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An empirical exploration of relationships between official development assistance (ODA) and advances in water and sanitation subsectors

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GENERAL & APPLIED ECONOMICS | RESEARCH ARTICLE

An empirical exploration of relationships between official development assistance (ODA) and advances in water and sanitation subsectors

Souha El Khanji

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GENERAL & APPLIED ECONOMICS | RESEARCH ARTICLE

An empirical exploration of relationships between official development assistance (ODA) and advances in water and sanitation subsectors

Souha El Khanji[1]*

Abstract: This paper explores aid effectiveness by studying the effect of aid, aid volatility, and key development indicators, focusing on safe access to water and sanitation (W&S) in both urban and rural areas. Despite the importance of official development assistance (ODA) for these two subsectors, little global attention is given to its importance and its connectivity with different socio economic factors. In this study, we focus on the countries that receive aid for water and sanitation. We find that aid does have a discernible impact on access to W&S, particularly in rural areas, but that this impact is reduced by aid volatility, there is a clear evidence that ODA for water and sanitation lacks the appropriate orientation, and is not targeting most of the areas that are really in need.

Subjects: Politics & Development; Rural Development; Urban Development; Economics and Development; Environment & the Developing World

Keywords: water and sanitation; MDGs; SDGs; official development assistance (ODA); aid volatility; urban areas; rural areas; FGLS; fixed effects

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Souha El Khanji is an economic researcher at the Middle East Enlight Research- MEER, Beirut, Lebanon. Her scholarly interests concern environmental, resource economics and public sectors as well as the interface between economics and ecology. She has published papers related to the role of water as an economic good in economic growth and development. Her research is both disciplinary and interdisciplinary where she is interested in collaborating with scholars from different disciplines. In broad terms she investigates different topics that are linked to water economics, and has a specific interest in the effect of different socio economic factors on water withdrawal for the agricultural and non-agricultural sectors, and in the analysis of different international public sector policies. Current areas of interest embodies the finance of environmental projects, effects of climate change on financial sectors and energy management and finally a special interest in development aid for water and sanitation sub-sectors.

PUBLIC INTEREST STATEMENT

This study tries to fill the gap in the literature that deals with development aid for water and sanitation. It explores the impact of aid and aid volatility on safe access to water and sanitation, using an available OECD/DAC database. Specifically, it analyzes several socioeconomic factors and the effect of aid with respect to the recipient countries using the data for 139 countries covering the period of 1995–2016. Many pieces of work focused on the costs and the benefits of the development of water and sanitation sector and its impact on improving the health sector, the focus of our analysis is the importance of financing water and sanitation and to explore the impact of given aid and aid volatility on the improvement of these two subsectors specifically to attain the international targets for water and sanitation.

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1. Introduction

Pressure for sustainable development has grown in recent decades. The World Bank and other international institutions are increasingly concerned with the role of water in economic development. For example, the United Nations declared the 22nd of March 2005 as the World's water day. Human Development Report (2006) considered access to safe water as a basic human need and an ultimate element of human rights. The annual economic benefit from reaching the Millennium Development Goals (MDGs) is estimated at 84 billion $US. According to WHO (2002), poor access to safe water and basic sanitation, leads to poor health situations accompanied by a high mortality rate, in addition to other serious health issues.

In general, productivity at the micro level depends on the productivity of different economic sectors within the economy. The production capacity of these economic sectors depends on their factors of production, in which the health of labour and people play a vital role in productivity. El Khanji and Hudson (2016) highlighted the fact that although water quantity is important for economic growth and development, water quality proves to have a higher impact on both, development and economic growth. Moreover, the Stockholm International Water Institute (SIWI, 2005) has issued five messages to develop the modus operandi of the policy-makers to deal with water as a part of economic development. The first message links the improvement of water resources to growth and concludes that poor countries with good access to water resources and sanitation exhibited annual economic growth of 3.7% whereas those with poor water and sanitation (W&S) saw growth of 0.1%. These two subsectors are highly affecting the health sector, where the WHO (2008) estimated that, globally, more than 80% of diarrhoea accompanied with 1.5 million deaths each year is caused by inadequate sanitation, polluted water or by poor access to safe water. At a global level, international efforts focused on the importance for development and poverty elimination in order to achieve the MDGs by 2015, where W&S play a vital role. Ultimately, access to safe drinking water and sanitation has improved during the Millennium Development Goal (MDG) period, statistics shows that the use of improved drinking water has increased globally from 76 to 89% between (1990 to 2012), and the improved sanitation has increased from 45 to 64% (WHO/UNICEF, 2014). However, UNICEF & WHO (2015) report on sanitation and drinking water worldwide designates that over 663 million still lack an access to safe drinking water and over 159 million still depend on surface water for their water consumption. On 25 September 2015, the United Nations adopted the 2030 Agenda for Sustainable Development Goals,[1] where hygiene that is aligned with public health is integrated with these new goals. Despite the importance of W&S in growth and development, aid for these two subsectors has taken little attention previously and we are trying to demonstrate its impact and importance in this study. To illustrate the importance of aid for these two subsectors, we summarized some facts to highlight the benefits of improving water and sanitation in Table 1, where we can see how W&S are directly linked with the health sector, whether this effect is a cost or a benefit.

In our study, we focus on the effect of W&S—targeted aid and aid volatility, whilst taking into consideration the different factors that affect the development of water and sanitation subsectors. In other words, we are focusing on water and sanitation sector-allocable aid. Our exploration addresses an interesting question on aid effectiveness with reference to access to water and sanitation, and it extends the growing empirical literature on the relationship between disaggregated aid categories and sector-specific outcome variables by looking at the case of water and sanitation, which have largely been neglected in previous research.

The rest of the paper proceeds as follows. The next section includes a literature review and a highlight for some specific issues concerning the development of water and sanitation subsectors. We then present the methodology we will be using in Section 3. Section 4 looks at the description and the sources of the data and Section 5 presents the results. Finally, we conclude the paper.

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Table 1. Statistics illustrating the benefits from investing in water and sanitation

- The Cholera epidemic that had spread across Peru in 1991 cost one billion US$ to be treated, while prevention of the epidemic could have cost one tenth of this cost according to estimations (Suarez & Bradford, 1993)
- Improved W&S can decrease diarrhoea by 25% Moll, McElroy, Sabogal, Corrales, and Gelting (2007)
- In sub-Saharan Africa, women spend more than 6 h wasting productive time to collect water, according to WHO estimates, saving that time would contribute highly to reach the MDGs by saving of 64 billion US$, Whittington, Mu, and Roche (1990) estimated the cost of time spent in collecting water in Kenya to be similar to the average wage rate for unskilled labour
- Unsafe contaminated drinking water with industrial and municipal waste water affects the mental and the physical health of children in China ((China Council for International Cooperation on Environment and Development (CCICED) in (Warford & Yining, 2002, chapter 3; Hansen & Bhatia, 2004)
- Hutton, Haller, and Bartram (2007) in a cost benefit analysis of improved W&S concluded that benefits exceed costs in all world sub-regions and the return on a US$1 investment was between US$5—US$46 in developing regions. Also, they estimated that a US $1 invested in safe water supply, sanitation and hygiene (WASH) gives a payback US$8 economic benefit
- Nandi et al. (2017) estimate the health and the economic benefits of scaling up piped water and improved sanitation amongst Indian households, they find that access improvement could avert 43,352 diarrhoeal episodes and 68 diarrhoeal deaths per 100,000 under-5 children, accompanied with saving of (in 2013 US$) $357,788 (95% $345,509 -$370,067) in out-of-pocket diarrhoea treatment expenditure

2. Background

Despite many individual countries not prioritizing W&S spending, its global importance is reflected in the aid data. Global concern relating to W&S and the realization of its role in alleviating poverty, promoting economic development and health is apparent in the proportion of water aid in bilateral aid over the period 2001–2016, which is approximately 9% of the ODA. As the concern increased to reach the MDG goals, the sectoral aid (ODA) increased by 35% between 2002 and 2004 after a decline of aid for W&S during the 1990s. Figure 1 illustrates the moving average for global commitment for W&S between the mid-1990s and 2016. We can see the increasing trend in countries' commitments for these two subsectors.

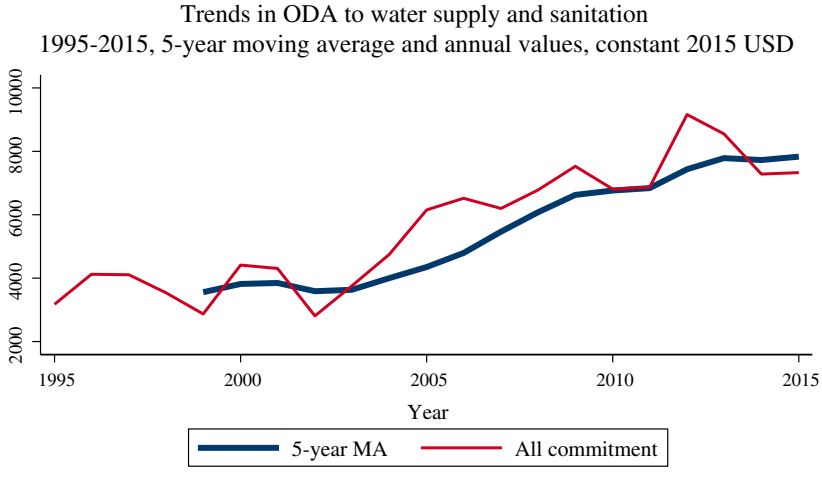

Figure 1. Five years moving average and yearly global aid commitment for water and sanitation.

The aid for water and sanitation represents only 7% of the total sector allocable aid according to 2009–2010 (OECD-DAC, 2012). Although the volume of aid for W&S has risen since 2001, Figure 2 illustrates that the volume of allocated aid for these subsectors is less than that allocated for health and education.

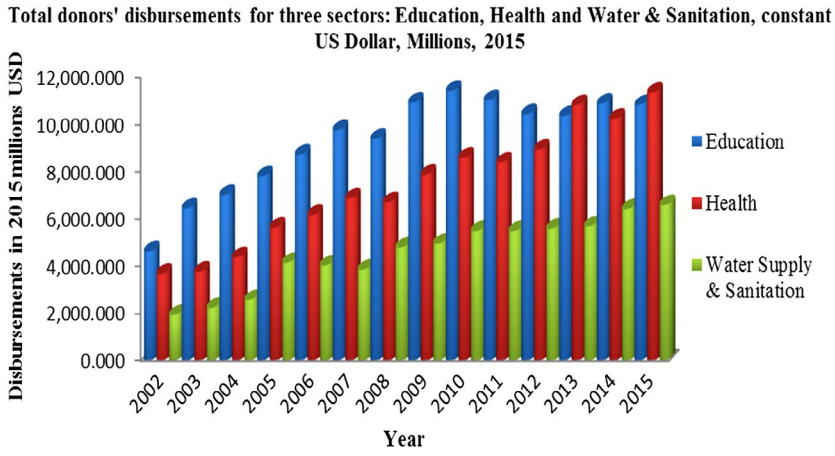

Figure 2. Volume of donors' disbursements for health, education and water & sanitation.

Source of Data: OECD-DAC official website.

Early estimations from the issuers of the MDG goals suggested that the financing needed to achieve the goals was about 0.25 per cent of the donors` GDP in 2003 and 0.44 per cent in 2006, which reached to 0.54 per cent in 2015, and this accounts for US$120 billion each year (UN, 2005). The cost assessment for target 10 of the MDGs varied from 9 billion to 30 billion US$ per year (GWP, 2000; World Bank, 2004 from the World Water Council report 2006, p. 7). The differences in assessment are due to several reasons, such as the restrictions in the definition of the target 10, the different means of analysis and calculations that lead to variations in estimating the unit cost. Another reason is the lack of consistent data for safe access to W&S. There are also the additional costs of instalment of infrastructure that can be highly expensive in some regions of the world, in addition to maintenance and water storage costs (Mehta, Fugelsnes, & Virjee, 2005; World Water Council, 2006). According to Winpenny (2003) global finance for safe access to water is estimated to be US$13 billion per year and US$17 billion per year for proper sanitation. Also, different reports estimate that the sanitation target will be two to five times more than the water target. For the developing world, total investment in W&S is projected to be between 14 and 16 billion US$ annually (without including waste water treatment) (GWP, 2000; Toubkiss, 2006, p. 7; Winpenny, 2003).

Hutton and Bartram (2008) mentioned the lack of studies that deal with the costs of improving the infrastructure to supply water and sanitation. They commented on the fact that although the targets 7.C in the MDGs distinguished between the urban and the rural areas in its definition, there are no special arrangements for rural and urban areas to be treated separately. Furthermore, it affects the unit costs because infrastructure, technologies and population growth differ between rural and urban areas, which generate reduced credibility in the unit cost estimations (Hutton & Bartram, 2008).

There has been limited analysis of the impact of aid and aid volatility on W&S. Wolf (2007) has discussed the effectiveness of official development assistance (ODA) and the effect of volatility of aid on the safe access to W&S. She finds the share of ODA for education and health seems to have a positive impact on outcomes in these sectors, while the total aid seems to have a negative impact.

3. Methodology

As we expressed in the introduction, our focus in this study is on exploring the effect of W&S-targeted aid and aid volatility on these two subsectors. In our model, the target variable is the safe access to water and sanitation. Building upon Hudson (2012), who used a linear model in examining the effect of aid and aid volatility on economic sectors, and adopting the illustration that is provided by Agénor, Bayraktar, and El Aynaoui (2006) that the share of population with access to safe water can be determined by *"population density, real income per capita and the public spending on infrastructure"*. We derive our linear model where safe access to water and sanitation is introduced in the following forms:

$$S_{it} = f(\text{ODA}, \Phi\text{ODA}, P, g, I, X_i) \quad (1)$$

where S_{it} is the safe access to water and sanitation for country i during period t, ODA is the aid for W&S, ΦODA is the volatility of aid, P is the policies, g represents geographical factor, I is the income per capita. The effect of all of these is to increase S. Population density is relevant as it is in general easier to provide the infrastructure in an urban area than a rural one. Finally, X represents the remaining variables that affect safe access to W&S. These include measures of government effectiveness, the rule of law, and political stability & absence of violence/terrorism index, for reasons we discuss later. We chose to run two sets of analysis, regression analysis for (i) which includes all the countries and (ii) just for the low-income countries.

$$\Delta Swater_{it-1,it}/sanitation_{it-1,it} = f(\text{ODAwater\&sanitation}_{it}/\text{GDP pc}_{it}, \Phi\text{ODA}_{it}, \text{time dummy variables for individual countries}_{it}) \quad (2)$$

$$S\,water_{it}/sanitation_{it} = f(\text{Net ODA as a \% of GNI}_{it}, \text{Log GDP pc}_{it}, \text{Population density}_{it}, \text{Gross national expenditure as \% of GDP}_{it}, \text{Governance variables}_{it}) \quad (3)$$

$$S\,water_{it}/sanitation_{it} = f(\text{ODAwater\&sanitation}_{it}/\text{GDP pc}_{it}, \Phi\text{ODA}_{it}, \text{Net ODA as \% GNI}_{it}, \text{Log GDP per capita}_{it}, \text{Population density}_{it}, \text{Gross national expenditure as \% of GDP}_{it}, \text{Governance variables}_{it}) \quad (4)$$

The collinearity test indicates a presence of collinearity between several variables of the estimation.[2] The heteroskedacticity test[3] indicates that there is heteroskedacticity. We thus use the feasible generalized least squares[4] estimator for estimating Equations (2 and 3). Equation (2) relates to the change in access to W&S in separate regressions. The underlying idea is that aid should impact on changes in W&S, rather than the level per se, as it seems unreasonable to argue that once aid ceases, W&S goes back to its former level, which is what is implied when it is included in a levels equation. In the Equation (3), we focus on the long run relationship between W&S and various socio-economic indicators. In this equation, there is no place for aid as a flow variable. Nonetheless, we do in the fourth equation—Equation (4)—bring both specifications together. It is estimated using Panel Data Fixed effects and this essentially focused on changes within countries rather than between countries and as such is geared more to the short-term than the long term. The problem with aid as a flow variable still exists, nonetheless in this specification it may be possible to pick up short run effects from aid. Carrying the regression analysis using the RHS of Equation (4) is a challenging task, where we are facing a potential endogeneity problem. The endogeneity problem is common in development studies (Duncan, Magnuson, & Ludwig, 2004) who justify that development researcher should try not to trade off theories for the sake of empirical necessities. Fixed effects here is an attractive and a powerful tool for removing omitted variable bias and in minimizing the bias, which makes it an effective model in capturing what occurs naturally in real world. Also, the effects of time-invariant regressors are unidentified in fixed-effects panel data model (Wooldridge, 2002).

The main hypotheses we are testing can be summarized as follows. *Hypothesis 1*: aid impacts positively on W&S access, *Hypothesis 2*: aid volatility has a negative effect, *Hypothesis 3*: W&S increases with population density; *Hypothesis 4*: W&S increase with good governance. Within this, the main focus is on Hypothesis 1 and Hypothesis 2 concerning aid and aid volatility.

4. Data

We are analyzing several socioeconomic factors and the effect of aid on the outcome of target 10 of the MDGs and consequently SDG targets 6.1 (safely managed drinking water service) and 6.2 (having a safely managed sanitation service). Data on safe access to W&S are derived from the WHO/UNICEF Joint Monitoring Programme (JMP) for W&S (1995–2016). The WHO use any of the following types of water supply for drinking: *"piped water, public tap, borehole or pump, protected well, protected spring or rainwater. Improved water sources do not include vendor-provided water, bottled water, tanker trucks or unprotected wells and springs"* (United Nations, 2008, p. 190). As for sanitation, it is included as the proportion of the population with access to improved sanitation. For both measures, this relates to a satisfactory level per se rather than an improvement on what they previously had. That is what access to an improved level means.

The aid data for W&S are obtained from the Creditor Reporting System (CRS)-Development Assistance Committee (DAC) database on aid disbursements and is at a constant US$ 2015 million for total W&S. The DAC data relate to activities that have W&S as their main purpose. The disbursement data are available from 2002, and this will allow us to track the early years following the announcement of the MDGs in 2000. Net ODA received is as a percentage of GNI due to the availability of observations. GDP per capita is in constant US$ 2010.

The World Bank governance indicators provided by the World Bank website, include government effectiveness, rule of law, and Political Stability and the Absence of Violence/Terrorism (1996–2016). The estimates of governance (range from approximately −2.5 (weak) to 2.5 (strong) governance performance).

Gross national expenditure as a % of GDP is included for a number of different reasons. First of all Mosley, Hudson, and Horrel (1987) commented on different modes for the impact of aid, which can be direct by disbursements from the donors, or can be indirect through governmental spending of the recipient country on the development of the public sector which is related to the policies applied by the recipient governments. The second reason for using this specification is the lack of data for W&S public governmental spending in the recipient countries. A high value for this reflects a commitment to spend more money on consumption, investment and public sector expenditure than the country is producing. This may be due to aid or it may be due to borrowing. Either way it reflects a potential commitment by government to develop the country. Based on this we would expect a positive impact on infrastructure. Of course, a government cannot spend beyond its means indefinitely and it is possible that a high value for this variable eventually puts pressure on government to reduce the deficit and this may have the opposite effect on some countries. In addition, low values of this variable reflect that the country is accumulating foreign exchange reserves, but equally is not spending all it might do and again this might affect infrastructure.

Finally, following Hudson (2012) aid volatility is determined as the square of the error term from regressing aid disbursements on a trend and trend squared for each country.[5] And *"If predicted aid from this regression is negative, then a lower bound of zero is imposed and the error adjusted accordingly"* (Hudson, 2012, p. 9). We also added a dummy variable for Tropical countries, for a Tropical country this takes the value of 1 and otherwise it equals 0. One reason behind the addition of the tropical dummy is the fact that tropical countries show underdevelopment (Sachs, 2001). A second reason is that the recent literature has emphasized the poor outcome of aid in Tropical regions (Dalgaard & Hansen, 2001; Hansen & Tarp, 2001; Lensink & White, 2001). For further illustration, we summarize the data and the descriptive statistics in Tables 2 and 3.

Table 2. The summary of data

Variable	Definition and source
Percentage of population with safe access to improved water	Improved water source (% of population with access), the proportion of population with sustainable access to an improved water source. Total, urban and rural (in percentage). Source: WHO/UNICEF Joint Monitoring Programme (JMP) for Water Supply and Sanitation (http://www.wssinfo.org/)
Percentage of population with proper access to improved sanitation	Improved sanitation facilities (% of population with access), the proportion of the population using improved sanitation facilities. Total, urban and rural (in percentage). Source: WHO/UNICEF Joint Monitoring Programme (JMP) for Water Supply and Sanitation (http://www.wssinfo.org/)
ODA W&S	Official development Assistance for water and sanitation (CRS- DAC database) (US Dollar, Millions, 2015)
GDP per capita	Constant 2010 US$. Source: World Development Indicators
Gross national expenditure (% of GDP)	Gross national expenditure (formerly domestic absorption) is the sum of household final consumption expenditure (formerly private consumption), general government final consumption expenditure (formerly general government consumption), and gross capital formation (formerly gross domestic investment). Source: World Bank Development Indicators
Net ODA received (% of GNI)	Net official development assistance (ODA) consists of disbursements of loans made on concessional terms (net of repayments of principal) and grants by official agencies of the members of the Development Assistance Committee (DAC), by multilateral institutions, and by non-DAC countries to promote economic development and welfare in countries and territories in the DAC list of ODA recipients. It includes loans with a grant element of at least 25 per cent (calculated at a rate of discount of 10 per cent). Source: World Bank Development Indicators
Population density	People per sq. km of land area. Source: World Development Indicators
Government effectiveness	Reflects perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. Estimate of governance (ranges from approximately −2.5 (weak) to 2.5 (strong) governance performance). Data from database: Worldwide Governance Indicators
Rule of law	Reflects perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence. Estimate of governance (ranges from approximately −2.5 (weak) to 2.5 (strong) governance performance). Data from database: Worldwide Governance Indicators
Political stability and absence of violence index	Reflects perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including politically-motivated violence and terrorism. Estimate of governance (ranges from approximately −2.5 (weak) to 2.5 (strong) governance performance). Data from database: Worldwide Governance Indicators

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Table 3. Summary statistics

Variable	Obs	Mean	Std. dev.	Min	Max
Improved water source, total	2,863	79.4735	17.9693	19.5	100
Improved water source, urban	2,883	90.7708	10.5955	24.1	100
Improved water source, rural	2,863	71.3072	21.4456	8.8	100
Improved sanitation, total	2,860	59.9054	29.6874	3	100
Improved sanitation, urban	2,865	70.0691	24.8749	11.3	100
Improved sanitation, rural	2,860	51.7316	31.6497	0	100
ODA W&S	1,844	31.4113	57.8722	0.000287	1065.899
Net ODA received (% of GNI)	2,753	7.374575	10.961	−2.6295	181.1032
GDP per capita	2,948	3710.6	3781.185	115.7941	20,333.94
Population density	3,053	117.3691	169.7294	1.479208	1391.64
Government effectiveness	2,474	−0.4984	0.6639	−2.445876	1.572235
Rule of law	2,501	−0.50678	0.6951	−2.606445	1.555118
Political stability & absence of violence	1,345	−0.39852	0.93224	−3.28	2.099854
Gross national expenditure (% of GDP)	2,646	110.23	21.57477	50.23931	444.7508

5. Empirical results

The empirical work is based on a longitudinal data for 139 countries (see Table A1–Appendix A) covering the period of 1995–2016. The regression results are included in Tables 4 through 7. See the results in Tables 4 and 5 for all the recipient countries and in Tables 6 and 7 for low-income countries.[6]

- The *aid (for W&S) to GDP* ratio is found to be significant at the 1% significant level for all of the recipient countries. The impact of aid is significantly positive in impacting on the population with access to improved water source. This supports *Hypothesis 1*, and as the results indicate, an increase in aid for *rural areas* of 1 unit point leads to a significant increase of 0.7% in safe access to water in rural areas, and a 0.12% increase in urban areas (logged dependent variable).
- *Aid volatility* is found to be significant for all recipient countries. Where the volatility of aid increases by 1 unit we can see that safe access to water slows down by 0.7% in urban areas. This provides support for *Hypothesis 2*. However, the fixed effects model that to an extent represents the effect on the short run shows the significance of aid and the insignificant effect of aid volatility.
- More results provide further insights on these two *Hypotheses 1* and *2*, that is clear in the analysis of the low-income countries (Table 6), *aid and aid volatility* are significant in both their effect on all the low-income countries in our panel and for the rural areas in these countries. This means that a 1unit point increase in aid when targeting rural areas improves safe access to water by 7.3%. This increase from year 2002 may sound large. In reality, it reflects starting from a low level of access to safe water. This finding is agreeable with Cha, Mankadi, Elhag, Lee, and Jin (2017) that some countries where there is a lack of an appropriate coverage of water and sanitation subsectors, receive less ODA per capita than did countries with better water and sanitation subsectors, which is a strong evidence that ODA for water and sanitation lacks the appropriate orientation, and is not targeting most of the areas that are really in need. Earlier, Fuller, Goldstick, Bartram, and Eisenberg (2016) have the same findings that there is heterogeneity in the progress between the covered countries and an inequality in access to safe drinking water and sanitation within the countries.
- Considering *safe access to proper sanitation*, from (columns 1, 3 and 5—Table 5), we can see that the aid for W&S per GDP is positive and significant for all the recipient countries, for both rural and urban areas. A 1unit point increase in ODA per GDP leads to a 1.1% positive improvement in safe access to proper sanitation in all the recipient countries, 0.4% for urban areas and a 1.1%

Table 4. Regression of safe access to water for all recipient countries

	LΔSwater/Total	LSwater/Total	LΔSwater/Urban	LSwater/Urban	LΔSwater/Rural	LSwater/Rural	LSwater/Fixed effect
	Column(1)	Column(2)	Column(3)	Column(4)	Column(5)	Column(6)	Column(7)
Constant	0.00122***	3.434***	0.0003	4.381***	0.0029***	3.161***	3.340***
	(4.22)	(130.78)	(1.86)	(305.99)	(6.49)	(69.93)	(50.35)
ODA W&S/GDP	0.0069***		0.0012***		0.0069***		0.0205**
	(22.5)		(14.55)		(17.68)		(3.29)
Aid volatility	−0.024***		−0.0071***		−0.0141		−0.0548
	(6.70)		(3.32)		(1.50)		(1.87)
Time dummies	Yes	No	Yes	No	Yes	No	No
Net ODA as% GNI		−1.432***		−0.858***		−2.435***	0.0908
		(4.15)		(3.73)		(4.25)	(0.62)
lGDP per capita		0.120***		0.0257***		0.128***	0.110***
		(45.32)		(17.6)		(28.91)	(12.35)
Population density		0.0194***		0.00494***		0.0551***	0.108***
		(11.29)		(7.15)		(18.85)	(6.63)
Dummy for Tropical countries		−0.0726***		−0.0471***		−0.113***	0
		(18.69)		(26.29)		(16.93)	(.)
Government effectiveness		0.0192**		0.00607*		0.0199	−0.0246***
		(3.07)		(2.27)		(1.89)	(3.95)
Rule of law		0.0614***		0.0445***		0.1000***	−0.0210**
		(10.81)		(16.95)		(9.93)	(2.79)
Political stability & absence of violence		−0.277***		−0.163***		−0.158***	0.0146
		(13.63)		(14.36)		(4.16)	(0.38)
Gross national expenditure as % of GDP		0.0624***		−0.0136*		0.149***	0.0260**
		(6.32)		(2.36)		(7.17)	(3.22)
N	1762	1152	1777	1154	1762	1152	805
R^2							0.35
adj. R^2							0.223
Wald χ^2	879.78***	5786.96***	387.05***	3311.93***	604.01***	4454.37***	

Notes: *t*-statistics are in parentheses; Column (1) through (6) are the FGLS regression results, Fixed effects for the effect of all the variables of interest on the safe access to water for the recipient countries are included in column (7); All the dependent variables are logged.

***Significant at 1% level.

**Significant at 5% level.

*Significant at 10% level.

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Table 5. Regression of safe access to proper sanitation for all recipient countries

	LΔS *sanitation*/ Total	LS *sanitation*/ Total	LΔS *sanitation*/Urban	LS *sanitation*/Urban	LΔs *sanitation*/Rural	LS *sanitation*/Rural	LS *sanitatio*/Fixed effect
	Column(1)	Column(2)	Column(3)	Column(4)	Column(5)	Column(6)	Column(7)
Constant	0.0020***	0.0796	0.00064*	2.114***	0.0014	−0.955***	2.368***
	(3.95)	(1.23)	(2.23)	(40.78)	(1.8)	(12.26)	(24.16)
ODA W&S/GDP	0.0110***		0.0039***		0.0109***		0.0398***
	(23.73)		(16.67)		(17)		(4.32)
Aid volatility	−0.0314***		−0.0121***		−0.0149		−0.0996*
	(6.93)		(4.57)		(1.56)		(2.30)
Time dummies	Yes	No	Yes	No	Yes	No	No
Net ODA as% GNI		−6.164***		−4.390***		−6.699***	−0.0855
		(9.05)		(6.89)		(5.94)	(0.39)
lGDP per capita		0.459***		0.253***		0.559***	0.163***
		(78.93)		(52.54)		(76.9)	(12.46)
Population density		0.0759***		0.0224***		0.131***	0.178***
		(20.19)		(7.79)		(27)	(7.39)
Dummy for Tropical countries		−0.367***		−0.234***		−0.525***	0
		(42.06)		(34.95)		(45.31)	(.)
Government effectiveness		−0.0256		0.0009		−0.0015	−0.049***
		(1.84)		(0.1)		(0.09)	(5.33)
Rule of law		−0.0234		−0.0191*		−0.0441*	−0.0171
		(1.69)		(2.03)		(2.38)	(1.54)
Political stability & absence of violence		−0.278***		−0.061		−0.614***	0.0715
		(4.23)		(1.35)		(7.42)	(1.26)
Gross national expenditure as % of GDP		0.0436***		0.0245***		0.0457***	0.0413***
		(15.74)		(12.4)		(14.84)	(3.46)
N	1766	1152	1766	1154	1766	1152	808
R^2							0.381
adj. R^2							0.26
Wald χ^2	840.38***	12,536.51***	438.15***	6046.94***	578.7***	25,340.32***	

Notes: *t*-statistics are in parentheses; Column (1) through (6) are the FGLS regression results, Fixed effects for the effect of all the variables of interest on the access to proper sanitation for the recipient countries are included in column (7); All the dependent variables are logged.

***Significant at 1% level.

**Significant at 5% level.

*Significant at 10% level.

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Table 6. Regression of safe access to water for low-income countries

	LΔSwater/Total	LSwater/Total	LΔSwater/Urban	LSwater/Urban	LΔSwater/Rural	LSwater/Rural	LSwater/Fixed effect
	Column(1)	Column(2)	Column(3)	Column(4)	Column(5)	Column(6)	Column(7)
Constant	0.0037*	3.268***	0.002***	4.693***	0.0045*	2.730***	2.539***
	(2.16)	(19.44)	(4.76)	(87.46)	(2.11)	(11.77)	(7.71)
ODA W&S/GDP	0.0592***		0.0031**		0.071***		0.183
	(8.14)		(2.85)		(7.96)		(1.00)
Aid volatility	−0.140***		−0.0106		−0.154**		−0.791
	(3.61)		(1.53)		(3.23)		(1.08)
Time dummies	Yes	No	Yes	No	Yes	No	No
Net ODA as% GNI		−1.259		−1.476***		−1.968	0.253
		(1.44)		(3.86)		(1.63)	(1.08)
lGDP per capita		0.134***		−0.021**		0.173***	0.220***
		(6.08)		(2.71)		(5.7)	(4.19)
Population density		0.0453***		0.0121***		0.0704***	0.0847
		(7.9)		(4.96)		(8.9)	(1.77)
Dummy for Tropical countries		−0.127***		−0.0657***		−0.128***	0
		(4.98)		(11.60)		(3.65)	(.)
Government effectiveness		−0.103**		−0.0257*		−0.0565	−0.0333*
		(3.02)		(2.49)		(1.20)	(2.56)
Rule of law		0.140***		0.0769***		0.127**	−0.0373
		(3.96)		(7.36)		(2.6)	(1.77)
Political stability & absence of violence		−0.183		−0.181***		−0.245	0.0991
		(1.15)		(4.48)		(1.11)	(0.93)
Gross national expenditure as % of GDP		0.0765		−0.0342		0.187**	0.0265
		(1.48)		(1.82)		(2.62)	(1.18)
N	702	462	705	462	702	462	330
R^2							0.435
adj. R^2							0.42
Wald χ^2	93.05***	199.15***	64.58***	892.48***	93.8***	192.56***	

Notes: *t*-statistics are in parentheses; Column (1) through (6) are the FGLS regression results, Fixed effects for the effect of all the variables of interest on the safe access to water for the recipient countries are included in column (7); All the dependent variables are logged.

***Significant at 1% level.

**Significant at 5% level.

*Significant at 10% level.

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Table 7. Regression of safe access to sanitation for low-income countries

	LΔS *sanitation*/ Total	LS *sanitation*/ Total	LΔS *sanitation*/Urban	LS *sanitation*/Urban	LΔS *sanitation*/Rural	LS *sanitation*/Rural	LS *sanitatio*/Fixed effect
	Column(1)	Column(2)	Column(3)	Column(4)	Column(5)	Column(6)	Column(7)
Constant	0.00660***	0.641***	0.00246**	1.907***	0.0027	0.261	1.052***
	(6.2)	(3.74)	(3.11)	(12.54)	(1.49)	(0.74)	(5.02)
ODA W&S/GDP	0.736***		0.178***		0.793***		2.769
	(11.54)		(5.23)		(7.73)		(1.74)
Aid volatility	−0.0416*		0.0334**		−0.0155		0.223
	(2.23)		(3.19)		(0.56)		(0.22)
Time dummies	Yes	No	Yes	No	Yes	No	No
Net ODA as% GNI		−0.318**		−0.269**		−0.336	0.0071
		(2.95)		(3.01)		(1.53)	(0.22)
lGDP per capita		0.404***		0.288***		0.414***	0.295***
		(21.58)		(14.59)		(10.81)	(8.89)
Population density		0.0555***		0.00787		0.131***	0.157***
		(7.48)		(1.04)		(8.74)	(4.07)
Dummy for Tropical countries		−0.556***		−0.472***		−0.766***	0
		(16.93)		(16.62)		(14.61)	(.)
Government effectiveness		−0.00854		0.0784**		−0.105	−0.071***
		(0.34)		(2.63)		(1.80)	(3.97)
Rule of law		−0.0725*		−0.128***		−0.0262	−0.0091
		(2.39)		(4.17)		(0.42)	(0.42)
Political stability & absence of violence		−0.108		0.0243		−1.076***	0.0583
		(0.82)		(0.16)		(3.88)	(0.53)
Gross national expenditure as % of GDP		0.0250***		0.0278***		0.00785	0.0454*
		(3.38)		(4.6)		(0.54)	(2.27)
N	705	462	705	462	705	462	330
R^2							0.44
adj. R^2							0.325
Wald χ^2	372.2***	2537.22***	136.21***	1253.03***	214.25***	685***	

Notes: *t*-statistics are in parentheses; Column (1) through (6) are the FGLS regression results, Fixed effects for the effect of all the variables of interest on the proper access to sanitation for the recipient countries are included in column (7); All the dependent variables are logged.

***Significant at 1% level.

**Significant at 5% level.

*Significant at 10% level.

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for rural areas. Also, we can see the significant effect of aid in the fixed effects regression. The results are shown in column 7 in Table 5 for the recipient countries and column 7 in Table 7 for the low-income recipient countries where this significance disappeared. That means still more effort should be done concerning sanitation for low-income countries.

- *Population density* proves to be positively significant in the outcome of the target (safe access). This supports *Hypothesis 3*. A 1unit increase in population density triggers an improvement in the water subsector by 2%, by 0.5% for urban areas and by 5.6% for the rural areas. The effect is apparent as well for the urban and the rural areas in the low-income countries. This is also in agreement with the postulation given by Agénor et al. (2006) that the costs of installing bigger infrastructure decrease with higher population density. It is cheaper and easier to provide W&S infrastructure to a densely populated country.
- The rule of law shows a significant positive effect on water access in the urban areas for all the recipients and the low-income countries as well. This thus provides support for *Hypothesis 4*. However, and more surprisingly, it has a negative significant effect on access to sanitation in urban and rural areas, and no significant effect on sanitation for rural areas in low-income countries (Table 7). It is apparent that government effectiveness and political stability play a small role in the development of sanitation for countries receiving aid for W&S that is obvious from the insignificant coefficients. Neumayer (2003, p. 9) mentioned that the existing literature is clear that aid boosts growth in the presence of good governance. For more emphasis, we rerun the regressions without the political stability and find that the regression results and the significant impact did not change for the rest of the variables.
- The results relating to the control variables provide further insights into the determinants of access to W&S. The *dummy variable for Tropics* is negative and significant at a 1% significance level in most of the results, which is consistent with the previous literature that discussed how aid and development efforts are not very effective in tropical areas (Sachs, 2001). Also, it seems that aid for W&S is working for all countries, but still there is a problem with safe access in Tropical countries where efforts must increase more.
- *Net ODA as a % of GNI* is negatively significant at the 1% significant level for urban and rural areas in all recipient countries for safe access to water (Table 4), while it shows no significant effect for sanitation in the short run (Table 5-column 7). The first effect reflects the state of the country, with poorer less developed countries getting more aid. These results are consistent with limitations on absorptive capacity with high aid elsewhere pulling resources away from W&S towards other projects. Also, the global interest of the donors and the official aid were concentrated substantially on health and education with a lower allocation of the ODA to other sectors which is apparent in the results. This is previously mentioned in an Off-track, Off-target (2011, p. 5) report *"In Sub-Saharan Africa, access to sanitation is now the most off-track 2015 Millennium Development Goal (MDG) target. On current trends it will not be met for two centuries. In developing countries, spending on water, sanitation and hygiene services is minimal compared to health and education, and the share of aid flows going to water and sanitation has fallen over the last 15 years. The unforeseen impact is that slow progress on this essential foundation for broader human development is holding back progress in health and education, despite increased spending in those areas. Furthermore, lack of access to water and sanitation is a major drag on economic growth, and costs African and Asian countries up to 6% of their Gross Domestic Product (GDP) each year"*. This also can be explained by the behaviour of the authorities in the recipient countries with aid being non-effective in some sectors due to their political interference in the allocation of the coming resources. Adding to that, the literature discusses how corruption in the recipient countries can suppress the effectiveness of contracts for W&S and the cost can be detrimental for the values of the projects (Dagdeviren & Robertson, 2016; Kenny 2006). However, the negative impact may reflect the state of the country, with poorer less developed countries getting more aid. Thus, when we add the fixed effects this disappears, and there is some evidence that overall aid supplements the impact of W&S aid.

- The *ratio of Gross National Expenditure as % of GDP* with respect to the access to improved water is significant and positive for the rural and urban areas in all recipient countries. This significance is evident in the long, and the short run (fixed effects). This ratio is in excess of one when the country is spending more than it produces. This could reflect a government's commitment to increase expenditure on infrastructure. Although, equally, other reasons are possible; for instance, the results in El Khanji (2017) are a clear evident that developments and advancements in infrastructure that support water provision for one sector in the economy enhances advancement in water provision for other sectors. The fact that it is significant in these regressions suggests it is in some measure picking up this commitment. Although because of other possible explanations for these variables, this interpretation needs to be treated with caution. In the case of these regressions, it can be due to the donors influence on governments, or otherwise, to increase spending for the public sector in the rural areas as a side effect to expanding spending to reach the SDG goals in alleviating poverty in the poorest areas.
- *Gross national expenditure as % of GDP* is insignificant for access to water for the low income countries at a 5% level for rural areas, but the significant effect is not present for sanitation in low income countries. It is possible, as we have argued, that a high share of government spending in GDP may reflect economic and political ambitions to drive the country forward, ambitions for which rural areas play no great part. Sridhar and Woods (2010) found that the development assistance provided to governments in recipient countries has a negative effect on government spending on health and conclude that aid for health is not transferred by governments for this purpose.
- The positive impact of the *GDP per capita* in the four regression tables is in parallel with the theme that economic growth and economic development usually leads to improved public sector delivery. We can see from the tables that a 1unit increase in GDP per capita increases the access to safe and improved water by approximately 12% for all the recipient countries, and by 14% for the low-income countries.

6. Conclusion

We have analyzed the impact of aid on access to W&S, finding a significant positive impact. In addition, the paper has sought to shed light on recent concerns about the effect of aid volatility. In terms of the hypotheses, we have provided evidence that aid volatility has a negative significant impact on W&S. In addition, we proved that the improvement for these two subsectors is also affected by the behaviour of the recipient countries, where access to W&S is negatively linked to levels of governance. The results suggest that more care is needed to develop arrangements in distinguishing between the urban and the rural areas. The findings indicate that ODA for water and sanitation lacks the appropriate orientation, and is not targeting most of the areas that are really in need, correspondingly a low amount of aid is allocated for W&S in the rural areas, which can affect poverty reduction on the long run. However, they also indicate the substantial impact aid can have in the rural areas. There may be a temptation to ignore rural areas as it may be more expensive to provide W&S to a more dispersed population. But our results nonetheless suggest that the impact of aid can be substantial. In part, this might be because the required infrastructure may be different and indeed cheaper for rural areas than urban ones.

The literature suggests that aid may be good for growth in low-income countries, and our results show that in itself will benefit access to W&S. However, additional aid to GDP may be constrained in its effect on growth due to the effect of different constraints like institutional, human capital, professional work force, macroeconomic indicators (World Bank, 2004) and in that case we need to focus aid more specifically on target areas. There is a case for focusing our attention not simply on the totality of aid, but on its composition. In the case of W&S sectorial aid one significant constraint is that of physical capital. The lack of suitable infrastructure in the recipient countries may affect the effectiveness of the allocated aid for that sector – although aid can help with that constraint. Considering aid for W&S, a lack of suitable infrastructure will lead to the allocation of high amounts of the received aid to install the required systems and this will slow down the delivery of the required service. In the long run this may lead to substantial benefits, but will slow down the immediate returns on aid.

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Notes

1. SDG targets 6.1 and 6.2 (call for universal and equitable access for all) relate to drinking water, sanitation and hygiene and are more ambitious than the previous MDG target 7c (aimed to halve the proportion of the population without access to water and sanitation by 2015) (WHO/UNICEF, 2017).
2. In the correlation matrix or covariance matrix for a group of variables the collinearity between the aid and the aid volatility is 0.3549, between the GDP per capita and the safe access to water 0.7402, between GDP per capita and the governance variables is 0.5767, the correlation between the safe access to sanitation and the GDP per capita is 0.7301, between rule of law and government effectiveness is 0.8709. We use Wooldridge test for autocorrelation in panel data (Drukker, 2003). Wooldridge test for autocorrelation in panel data is F(1,117) = 3060.420*** (H_0: no first-order autocorrelation) for safe access to water equation and F(1,117) = 2944.472***(H_0: no first-order autocorrelation) for safe access to proper sanitation.
3. Breusch-Pagan/Cook-Weisberg test for heteroskedasticity (Ho: Constant variance) the chi squared is 72.32*** for safe access to water equation (all variables used in equation 4 when dependent variable is safe access to water) and 99.40*** for access to improved sanitation equation (all variables used in equation 4 when dependent variable is safe access to sanitation).
4. FGLS is a variance covariance method using the independent autocorrelation structure. We did not report the R squared for the GLS regression as *"When you estimate the model's parameters using generalized least squares (GLS), the total sum of squares cannot be broken down in the same way as in OLS, making the R-squared statistic less useful as a diagnostic tool for GLS regressions"*. McDowell (2003) accessed online at: http://www.stata.com/support/faqs/statistics/r-squared-after-xtgls/).
5. We do not have enough observations (2002–2016) and hence we use this method, which with a small sample give similar results to the Hodrick–Prescott filter.
6. The World Bank classifies low-income countries as countries that have GNI per capita of US$1,005 or less.

Cover image
Source: Amr Emam-IRIN.

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Appendix A

Table A1. List of 139 countries and the 53 low-income countries included in the study

List of 139 countries in the study			The low income countries
Afghanistan	Georgia	Pakistan	Afghanistan
Albania	Ghana	Palau	Bangladesh
Algeria	Grenada	Panama	Benin
Angola	Guatemala	Papua New Guinea	Bhutan
Argentina	Guinea-Bissau	Paraguay	Burkina Faso
Armenia	Guinea	Peru	Burundi
Azerbaijan	Guyana	Philippines	Cambodia
Bangladesh	Haiti	Rwanda	Central African R
Barbados	Honduras	Saint Kitts and Nevis	Chad
Belarus	India	Saint Lucia	Comoros
Belize	Indonesia	St Vincent & the Grenadines	Congo, Dem. Rep.
Benin	Iran	Samoa	Cote d'Ivoire
Bhutan	Iraq	Senegal	Eritrea
Bolivia	Jamaica	Serbia	Ethiopia
Bosnia and Herzegovina	Jordan	Seychelles	Gambia, The
Botswana	Kazakhstan	Sierra Leone	Ghana
Brazil	Kenya	Solomon Islands	Guinea
Burkina Faso	Kiribati	Somalia	Guinea-Bissau
Burundi	Kyrgyzstan	South Africa	Haiti
Cambodia	Lao Republic	Sri Lanka	India
Cameroon	Lebanon	Sudan	Kenya
Cape Verde	Lesotho	Suriname	Korea, Dem. Rep.
Central African Republic	Liberia	Swaziland	Kyrgyz Republic
Chad	Libya	Syria	Lao PDR
Chile	Macedonia	Tajikistan	Liberia
China	Madagascar	Tanzania	Madagascar
Colombia	Malawi	Thailand	Malawi
Comoros	Malaysia	Timor-Leste	Mali
Congo	Maldives	Togo	Mauritania
Costa Rica	Mali	Tonga	Mongolia
Croatia	Marshall Islands	Trinidad and Tobago	Mozambique
Cuba	Mauritania	Tunisia	Myanmar
Côte d'Ivoire	Mauritius	Turkey	Nepal
Democratic R. of Korea	Mexico	Turkmenistan	Niger
Democratic R. of the Congo	Micronesia	Uganda	Nigeria
Djibouti	Moldova	Ukraine	Pakistan
Dominica	Mongolia	Uruguay	Papua New Guinea
Dominican Republic	Montenegro	Uzbekistan	Rwanda
Ecuador	Morocco	Vanuatu	Senegal
Egypt	Mozambique	Venezuela	Sierra Leone

List of 139 countries in the study			The low income countries
El Salvador	Myanmar	Vietnam	Solomon Islands
Equatorial Guinea	Namibia	West bank and Gaza	Somalia
Eritrea	Nepal	Yemen	Sudan
Ethiopia	Nicaragua	Zambia	Tajikistan
Fiji	Niger	Zimbabwe	Tanzania
Gabon	Nigeria		Timor-Leste
Gambia	Oman		Togo
			Uganda
			Uzbekistan
			Vietnam
			Yemen, Rep.
			Zambia
			Zimbabwe

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