

However, inadequate financing of water and sanitation investments remains a major challenge to the achievement of SDG 6. According to the UN-Water GLAAS report released in 2017, the current level of water, sanitation and hygiene (WASH) financing is not sufficient to meet the SDG targets. National WASH budgets are inadequate to meet national WASH targets in 80 percent of reporting countries. Aid commitments to the entire WASH sector declined by about 20 percent between 2012-2015, while commitments to the water sub-sector dropped by 9 percent between 2017 and 2018. On the brighter side, disbursements of ODA to the water sector increased by 6 per cent between 2017-2018, including an increase of $346 million to sub-Saharan Africa for large

[4] Improved drinking water sources are defined by the WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP) as those that have the potential to deliver safe water by nature of their design and construction, and include water piped into the dwelling, public taps and standpipes, boreholes or tube wells, protected dug wells, protected springs, rainwater, and packaged or delivered water. Unimproved sources include unprotected wells or springs and water collected directly from a river, dam, lake, stream or irrigation canal. The JMP defines three categories of improved drinking water sources – limited, basic and safely managed. If water collection from an improved source exceeds 30 minutes it will be categorized as a limited service. If water collection takes 30 minutes or less, it is categorized as a basic service. To be classified as safely managed, the improved water source must meet three criteria: it should be accessible on premises, water should be available when needed, and the water supplied should be free from contamination. In 2017, 2.2 billion people lacked access to safely managed drinking water. These distinctions highlight the importance of analyzing the impact of aid on the burden of water collection. Source: https://washdata.org/monitoring/drinking-water

[5] https://washdata.org/monitoring/drinking-water

drinking water systems and water sector policy and administrative management. At the same time, the gap between ODA commitments to the WASH sector and actual disbursements to the sector grew to over USD 2.6 billion in 2019 from USD 100 million in 2016.[6]

Clearly, there is a need for a radical increase in global financing of water and sanitation investments if SDG Goal 6 is to be met by 2030. Given the proportion of countries that lack sufficient domestic resources to meet the financing requirements for achieving SDG6, most of this must come in the form of increased development assistance to the WASH sector. In order to justify targeting more resources to water and sanitation, aid donors need more evidence on the effectiveness of WASH aid in improving access to water and sanitation in recipient countries. This is particularly true for Sub-Saharan Africa. Although the region received the largest share of ODA disbursements for the water sector of any SDG region (34%) aid to the WASH sector is still less than 5% of total aid disbursements to the region.[7] The question of whether increasing ODA to the WASH sector will result in improved outcomes in the sector remains especially important, both for the region as a whole, and for individual countries within the region.

Economists have devoted relatively less attention to the question of aid effectiveness in the WASH sector than they have to aid effectiveness in other sectors such as health, and most studies so far have relied on macro level data and cross-country analysis (see Gopalan and Rajan, 2016; Ndikumana and Pickbourn, 2017 for detailed reviews of this literature) Empirical evidence on the effectiveness of WASH aid in increasing access to water and sanitation services from cross-country studies has been mixed, and even those studies that find evidence of a positive impact of WASH aid on access to these services also suggest that there is significant cross-country variation in the effectiveness of WASH (Ndikumana and Pickbourn, 2017). This, of course, is not surprising, as cross-country studies typically fail to control for heterogeneity across countries and confirms the need for research at the sub-national level to assess and quantify the effectiveness of WASH aid.

[6] Source: https://www.unwater.org/water-facts/financing/
[7] Source: https://www.unwater.org/water-facts/financing/

The analysis of aid effectiveness at the sub-national level offers several advantages over cross-country studies. For one thing, aid is typically allocated to fund specific projects in particular countries. The impact of these projects is likely to be highly localized while the effect on aggregate outcomes may be negligible (Dreher and Lohmann, 2015). For conceptual and empirical reasons, therefore, the effectiveness of aid should be examined at the point of the intervention (Pickbourn and Ndikumana, 2013). Furthermore, sub-national studies using household surveys can provide information on measures of aid effectiveness that may not be available in more aggregated datasets. For example, although aggregate data on access to water is available for most countries, data on the time burden of water collection at the national level is less readily available. In addition, exploiting sub-national data on the location of aid projects in combination with comprehensive household surveys allows researchers to use quasi-experimental techniques to gauge the impact of aid on outcomes of interest at the micro-level by comparing these outcomes across subnational locations that receive aid projects and those that do not (Odokonyero et al., 2018)). From a policy standpoint, cross-country studies provide only an estimate of the average effect of aid across very different countries; policy decisions about where and how to allocate aid should be based on far more granular evidence that can only be obtained from subnational studies.

This paper combines geocoded subnational data on the location of WASH aid projects in Uganda with nationally representative household-level panel survey data to evaluate the impact of WASH aid on access to water and on the burden of water collection in that country. Specifically, it examines whether proximity to aid-funded WASH projects improves household access to these services and reduces the time burden of water collection. Unlike earlier studies that define access to only in terms of the type of water source, access to water in this paper is evaluated along three dimensions: access to an improved water source, travel time to the primary water source and waiting time at the primary water source.

Uganda is an interesting case study for several reasons. The country has made progress in increasing access to water and sanitation, but it still faces major challenges. Since 2000, the share of the population with access to basic water services has increased from 24% to 39%; however, significant rural-urban disparities remain, and over 60 percent of the population spends more than 30 minutes on water collection (see Appendix Table A1). Worryingly, the share of the budget devoted to the water and sanitation sector declined from 7.9% in 2002-03 to 2.4% in 2008-09

(Salami et al., 2014). Funding to the sector as a share of the national budget has continued to lag behind other sectors, averaging 2.9 percent between 2015-2018 (Burr, 2019). This was due in part to a steady decline in WASH aid as a share of total aid from about 13% in 1995 to about 5% in 2008, even as total aid to the country remained fairly constant, reflecting weak donor support for the sector (Burr, 2019, p. 305).This trend of declining development partner support for the WASH sector has continued to the present, and household expenditure on water and sanitation services remains the largest contributor to overall sector financing. The government's Strategic Sector Investment Plan (SSIP) estimates that a WASH investment of USD 935 million a year is required to meet the SDG targets of universal access to safely managed water and sanitation by 2030: this is over three times the current level of investment in WASH service provision (Burr, 2019). Given the size of the financing gap in the WASH sector in Uganda, the question of whether increased aid to the sector can help increase population access to water and reduce the burden of water collection remains highly relevant.

We use a difference-in-differences approach with panel data fixed-effects regressions to examine the effects of proximity to aid-funded WASH projects on three measures of access to water: access to an improved water source, waiting time at an improved water source, and travel time to an improved water source. This approach allows us to minimize estimation biases that may arise from unobserved heterogeneity across households. One concern is that the allocation of aid projects may not be random, which may bias the results. To account for this potential bias, we estimate the model using an inverse probability weighted difference-in-differences (IPW-DID) estimator. The IPW-DID uses a logistic propensity score model for the probability of being in the treated group, and ensures that the treatment and control groups include households that are similar before the treatment across a range of variables that are assumed to determine the probability of treatment. This study makes a contribution to the growing literature on the effectiveness of aid allocated to specific sectors at the subnational level by expanding our understanding of sub-national variations in aid effectiveness in the water and sanitation sector.

2. Related literature

Research on the effectiveness of aid targeted to water and sanitation (WASH aid) has been relatively limited and consists primarily of cross-country studies which have yielded mixed results.

Using OLS regression analysis of cross-sectional data on public service production functions in 110 developing countries, Wolf (2007)finds that the share of total aid committed to the water and sanitation sector in 2000 has no impact on access to sanitation, and a negative impact on access to water in 2002. In contrast, using Spearman's rank correlation coefficients between WASH aid received and access to these services in a sample of 48 countries, Botting et al. (2010) find that low-income countries receiving the most aid to the water and sanitation sector are 4-18 times more likely than countries in the lowest tercile of foreign aid receipts to achieve greater gains in access to water over the period 2002-2006. However, this effect disappears when they control for GDP, public health expenditure and land area. Using OLS regressions on household-level data from 31 cities in sub-Saharan Africa, Hopewell and Graham (2014) find no significant association between ODA allocated to large water and sanitation systems at the national level over 2000-2010 and urban household access to water and sanitation, although they do find a negative and significant association between their measure of aid and the prevalence of open defecation.

More recent studies have addressed some of the major shortcomings of earlier work by paying attention to possible endogeneity of aid allocation, the effects of time-invariant country-specific variables on aid effectiveness and the likelihood of non-linearities in the relationship between WASH aid and access to WASH services. Again, the conclusions have been mixed. Using fixed-effects regressions on panel data covering 20 years and 114 countries, Bain et al. (2013) do not find any significant effect of aid disbursements to water and sanitation on improved water and sanitation coverage over the period 2000-2010. In contrast, J Wayland (2013) uses fixed-effects regressions on panel data covering 50 years and 133 countries and finds a positive association between WASH aid commitments and access to improved water sources. Using generalized methods of moments (GMM) and fixed effects regressions on panel data from a sample of 139 middle- and low-income countries, Gopalan and Rajan (2016) find that gross aid disbursements over the 2002-2012 period are associated with increases in population access to both water and sanitation, especially in rural areas. They also find that aid disbursements are effective only in lower middle-income countries, but not in low-income or upper middle-income countries. Using similar techniques, but focusing on a sample of 29 countries in sub-Saharan Africa, Ndikumana and Pickbourn (2017) find that over the period 1990-2010, increased aid to the WASH sector as a share of GDP was associated with increases in rural access to improved sources of sanitation and increases in rural and urban access to improved sources of water. Their results also indicate substantial cross-country variation in the impact of aid on access to water and sanitation, suggesting that the effect of aid on access to water and sanitation may vary across countries based on country-specific circumstances, and pointing to the need for sub-national analysis to better understand the within-country effects of aid.

The use of sub-national data on the location of aid projects, in combination with household surveys has gained traction in the aid effectiveness literature. Studies of aid effectiveness that take this approach include Dreher and Lohmann (2015) who find a positive association between aid and development and Van Weezel (2015) who finds evidence that aid is associated with reductions in conflict. Studies that focus on aid and health outcomes find that health aid is associated with reductions in diarrhea prevalence (De and Becker, 2015) reductions in malaria prevalence (Marty et al., 2017), reductions in neonatal, infant and child mortality (Kotsadam et al., 2018; Wayoro and Ndikumana, 2020); and in the productivity burden of disease (Odokonyero et al., 2018).

To date, there have been relatively few attempts to extend this approach to the study of aid effectiveness in the water and sanitation sector at the subnational level. Using propensity score matching and generalized propensity score matching techniques, (J. Wayland, 2019) finds that households located near WASH aid projects in Malawi are significantly more likely to report using improved sources of drinking water and sanitation, although the impact is constrained by water availability, remoteness and household income level. The impact of WASH aid projects on the burden of water collection likewise remains relatively understudied. A handful of studies using cross-sectional village-level data in Nigeria and Mozambique suggest that having better access to water results in substantial time savings of between 30 minutes to 5 hours (Blum et al., 1990; Cairncross and Cuff, 1987). Devoto et al. (2012) find that urban households in Morocco that switched from a public water source to a private water source save 27 minutes per day, while Gross et al. (2018) find that rural households in Benin spent up to 41 minutes less per day on water collection as a result of the provision of new public water sources, although water collection still took up to 2 hours per day as households increased their demand for water. Our study adds to this nascent literature by assessing the impact of aid to the WASH sector on household access to water and on the burden of collecting water in Uganda over the period 2005-2016.

3. Data sources and stylized facts

The primary data sources used in this study consist of six waves of the Uganda National Panel Survey -provided by the Uganda Bureau of Statistics and the AidData Uganda AIMS Geocoded Research Release Version 1.4.1 maintained by the Global Research Institute at William & Mary (AidData, 2016) .

The household survey data include the waves of 2005, 2009, 2010-2011, 2011-2012, 2013-2014, and 2015-2016. These surveys contain information about household composition and characteristics, resources, health, and access to various services, including water and sanitation. Households are linked across survey waves with a unique identifier for the household. Due to changes in response codes across the surveys, relevant items were recoded to reflect as closely as possible the responses in the 2015-2016 survey wave. Table A2 in the Appendix shows the questionnaire for the survey items used in the analysis and how these items were coded.

While the 2011-2012 survey contains locational data, this data was anonymized by adding random error components to the longitude and latitude. Since such adjustments could cause matching errors in our analysis, confidential exact locational data for the households was obtained directly from the Uganda Bureau of Statistics. This data was provided for the most recent survey wave, so households are assumed to have stayed in the same location across survey waves. Locational data is merged with the household data by matching villages within a given district and parish.

The geographically referenced data on aid-funded WASH projects is obtained from AidData and includes all geocoded WASH projects from Uganda's Aid Management Platform. Although it is possible that this data may underestimate the total amount of aid received for water and sanitation, this is the only source of georeferenced aid data currently available. AidData codes each project with a geographic precision code which references the spatial coverage of the project; i.e., whether the project covers the entire country, a particular region, district, or village (Table A3). Our analysis was limited to aid-funded WASH projects in 48 locations initiated between 2009 and 2014 with the most precise location information; i.e., those with a precision code of 1(Table A4).[8] In other words, the analysis includes only projects that were installed at a precise location (for example, the construction of a well or borehole near a school or the installation of a water-reservoir and water-supply pipelines in a specific village). WASH projects which are funded at a district or higher-level administrative area (i.e., those with precision codes 2 - 6) are not associated with exact geographical coordinates for each component of the project and are therefore excluded from our analysis. We code households as located within 1 km and 5 to 25 km radii from an aid-funded WASH project at 5 km intervals. The distance in kilometers from each household to each project is computed using the Vincenty Ellipsoid great-circle distance method (Vincenty, 1975).[9]

The majority of aid-funded WASH projects used for the analysis were completed between 2011 and 2013 (Figure 1). Figure 2 shows the distribution of these projects across the country, and Table 1 provides information on the amount of aid associated with these projects.

[8] This corresponds to 14 separate projects. AidData assigns a precision code of 1 if the geographical coordinates of the project correspond to an exact location, such as a populated place or a physical structure such as a school or health center. This code may also be used for locations that join other locations to create a line such as a road, power transmission line or railroad (Source: AidData GeoCoding Methodology v.2.0.2, June 2017; http://docs.aiddata.org/ad4/files/geocoding-methodology-updated-2017-06.pdf)

[9] The R documentation on this method can be found here: https://rdrr.io/cran/geosphere/man/distVincentyEllipsoid.html

Figure 1: Distribution of aid projects by year of completion

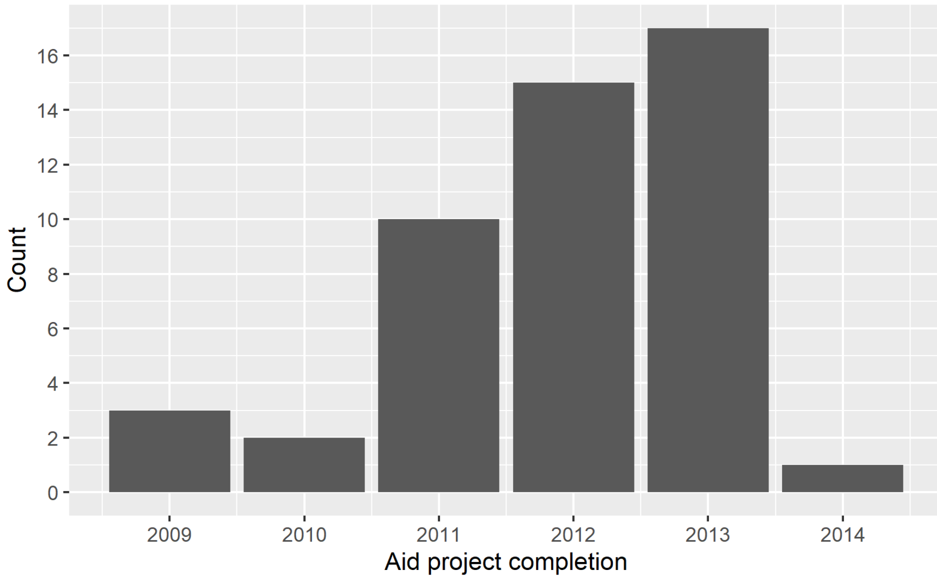
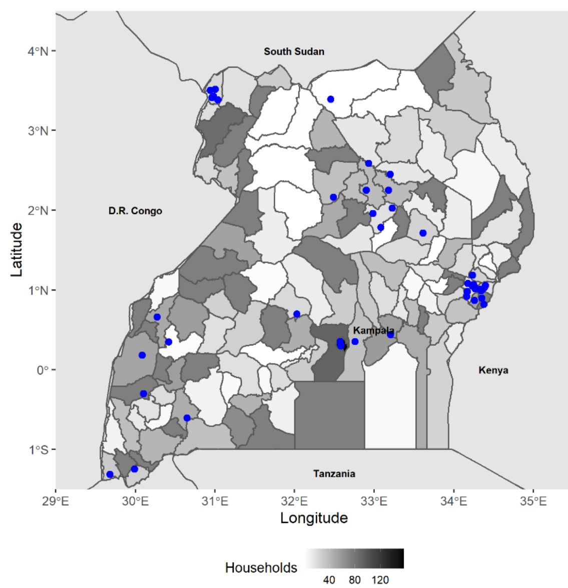


Figure 2: Location of water and sanitation projects



Source: Authors' construction

Table 1: Projects by year and funding

Project end year	Number of project locations	Avg. disbursements (USD)	Avg. commitments (USD)
2009	3	NA	1,014,095.2
2010	2	80,955.7	87,462.8
2011	10	5,325,122.9	61,634.8
2012	15	9,249,771.4	171,416,340.3
2013	17	7,146,719.8	NA
2014	1	NA	NA

Table 2 shows the proportion of households with access to improved water sources, by region and by survey wave. The Central and Western regions have the lowest coverage, while the Eastern and Northern regions have the highest coverage. Not surprisingly, access to improved water supply is highest in Kampala, the capital of Uganda.

Table 2: Household access to water by survey year (proportion of households with improved water)

Year	Kampala	Central	Eastern	Northern	Western
2005	0.9	0.6	0.8	0.7	0.6
2009	0.9	0.6	0.9	0.8	0.6
2010-2011	0.9	0.6	0.9	0.8	0.6
2011-2012	1	0.6	0.9	0.8	0.6
2013-2014	0.9	0.5	0.9	0.8	0.6
2015-2016	1	0.6	0.9	0.8	0.6

Table 3: Travel time to main water source by region and survey year (mean household travel time to water)

Year	Kampala	Central	Eastern	Northern	Western
2005	9.2	36.6	55.3	29	38.7
2009	8.4	27.8	25.1	31.1	32.2
2010-2011	8.5	28.9	21.9	25.6	29.8
2011-2012	8	29.3	18.7	23	28.7
2013-2014	8.7	25.4	23.4	23.7	30.4
2015-2016	6.5	24.7	20.4	22.8	25.6

On average, Ugandan households travel about 27 minutes to their main source of water, although this varies across regions, with households in the Central and Western regions having the longest travel times (Table 3). Households in Kampala have the shortest travel times, averaging just slightly under 10 minutes. Time spent waiting at the water source, which averages almost 15 minutes nationally, is lowest in the Central and Western regions, and highest in the Eastern and Northern regions (Table 4).

Table 4: Waiting time to main water source (mean household waiting time for water)

Year	Kampala	Central	Eastern	Northern	Western
2005	10.4	16.9	30.9	43.4	20.1
2009	6.6	12	28.2	30.1	9.1
2010-2011	4.6	10.7	21.6	23.8	5.9
2011-2012	6	9.5	14.3	15.3	5.4
2013-2014	5.2	8.5	10.8	12.4	6
2015-2016	3.7	6.3	10.9	12.5	4.8

Table 5: Distance to closest WASH project by region

Region	Average minimum distance to closest project (km)[10]
Kampala	6.7
Central	49.9
Eastern	31.6
Northern	57
Western	39.5

Table 5 shows the average minimum distance between households and the nearest project in each region. The average minimum distance is lowest in Kampala and highest in the Northern Region.

[10] The table reports the average minimum distance of households across these years. For example, if a household is 0.5 km to a 2009 project, 10km to a 2010 project, etc., the minimum of these figures will be the closest distance to an aid project at any point. We then compute the regional average across households.

4. Empirical model

We examine the relationship between spatial proximity to aid-funded WASH projects and household access to water by focusing on three separate outcomes that capture a household's access to water as well as the burden of water collection on the household: whether or not a household had access to an improved water source, the time taken to travel to the water source, and the time spent waiting at the water source. We are interested in determining whether households located within a given radius of an aid-funded WASH project have greater access to improved water or a lower burden of water collection compared to households that fall outside this radius.

We use a difference-in-differences (DID) with fixed effects estimation method to examine the impact of WASH aid on access to water and sanitation. The full DID model is as follows:

$$W_{i,t} = \beta_0 + \beta_1 . D + \boldsymbol{X}_{i,t}\Gamma + \gamma_j + \delta_t + \varepsilon_{i,t} \qquad \text{(Equation 1)}$$

where *i* refers to a household and *t* is time (a binary variable that is 0 in the baseline year and 1 in the endline year). The staggered treatment design implies that the pre- and post-treatment periods vary according to the date of completion of each project. For any given project, the pre-treatment period covers all surveys conducted before the completion year, and the post-treatment period covers all surveys conducted after the completion year. The dependent variable $W_{i,t}$ takes three different forms: a binary variable that is equal to 1 if the household has access to an improved water source at time t; a continuous variable that measures the travel time in minutes to the primary water source; and a continuous variable that measures waiting time in minutes at the primary water source. D is the treatment variable and is equal to 1 if the household lives within a specified distance from an aid-funded WASH project after the project's completion date. $X_{i,t}$ is a vector of household level variables that could affect a household's access to water as well as the burden of water collection. These include household size, the education and gender of the household head, whether or not the household is urban and the household's ability to pay for water services, as measured by household wealth and receipts of remittances as proxies for household income. The correlation coefficients among the wealth variables are provided in Table A5. Γ is a vector of coefficients, γ_j and δ_t are district and survey year fixed effects, respectively, and $\mathcal{E}$ is a random error term.

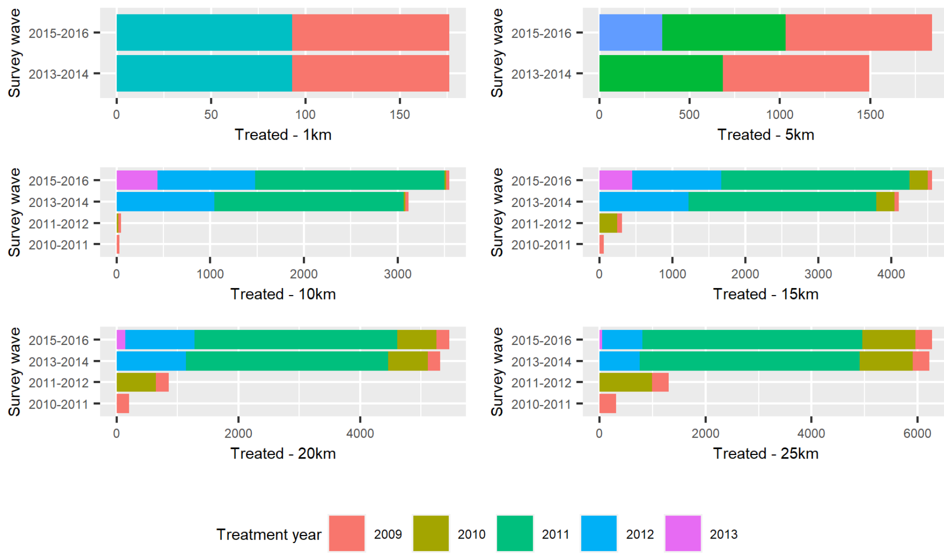
We first estimate the basic model in equation 1 (without the control variables) using a simple DID estimator on the full sample of households. We then estimate the model with the full set of controls. The indicators of household wealth and remittance receipts are each entered into the regressions separately.[11] Finally, we estimate the model using an inverse probability weighted difference-in-differences (IPWDID) estimator. This estimator uses a logistic propensity score model for the probability of being in the treated group, and controls for the non-randomness of aid allocation by ensuring that the treatment and control groups consist of households that are similar before the treatment across a range of variables that are assumed to determine the probability of treatment (Abadie, 2005; Sant'Anna and Zhao, 2020). Because aid donors may locate aid projects based on a variety of considerations that we cannot observe, differences in outcomes between households located within a given radius of an aid project and those outside this radius may be due to unobserved differences between the two groups, rather than to the impact of the project *per se*. The IPW-DID estimator minimizes the effect of this potential source of bias by weighting each household according to the probability of being treated. Formally, the weight is 1/(1 – p) where p is the probability of being treated.

Households are coded as treated if they fall within the relevant radius (e.g., 1km, 5 km and so on) and the project is completed before a given survey wave starts. For example, a household which is within 10 kilometers of an aid project that was completed in 2009 would be considered treated in the 2010-2011 household survey and in subsequent editions of the household survey. Figure 3 shows the number of treated households for each survey wave. The control groups include all households that fall outside the relevant radius. We do this to avoid making arbitrary determinations about which households to exclude from the control groups.[12]

[11] The correlation between these indicators is very low as can be seen in Table A5, implying low multicollinearity bias when they are entered into the regression simultaneously.

[12] We are aware that this could result in a potential underestimation of the effect of aid if there are spillover effects. For example, the comparison group for households that fall within a 1 km radius of a project includes households that fall within a radius of more than 1km from the project. Households close to the threshold could also benefit

Figure 3: Treated households by survey wave



5. Results

Access to improved water sources

The results from basic DID estimations on the full sample (Tables 6) suggest that proximity to a completed aid-funded WASH project increases access to improved water sources for households located within 5 to 25 km radii from the project. The absence of a significant impact on households located within 1 km of the project could be partly the result of our decision not to exclude households that fall just outside the 1km threshold from the control group or to the small number of treated units that fall within this radius.

from the project, in which case the effect size of the project would be underestimated. However, we choose to err on the side of caution, since the decision of which households to exclude from the control group would be necessarily arbitrary – should we exclude households that fall within 1 – 5 km, or 1- 10 km, or 1 – 3 km? This should be borne in mind when interpreting the results of our analysis.

Table 6: Improved water, basic DID results

	(1) 1km	(2) 5km	(3) 10km	(4) 15km	(5) 20km	(6) 25km
Aid project	0.044	0.072^{***}	0.075^{***}	0.066^{***}	0.062^{***}	0.059^{***}
	(0.107)	(0.025)	(0.021)	(0.020)	(0.020)	(0.020)
Observations	42615	42615	42615	42615	42615	42615

Standard errors clustered at the household level in parentheses
All models include district and survey year fixed effects.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Table 7: Improved water, full DID results

	(1) 1km	(2) 5km	(3) 10km	(4) 15km	(5) 20km	(6) 25km
Aid project	0.026	0.043	0.056^{**}	0.050^{**}	0.053^{**}	0.049^{**}
	(0.101)	(0.026)	(0.022)	(0.022)	(0.021)	(0.021)
Size	0.001	0.001	0.001	0.001	0.001	0.001
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Education	0.031^{**}	0.031^{**}	0.031^{**}	0.031^{**}	0.031^{**}	0.031^{**}
	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
Female	0.008	0.008	0.008	0.008	0.008	0.008
	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)
Urban	0.137^{***}	0.135^{***}	0.133^{***}	0.134^{***}	0.134^{***}	0.134^{***}
	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)
Remittances	0.013	0.013	0.011	0.011	0.011	0.012
	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)
Roof	0.059^{***}	0.059^{***}	0.060^{***}	0.060^{***}	0.060^{***}	0.060^{***}
	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)
Wall	0.109	0.111	0.115	0.115	0.117	0.117
	(0.104)	(0.104)	(0.104)	(0.105)	(0.104)	(0.104)
Generator	-0.093^{*}	-0.092^{*}	-0.090	-0.091	-0.091	-0.093^{*}
	(0.055)	(0.055)	(0.055)	(0.055)	(0.055)	(0.055)
Land	0.048^{***}	0.047^{***}	0.047^{***}	0.047^{***}	0.048^{***}	0.048^{***}
	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)
Observations	34770	34770	34770	34770	34770	34770

Standard errors clustered at the household level in parentheses
All models include district and survey year fixed effects.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

The results from DID estimations on the full sample with the full set of household level controls suggests that households within 10 to 25 km radii of a completed WASH project benefit from increased access to improved water sources (Table 7). Having a household head who completed primary school, being located in an urban area, having a metal roof or owning land are all positively associated with household access to water. Owning a generator is negatively associated with access to an improved water source. This result is consistent with a scenario in which households live in communities that are deprived of both electricity and water.

Table 8 presents the results for the IPW-DID estimation. These results are slightly different from the basic DID and the DID estimates with the full set of controls. Location within 1 km of an aid-funded WASH project appears to increase household access to improved water, although the effect is not strongly significant. The effect disappears for households located within 5 km and 10 km radii of a project and reappears for households located within 15 km and 20 km radii. This result can be explained by the presence of large water system projects, the impacts of which are not limited only to nearby households.[13]

Table 8: Improved water, IPW DID results

	(1) 1km	(2) 5km	(3) 10km	(4) 15km	(5) 20km	(6) 25km
Aid project	0.184*	0.053	0.034	0.055*	0.057**	0.044*
	(0.105)	(0.050)	(0.033)	(0.030)	(0.027)	(0.025)
Size	0.001	0.001	0.001	0.000	0.001	0.000
	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)
Education	0.016	0.047*	0.067**	0.072***	0.067***	0.067***
	(0.035)	(0.029)	(0.026)	(0.025)	(0.024)	(0.023)
Female	-0.007	-0.036	-0.030	-0.023	-0.013	-0.015
	(0.038)	(0.035)	(0.034)	(0.031)	(0.028)	(0.027)
Urban	0.391***	0.329***	0.264***	0.248***	0.222***	0.203***
	(0.144)	(0.048)	(0.040)	(0.038)	(0.036)	(0.034)
Remittances	-0.142**	-0.016	0.029	0.029	0.035	0.037
	(0.060)	(0.056)	(0.046)	(0.039)	(0.034)	(0.032)
Roof	0.021	0.023	0.048	0.052	0.059*	0.049*
	(0.036)	(0.040)	(0.035)	(0.033)	(0.030)	(0.029)
Generator	-0.128*	-0.110	-0.112*	-0.126*	-0.146*	-0.146*
	(0.072)	(0.068)	(0.068)	(0.068)	(0.075)	(0.075)
Land	-0.002	0.041	0.063**	0.065**	0.065***	0.065***
	(0.043)	(0.038)	(0.032)	(0.027)	(0.025)	(0.024)
Observations	14429	15686	16980	18014	18952	19639

[13] Unlike boreholes, large water system projects are capable of providing water to distant households, but require additional infrastructure to connect households to the water main. It is conceivable that households located close to these projects may not benefit from the improved water supply, especially if they have to pay to be connected to the water services, while households further away can benefit if they are willing to incur the additional costs of connection.

Standard errors clustered at the household level in parentheses
Weighted regressions using IPW weights. All models include district and survey year fixed effects. Metal wall variable removed due to multi-collinearity.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Travel time to water sources

The baseline estimations for water travel time suggest that proximity to an aid-funded WASH project does not have a significant impact on the time households spend travelling to the primary source of water (Table 9). However, the results from the estimations with the household-level controls suggest that aid-funded WASH projects are associated with higher travel time to collect water after project completion, but only for households within a 5km radius (Table 10). The results suggest that these households spend about 3 minutes more traveling to the water source after the project is completed. This is compatible with a scenario in which households prefer better quality water and are willing to travel further for it. On average, urban households spend about 10 minutes less on traveling to the primary water source. Having an educated head or a female head or owning land are associated with lower travel times. Larger households appear to spend marginally more time traveling to collect water.

Table 9: Water travel time, basic DID results

	(1) 1km	(2) 5km	(3) 10km	(4) 15km	(5) 20km	(6) 25km
Aid project	-2.922	0.701	-1.251	-1.745	-1.571	-1.369
	(3.056)	(1.516)	(1.298)	(1.192)	(1.168)	(1.222)
Observations	38477	38477	38477	38477	38477	38477

Standard errors clustered at the household level in parentheses
All models include district and survey year fixed effects.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Table 10: Water travel time, full DID results

	(1) 1km	(2) 5km	(3) 10km	(4) 15km	(5) 20km	(6) 25km
Aid project	0.134	3.493^{**}	0.879	-0.482	-0.027	-1.344
	(3.509)	(1.598)	(1.358)	(1.259)	(1.229)	(1.338)
Size	0.521^{***}	0.522^{***}	0.521^{***}	0.521^{***}	0.521^{***}	0.520^{***}
	(0.149)	(0.148)	(0.148)	(0.149)	(0.149)	(0.149)
Education	-2.122^{**}	-2.142^{**}	-2.133^{**}	-2.120^{**}	-2.122^{**}	-2.113^{**}
	(0.977)	(0.977)	(0.977)	(0.977)	(0.977)	(0.977)
Female	-2.695^{**}	-2.648^{**}	-2.693^{**}	-2.696^{**}	-2.696^{**}	-2.688^{**}
	(1.094)	(1.093)	(1.094)	(1.093)	(1.093)	(1.093)
Urban	-10.065^{***}	-10.215^{***}	-10.132^{***}	-10.038^{***}	-10.063^{***}	-9.992^{***}
	(1.181)	(1.182)	(1.180)	(1.178)	(1.179)	(1.176)
Remittances	-1.559	-1.618	-1.584	-1.545	-1.558	-1.550
	(1.562)	(1.544)	(1.560)	(1.560)	(1.561)	(1.551)
Roof	-0.712	-0.716	-0.702	-0.722	-0.713	-0.740
	(1.429)	(1.429)	(1.429)	(1.428)	(1.428)	(1.428)
Wall	-3.568	-3.391	-3.487	-3.625	-3.573	-3.774
	(10.425)	(10.396)	(10.417)	(10.437)	(10.433)	(10.456)
Generator	3.506	3.556	3.535	3.504	3.506	3.552
	(4.404)	(4.411)	(4.394)	(4.404)	(4.405)	(4.398)
Land	-3.295^{**}	-3.358^{**}	-3.313^{**}	-3.287^{**}	-3.294^{**}	-3.303^{**}
	(1.634)	(1.635)	(1.636)	(1.635)	(1.633)	(1.631)
Observations	30954	30954	30954	30954	30954	30954

Standard errors clustered at the household level in parentheses
All models include district and survey year fixed effects.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

The results change quite dramatically, both in terms of magnitude and significance, when we use the IPW-DID estimator (Table 11).[14] Being located within 5 km to 20 km radius of a WASH project increases travel time by between 18 minutes (for households within10 km of a project) to over 60 minutes (for households within 5 km of a project). A reasonable interpretation is that when an improved water source is installed, households are willing to travel longer distances relative to their existing unimproved water sources. Regarding controls, wealthier households and urban households appear to spend less time travelling to collect water.

[14] Note that households located within a 1 km radius of an aid-funded WASH project are dropped from the IPW-DID analysis due to an insufficient number of observations upon which to compute the inverse probability weights. None of the units treated at 1km have both the outcome and pre-treatment values for the relevant variables.

Table 11: Water travel time, IPW DID results

	(1) 5km	(2) 10km	(3) 15km	(4) 20km	(5) 25km
Aid project	67.148***	18.385*	28.169*	44.553**	30.916
	(8.001)	(10.664)	(16.728)	(19.863)	(19.049)
Size	5.138***	1.791*	2.583**	3.573***	2.726**
	(0.934)	(1.021)	(1.249)	(1.324)	(1.263)
Education	9.465***	4.392	6.719**	7.697***	7.058**
	(3.636)	(4.033)	(2.895)	(2.153)	(2.844)
Female	10.083	2.818	6.538	9.934	5.367
	(12.734)	(5.521)	(6.850)	(6.763)	(6.642)
Urban	-23.610***	-19.418***	-20.618***	-21.843***	-20.918***
	(7.474)	(4.038)	(4.326)	(4.645)	(4.630)
Remittances	17.368	-2.957	0.421	3.151	1.252
	(13.277)	(4.226)	(6.114)	(7.907)	(6.330)
Roof	-22.382***	-1.213	-2.121	-4.033	-3.033
	(6.260)	(3.195)	(3.352)	(3.705)	(3.390)
Generator	-16.755	-0.169	3.240	5.913	3.432
	(12.927)	(7.675)	(7.817)	(8.465)	(7.698)
Land	-148.42***	-50.700*	-74.620**	-100.91***	-75.745**
	(6.955)	(29.173)	(35.141)	(32.631)	(34.853)
Observations	12999	13935	14938	15824	16507

Standard errors clustered at the household level in parentheses
Weighted regressions using IPW weights. All models include district and survey year fixed effects. Metal wall variable removed due to multi-collinearity.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Waiting time at water sources

The baseline estimation suggests that the amount of time that households spend waiting at a water source after project completion is greater for households located within 1 km (by about 11 minutes), 5 km (by about 6 minutes) and 10 km (by about 3 minutes) of aid-funded WASH projects (Tables 12). These results remain more or less the same when the full set of controls are included in the regression (Table 13). Similar to the case of travel time, these results suggest that households are willing to wait longer to fetch water from an improved source compared to pre-existing non-improved sources. This is an indication that the supply of improved water sources is still insufficient relative to demand as measured by the population density. The results for the control factors are also similar to those for improved water. Educated households and households in urban areas spend slightly less time waiting for water, while land-owning households spend slightly more time waiting for water.[15]

Table 12: Water waiting time, basic DID results

	(1) 1km	(2) 5km	(3) 10km	(4) 15km	(5) 20km	(6) 25km
Aid project	10.813**	5.756***	2.346*	1.814	1.396	-0.025
	(5.053)	(1.499)	(1.215)	(1.205)	(1.171)	(1.210)
Observations	38427	38427	38427	38427	38427	38427

Standard errors clustered at the household level in parentheses
All models include district and survey year fixed effects.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Table 13: Water waiting time, full DID results

	(1) 1km	(2) 5km	(3) 10km	(4) 15km	(5) 20km	(6) 25km
Aid project	10.933**	6.421***	2.838**	1.455	0.616	-1.024
	(5.255)	(1.602)	(1.330)	(1.320)	(1.271)	(1.339)
Size	0.204	0.199	0.197	0.197	0.197	0.196
	(0.161)	(0.161)	(0.162)	(0.162)	(0.162)	(0.162)
Education	-2.680***	-2.698***	-2.697***	-2.670**	-2.664**	-2.655**
	(1.036)	(1.036)	(1.039)	(1.037)	(1.037)	(1.037)
Female	0.237	0.292	0.213	0.204	0.202	0.210
	(0.973)	(0.972)	(0.976)	(0.976)	(0.975)	(0.975)
Urban	-4.623***	-4.873***	-4.813***	-4.674***	-4.630***	-4.538***
	(1.383)	(1.387)	(1.386)	(1.381)	(1.382)	(1.379)
Remittances	2.773	2.751	2.777	2.824	2.855	2.868
	(2.409)	(2.405)	(2.402)	(2.427)	(2.426)	(2.422)
Roof	0.597	0.595	0.633	0.630	0.613	0.577
	(1.490)	(1.488)	(1.492)	(1.497)	(1.497)	(1.496)
Wall	-7.108	-6.870	-6.931	-7.026	-7.112	-7.351
	(4.662)	(4.738)	(4.720)	(4.707)	(4.690)	(4.660)
Generator	-0.901	-0.825	-0.823	-0.911	-0.924	-0.882
	(3.336)	(3.326)	(3.348)	(3.344)	(3.338)	(3.329)
Land	1.879*	1.837*	1.892*	1.932*	1.952*	1.946*
	(1.064)	(1.065)	(1.066)	(1.067)	(1.068)	(1.068)
Observations	30923	30923	30923	30923	30923	30923

Standard errors clustered at the household level in parentheses
All models include district and survey year fixed effects.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

[15] About 81 percent of the households in the sample that own non-agricultural land live in rural areas. This result is capturing the scarcity of improved water sources in the rural area.

Table 14 presents results from the IPW-DID estimation.[16] Households located within 5 km of a completed project spend about half an hour longer waiting for water. The difference in waiting time appears to decrease the further away the household is located from the project, with households located within a 20 km radius seeing the smallest increase in their water waiting time. This result is compatible with a scenario in which households located farther away from a project gain access to water and also see a reduction in the time spent waiting for water after the project is completed, either directly as a result of the project, or indirectly through reductions in the numbers of people using a particular source.

Table 14: Water waiting time, IPW DID results

	(1) 5km	(2) 10km	(3) 15km	(4) 20km	(5) 25km
Aid project	32.685***	7.789***	5.060*	3.951*	1.435
	(6.859)	(2.650)	(2.613)	(2.292)	(1.908)
Size	5.514***	1.019*	1.114*	0.905	0.590
	(0.993)	(0.595)	(0.647)	(0.558)	(0.376)
Education	-1.432	-5.327**	-4.839**	-4.684**	-3.242*
	(4.615)	(2.491)	(2.223)	(2.178)	(1.800)
Female	23.320**	3.978	3.600	2.172	2.663
	(11.823)	(3.831)	(2.557)	(2.185)	(2.023)
Urban	3.382	-6.724*	-8.861***	-9.435***	-8.202***
	(12.954)	(4.044)	(2.972)	(2.598)	(2.281)
Remittances	2.294	-3.941	-0.395	1.995	0.717
	(8.767)	(5.788)	(5.229)	(5.155)	(4.502)
Roof	-34.794***	-4.461	1.415	1.331	1.279
	(12.974)	(4.440)	(3.342)	(3.064)	(2.826)
Generator	15.253	15.205	2.995	4.631	3.389
	(16.933)	(13.673)	(7.167)	(8.232)	(6.172)
Land	-17.095***	1.813	0.033	0.152	1.733
	(5.305)	(2.180)	(2.348)	(2.370)	(1.617)
Observations	12922	13858	14861	15747	16430

Standard errors clustered at the household level in parentheses
Weighted regressions using IPW weights. All models include district and survey year fixed effects. Metal wall variable removed due to multi-collinearity.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

[16] Households located within a 1 km radius of an aid-funded WASH project are dropped from the IPW-DID analysis due to an insufficient number of observations upon which to compute the inverse probability weights.

6. Conclusion

This paper sought to investigate the impact of foreign aid on access to improved water at the household level in Uganda using geocoded subnational data on the location of WASH aid projects combined with data from nationally representative household-level panel surveys. The paper adds to the growing body of work that analyzes aid effectiveness at the subnational level by extending this approach to the water sector. It also adds to the literature on aid effectiveness in the WASH sector by examining the impact of aid funded projects on two dimensions of access to water – the type of water source, and the time-burden of water collection.

The results suggest that while aid-funded WASH projects increase household access to improved water sources, households may also see the burden of water collection increase, as they may need to travel longer distances and also experience longer wait times. This may be due to increased demand for better quality water, but it also suggests that there is an unmet need for improved water sources. The distance travelled for water can be shortened if water sources are located closer to households while wait times can be reduced if the number of water sources is increased in line with the density of the served areas.

There are some limitations to the analysis presented here. Firstly, while AidData identifies the precise location of the project, details on the nature of the project at that location are often not available. While we could confirm that some of the projects constructed boreholes, for other projects, it was not possible to identify exactly what improved water infrastructure was constructed. Despite detailed data on the type of water source accessed in the survey data, this means we could not directly confirm that a treated households' improved access to water was due to their accessing a specific aid project. Ideally, we would be able to match survey responses on the type of water source accessed to the construction of the project.

Nevertheless, the results suggest that providing more water projects *and* locating them closer to households can help to increase household access to water and reduce the time burden of water collection.

References

AidData. (2016). UgandaAIMS_GeocodedResearchRelease_Level1_v1.4.1 geocoded dataset. Williamsburg, VA and Washington, DC: AidData.

Bain, R., et al. (2013). Universal Access to Drinking Water (Vol. 2013). Helsinki, Finland: UNU-WIDER.

Blum, D., et al. (1990). The Imo State (Nigeria) Drinking Water Supply and Sanitation Project, 1. Description of the project, evaluation methods, and impact on intervening variables. *Transactions of the Royal Society of Tropical Medicine and Hygiene, 84*(2), 309-315.

Botting, M. J., et al. (2010). Water and sanitation infrastructure for health: The impact of foreign aid. *Globalization and Health, 6*(1), 1-8. doi:10.1186/1744-8603-6-12

Burr, P. (2019). The state of WASH financing in Eastern and Southern Africa: Uganda Country Level Assessment.

Cairncross, S. and Cuff, J. L. (1987). Water use and health in Mueda, Mozambique. *Transactions of the Royal Society of Tropical Medicine and Hygiene, 81*(1), 51-54.

De, R. and Becker, C. (2015). The Foreign Aid Effectiveness Debate: Evidence from Malawi. AidData Working Paper #6. Williamsburg, VA: AidData at William & Mary.

Devoto, F., et al. (2012). Happiness on tap: Piped water adoption in urban Morocco. *American Economic Journal: Economic Policy, 4*(4), 68-99.

Dreher, A. and Lohmann, S. (2015). Aid and growth at the regional level. *Oxford Review of Economic Policy, 31*(3-4), 420-446. doi:doi:10.1093/oxrep/grv026

Gopalan, S. and Rajan, R. S. (2016). Has Foreign Aid Been Effective in the Water Supply and Sanitation Sector? Evidence from Panel Data. *World Development, 85*, 84-104.

Gross, E., et al. (2018). Women are walking and waiting for water: the time value of public water supply. *Economic Development and Cultural Change, 66*(3), 489-517.

Hopewell, M. R. and Graham, J. P. (2014). Trends in access to water supply and sanitation in 31 major sub-Saharan African cities: an analysis of DHS data from 2000 to 2012. *BMC Public Health, 14*(1), 1-12. doi:10.1186/1471-2458-14-208

Kotsadam, A., et al. (2018). Development aid and infant mortality. Micro-level evidence from Nigeria. *World Development, 105*, 59-69.

Marty, R., et al. (2017). Taking the health aid debate to the subnational level: the impact and allocation of foreign health aid in Malawi. *BMJ Global Health, 2*(1), e000129.

Ndikumana, L. and Pickbourn, L. (2017). The Impact of Foreign Aid Allocation on Access to Social Services in sub-Saharan Africa: The Case of Water and Sanitation. *World Development, 90*, 104-114.

Odokonyero, T., et al. (2018). The impact of aid on health outcomes in Uganda. *Health economics, 27*(4), 733-745.

Pickbourn, L. and Ndikumana, L. (2013). Impact of sectoral allocation of foreign aid on gender equity and human development. *WIDER Working Paper 2013/066*.

Salami, A. O., et al. (2014). Development aid and access to water and sanitation in Sub-Saharan Africa. *Water International, 39*(3), 294-314. doi:10.1080/02508060.2013.876570

UN-Water. (2021). *Summary Progress Update 2021 – SDG 6 – water and sanitation for all.* . Retrieved from Geneva, Switzerland.: https://www.unwater.org/publications/summary-progress-update-2021-sdg-6-water-and-sanitation-for-all/

UN. (2021). *The Sustainable Development Goals Report*. Retrieved from https://unstats.un.org/sdgs/report/2021/The-Sustainable-Development-Goals-Report-2021.pdf

Van Weezel, S. (2015). A Spatial Analysis of the Effect of Foreign Aid in Conflict Areas. AidData Working Paper #8. Williamsburg, VA: AidData at William & Mary.

Vincenty, T. (1975). Direct and inverse solutions of geodesics on the ellipsoid with application of nested equations. *Survey review, 23*(176), 88-93.

Wayland, J. (2013). *A Drop in the Bucket? The Effectiveness of Foreign Aid in the Water, Sanitation, and Hygiene (WASH) Sector* (Phd Master's Thesis), American University. Retrieved from http://hdl.handle.net/1961/16922

Wayland, J. (2019). Constraints on aid effectiveness in the water, sanitation, and hygiene (WASH) sector: evidence from Malawi. *African Geographical Review, 38*(2), 140-156.

Wayoro, D. and Ndikumana, L. (2020). Impact of development aid on infant mortality: Micro-level evidence from Côte d'Ivoire. *African Development Review, 32*(3), 432-445.

WHO/UNICEF. (2021). WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP) Global database

Wolf, S. (2007). Does Aid Improve Public Service Delivery? *Review of World Economics, 143*(4), 650-672.

Appendix

Table A1: Population access to water in Uganda

Water source/Population coverage in Uganda	**2000**	**2015**	**2020**	
Surface	14.4	6.9	4.7	
Unimproved	24.8	15.1	12.2	
Basic	24.2	35.6	39.2	
Limited	34.3	30.1	27.3	
Safely managed	2.3	12.2	16.6	
Improved (total)	60.8	77.9	83.1	
Type of water service	**Rural (2000)**	**Rural (2020)**	**Urban (2000)**	**Urban (2020)**
Surface	16.6	5.9	1.6	1.1
Unimproved	27.8	14.1	7.1	6.4
Basic	18.9	40.3	54.8	35.9
Limited	36.6	31.8	21.4	13.7
Safely managed	0.1	7.9	15.1	42.8

Source WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP) Global database **(WHO/UNICEF, 2021)**

Table A2: Variable definitions

Variable	Question	Coding
Household head primary education	What was the highest grade/class that [NAME] completed?	1 if the household head for a family completed primary school, 0 otherwise
Household head female	Sex	1 if the household head is female, 0 otherwise
Urban	-	1 if the household lives in an urban area, 0 otherwise
Remittances	Has the household received any income (in cash & in kind) from remittances from abroad in the past 12 months?	1 if the household has received any remittances from abroad, 0 otherwise
Metal roof	What is the major construction material of the roof?	1 if the household has an iron sheet or tin roof, 0 otherwise
Metal wall	What is the major construction material of the external wall?	1 if the household has iron or tin walls, 0 otherwise
Motor vehicle	Does any member of your household own a motor vehicle at present?	1 if the household owns a motor vehicle, 0 otherwise
Generator	Does any member of your household own a generator at present?	1 if the household owns a generator, 0 otherwise
Non-agricultural land	Does any member of your household own non-agricultural land at present?	1 if the household owns non-agricultural land, 0 otherwise
Improved water	What is the main source of water for drinking for your household?	1 if the household mainly receives water from one of the following sources: Piped water into dwelling, Piped water into yard, Public Taps, Borehole in yard/plot, Public borehole, Protected well/spring; 0 otherwise
Water travel time	How long does it take to collect the drinking water from the main source (to and from)?	Time in minutes
Water waiting time	How long does it take to collect the drinking water from the main source (waiting time)?	Time in minutes

Table A3: Water and Sanitation projects and project locations by precision code

	Precision code	Num. projects	Num. project locations
1	Exact location	14	48
2	Approximate location	4	7
3	District	23	205
4	Region	2	4
5	Geographic feature	2	4
6	National	5	5
7	National (Ministry/Institution)	6	6

Table A4. Water and Sanitation projects in Uganda with precise locations: Commitments and disbursement (USD)

Title	Number of locations	Commitments	Disbursements	Split-even commitments	Split-even disbursements
Emergency water supply and sanitary facilities for returning populations in Lira and Kitgum	3	1014095	Na	202819	Na
Integrated drylands development programme (IDDP)-support for the implementation of UNCCD in the context of TERAFRICA intiative	1	Na	Na	Na	Na
Kampala Urban Poor Sanitation project	3	11829269	11250217	3943090	3750072
National Environment Management Authority (NEMA)	9	285683348	15358697	31742594	1706522
Territorial approach to climate change	13	Na	98184	Na	5776
The project for improvement of access to safe water and sanitation in Kyakarafa parish, Kamwenge district	1	70283	61459	70283	61459
The project for improvement of access to safe water for returnees in Lira and Dokolo district	5	64436	58295	12887	11659
The project for improvement of access to safe water in 17 schools in Koboko district	5	35	86678	6	14446
The project for improvement of access to safe water in Bukomero town in Kiboga district	1	81792	71235	81792	71235
The project for improvement of access to safe water in Rubirizi district	1	146163	86467189	146163	86467189
The project for improvement of access to safe water in Sironko district	1	36	52701249	36	52701249
The project for improvement of access to safe water in three districts in Lango sub-region	2	71029	62906	14206	12581
The project for improving access to safe water in Mbale district	2	87463	80956	43731	40478
The project for installing rain water harvesting tanks in Kisoro district	1	94793	84904	94793	84904

Table A5: Correlation coefficients among wealth variables

	Remittances	Roof	Wall	Motor vehicle	Generator	Land
Remittances	1.000					
Roof	0.059	1.000				
Wall	-0.004	0.018	1.000			
Generator	0.040	0.057	-0.003	0.138	1.000	
Land	0.007	-0.007	-0.017	0.024	0.035	1.000