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Universal access to drinking water: the role of aid

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Abstract

Financing and the role of aid within the water sector are poorly understood. We estimate the levels of spending achieved in developing countries during the Millennium Development Goals period to be US$80 billion per year. Aid represented a substantial proportion of total sector financing in sub-Saharan Africa and Oceania (25 and 10 per cent, respectively) but less in other regions. Longitudinal analysis shows no detectable effect of volume of aid on progress. Importantly, we were unable to evaluate 'catalytic' aid. As the world approaches universal access to improved water, aid must increasingly focus on sustaining progress and assisting countries that still have sizable unserved populations.

Keywords: water supply, foreign aid, Millennium Development Goals
JEL classification: F35, O18, H41, L95

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Acronyms and abbreviations

Given at the end of the paper

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1 Introduction

The increase in the use of improved sources of drinking water during the period assigned for the achievement of the Millennium Development Goals (MDGs) has been substantive. Many countries surpassed their targets and the global target was met five years early (WHO/UNICEF 2012). Moreover, the great majority of the progress has been in the highest service category currently monitored, piped water on premises (WHO/UNICEF 2012).[1] However, progress has been heterogeneous, and many countries still lag far behind, with persistently low coverage levels and poor quality services.[2]

When targeted appropriately, investments in basic water services have the potential to be both pro-poor and socially progressive. It is therefore not surprising that water has long been a mainstay of aid to the social sectors. Aid to water and sanitation is on the order of billions of dollars per year. According to the OECD Creditor Reporting System (OECD-CRS), which monitors overseas development assistance (ODA), on average US$6 billion was disbursed to water and sanitation by all OECD countries during the period 2009 to 2010 (OECD 2012a). In contrast to other social sectors, especially health and education, little is known about the role of aid in water service provision in developing countries.[3]

The evidence shows that aid to water and sanitation is not allocated commensurate with need (WHO 2012), and a range of donor priorities and levels of recipient preparedness influence allocation. With large amounts of aid being earmarked for water and sanitation in some countries, but not others, it is important to question whether the amount of aid received by countries relates to the amount of progress made. If aid has a strong influence on countries' development trajectories, this should be apparent when comparing country progress with levels of aid.

Previous studies have not shown aid to be strongly related to increased coverage of improved sources. For a group of forty-eight countries, Botting et al. (2010) find that countries receiving top tercile aid per capita were found to be eight times more likely to be in the top two-thirds of countries ranked by increases in improved source access. However, this effect was not significant when adjustments were made for confounders, such as GDP. An earlier model, based on ordinary least squares regression, did not find a significant relationship between coverage of improved sources and the share of aid to water and sanitation coverage (Wolf 2007). Both of these analyses suffer from methodological limitations and consequently say little about any causal link between aid and water service provision.

With increasing recognition of the Human Right to Water (de Albuquerque and Roaf 2012) and as we approach the end of the MDG period in 2015, there have been renewed[4] calls for more ambitious targets, including for universal access to basic water services and progressive

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[1] According to the most recent JMP report (WHO/UNICEF 2012), the proportion of the population with access to improved sources in developing regions increased by 16 per cent between 1990 and 2010, 87.5 per cent of which was due to increases in the proportion of the population with household connections.

[2] The achievement has been questioned because monitoring did not account for safety or sustainability as required in the MDG target formulation that called for the 'halv[ing] the proportion of the population without access to safe and sustainable drinking water'.

[3] By 'developing countries' we refer to the countries included in the MDG regional groupings that are not classed as developed countries. Refer to: www.mdgs.un.org/unsd/mdg/Host.aspx? Content =Data/ Regional Groupings.htm

[4] The International Drinking-Water Supply and Sanitation Decade (1981-90) also called for universal access.

improvements in level of service and service quality (WHO/UNICEF 2013). Consequently, it is essential to assess the affordability of these targets to determine whether countries will be able to sustain universal coverage. Several studies have estimated the costs of attaining the MDG targets and achieving universal water access coverage. Although crude, a similar approach can be used to estimate the levels of spending that were achieved during the MDG period, and the relative contribution of aid to this spending. This approach may provide insights into the financing of water service provision as well as the role of aid.

With the above in mind, this paper investigates the following questions: (i) How much does water infrastructure cost to build and maintain? (ii) How much has been spent on water infrastructure during the MDG period? (iii) In what form is aid to water supply deployed? (iv) Which countries benefit from aid and is aid to water allocated commensurate to need? (v) How much does aid contribute to investment in water supply? (vi) Is more aid associated with greater progress? (vii) Why are some countries making limited progress? (viii) What are the long-term goals for water services and how much would it cost to sustain universal coverage? The paper presents the findings of our research and raises questions for further investigation. A summary of the data analysis methods is provided in the appendix.

2 How much does water infrastructure cost to build and maintain?

The costs of water infrastructure comprise capital expenditure (for new coverage and rehabilitation or replacement of existing infrastructure), operations and maintenance (O&M) and programme costs. In a recent global analysis of the cost and benefits of water supplies, annualized costs for each country were reported (Hutton 2012); this is the only global dataset of water service provision costs known to the authors. In order to calculate the amount spent during the MDG period, we retabulate these costs based on a new model, which does not annualize the costs (Table 1). The estimates have been combined with ratios derived from an earlier study (WHO/UNICEF/WSSCC 2000) to allow for more detailed investigation of trends in water source technologies. We used constant 2010 USD throughout. It should be noted that these estimates may understate the overall costs of service provision as they do not account for infrastructure that may be required for the storage and bulk transport of water (e.g., dams). Details of these calculations are provided in the appendix (A1 and A2).

Piped supplies with household connections represent the most costly option, at approximately three to four times the per capita capital cost of other improved sources such as rainwater and protected dug wells. The next most expensive option is boreholes, at around half to three-quarters of the capital cost. In some countries where specialization has occurred, such as India and Mozambique, boreholes are substantially lower cost than piped supplies. For boreholes, standpipes and other community sources, the number of people using each water source can differ substantially and may account for some of the variation in cost per capita between countries. Variation may also be the result of corruption in the water sector; in Southern Asia, Davis (2004) finds that corruption could increase costs by 20 to 35 per cent.

There are large variations in per captain costs between regions: water services in sub-Saharan Africa (SSA) and Western Asia are particularly costly. In SSA the costs are generally high in comparison to the other region with low levels of coverage, Southern Asia. Regional averages mask substantial differences between countries: for example the capital cost of a household connection in Mozambique is estimated to be US$24 per capita compared with US$283 in Angola. Sub-national variation is also to be expected—a reminder that setting cost targets (dollars per beneficiary) is challenging and presents risks when some people are more difficult and expensive to serve than others. Cost-benefit or aid efficiency considerations may clash with pro-equity policy (Kelman 1981) and the obligations related to the Human Right to Water and Sanitation.

Table 1: Water service provision average costs per capita in developing countries, excluding programme costs (2010 USD)

Location	Water supply technology	Capital cost[1] (2010 US$)	Lifetime (years)	Annual O&M[2] (2010 US$)
Rural	Piped on premises	91	20	4.4
	Standpipe	39	20	1.9
	Borehole	76	30	1.4
	Other[3]	32	30	0.6
	Unimproved	-	-	-
Urban	Piped on premises	218	20	14.4
	Standpipe	93	20	6.2
	Borehole	108	30	1.0
	Other[3]	46	30	0.4
	Unimproved	-	-	-

Notes: [1] Calculated based on Hutton (2012) and WHO/UNICEF/WSSCC (2000) using the average annualized capital cost with a cost of capital of 8 per cent as used in the WHO Global Cost-benefit Analysis. Where a unit cost study utilized context-specific expected life spans, these are not reported in Hutton 2012. We therefore use the values presented in this table; [2] Mean value averaged across countries; [3] Includes rainwater harvesting, protected wells and protected springs.

Source: Authors' calculations based on Hutton (2012) and WHO/UNICEF/WSSCC (2000).

Somewhat counterintuitively, given that economies of scale would be expected with higher population densities, urban services are reported to be more expensive than rural supplies for the same technology (Hutton 2012). This may suggest that service levels and quality are higher in urban areas. For piped water, there is a great difference between systems that function continuously and provide treated water of a high quality and intermittent systems with no or irregular treatment. The difference may also be in part due to lower labour costs or purchasing power in rural areas.[5] It may also reflect more common use of communal sources in rural areas (with the possible exception of standpipes) and greater numbers of households sharing a given water supply.

The cost of service provision of course is not limited to capital costs and maintenance. Additional expenditures result from programme costs, including planning, monitoring and evaluation, and administration. These costs are poorly understood (Hutton 2012), limiting the ability to assess and benchmark them.[6] In the case of foreign aid, programme costs could be much higher than the 20 per cent assumption we use in this analysis, for example because aid can be spent on consultants from donor countries or may increase local salaries (MacKinnon 2003). Aid can also have high transaction costs for both governments and donors. As with capital and recurrent costs, programme costs may also be inflated by corruption.

In many cases, the actual costs of service provision may be higher than our estimates suggest due to the limited sustainability of water infrastructure investments in both urban and rural

5 Adjustment for PPP between rural and urban areas might help to explain these differences, however no global datasets for subnational are available (Majumder, Ray and Sinha 2012).

6 In the health sectors, programme costs are known to range considerably: one study finds that the costs ranged from 8-15 per cent for antenatal care whereas they were much high, at around 60-70 per cent, for education of sex workers (Johns, Baltussen and Hutubessy 2003: 1).

areas. Lack of investment in recurrent costs may result in 'asset mining' i.e., insufficient expenditure to secure lifetime performance of capital assets, resulting in premature permanent failure.

There is no single 'best' approach to financing for water services. Financing is derived from three main routes: taxes, tariffs or transfers (OECD 2009) (see also Figure 5). Two distinct, but related patterns are often observed: (i) no or partial cost recovery in urban settings (WSP 2011) and (ii) no or minimal spending on operations and maintenance of rural water supplies, with low levels of functionality and premature permanent failure (McIntyre 2010). Understanding the factors that lead to these outcomes and how they might be overcome is a key area for future research.

It is believed that for financing to be sustainable, there is a need for greater transparency, better monitoring of cost recovery and closer alignment between donors and recipients. Improved monitoring would draw attention to issues including corruption and could provide evidence to assess the extent to which financing is targeted at the poorest. There are a number of current initiatives that seek to improve sector finance monitoring and transparency, including TrackFin[7] (Trémolet and Rama 2012) and the Water Integrity Network.[8]

3 How much has been spent on water supply during the MDG period?

We entered the MDG period with a substantive stock of infrastructure and this has grown with both increased coverage rates and increased coverage levels (especially piped water supplies on premises). Since actual expenditure on water supply is known for only a small number of countries and no global dataset exists (van Ginneken, Netterstrom and Bennett 2011; Wolf 2007), we estimate expenditure based on the costs presented in the previous section. We estimate the total amount spent, which includes contributions from governments, households and donors (see A3 in the appendix for further details).

In total, an estimated US$860 billion[9] has been spent in low and middle-income countries between 2000 and 2010. The spending largely comprised rehabilitation and replacement of existing infrastructure (US$240 billion), operations and maintenance (US$320) and new coverage (US$160 billion). We have assumed that programme costs add an additional US$140 billion (17 per cent). Figure 1 illustrates the variation in the amounts spent per capita between MDG regions. Southern Asia, SSA and Oceania have all spent less than an estimated US$5 per capita per year, in total US$50, US$40 and US$0.8 billion a year, respectively. On a per capita basis, spending has been greatest in Western Asia—countries with high levels of service and comparatively high per-user costs.

We also calculate the extent to which the value of water and sanitation infrastructure has changed over the period (A4 in the appendix). Overall, the value of infrastructure assets, defined as the proportion of the stock cost multiplied by the remaining useable life of the

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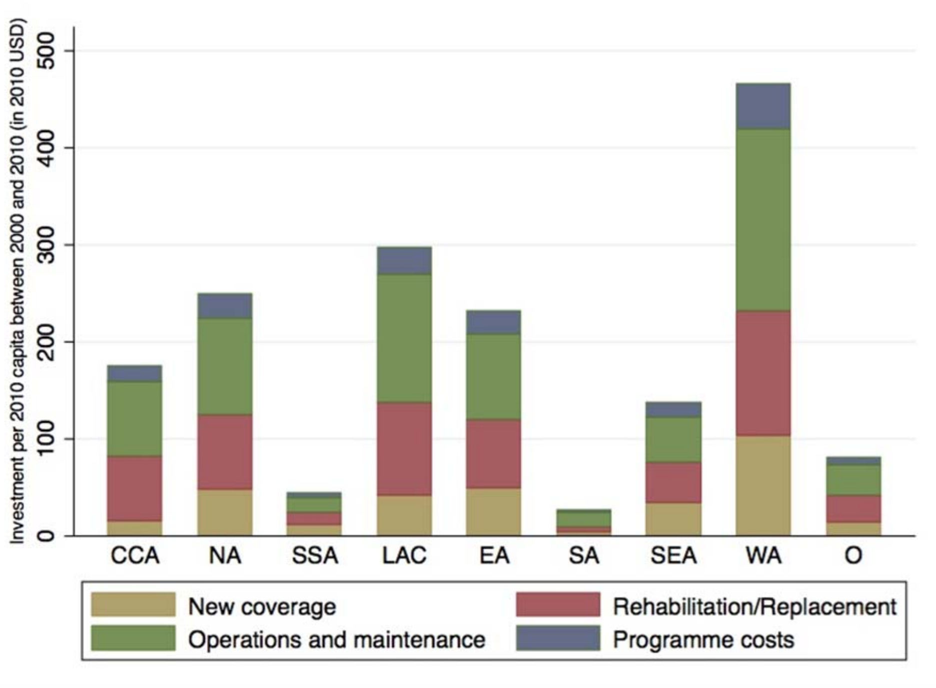
[7] The objectives of the UN-Water GLAAS TrackFin initiative are to define and test a globally accepted methodology to track WaSH financing.

[8] The Water Integrity Network formed in 2006 promotes increased transparency and integrity in the water sector. More information on the network can be found at: www.waterintegritynetwork.net

[9] The level of investment can be compared to estimates for other sectors, including transport, telecoms or social sectors (health, education). See section 10 for more details.

infrastructure, is estimated to have risen by US$45 billion to US$290 billion between 2000 and 2010. The increase is much lower than the total spent due to the large operations and maintenance (O&M) costs, depreciation (US$270 billion) and abandoned investment (US$78 billion). Abandoned investment results from users switching from one source to another, due either to a better source becoming available or migration. Such costs cannot be well estimated based on coverage; our estimate of the costs of abandoned investments may be low given that we are unable to account for some stepwise changes in technologies or migration within urban or rural areas. On the other hand, although they are no longer the household's primary source of drinking water, these sources may be beneficial for productive uses or as a backup drinking water supply.

Figure 1: Estimated spending per capita in 2010, by MDG regions



Notes: Our estimate of spending includes the costs of new coverage, rehabilitation or replacement, operations and maintenance and programme costs. It assumes that entering the MDG period (2000-10), existing infrastructure had half of its useful life remaining.
Millennium Development Goal regions are: CCA–Caucasus and Central Asia; NA–North Africa; SSA–sub-Saharan Africa; LAC–Latin America and the Caribbean; EA–Eastern Asia; SA–Southern Asia; SEA–South-east Asia; WA–Western Asia; O–Oceania.
Source: Authors' calculations based on data from WHO/UNICEF (2012) and Hutton (2012).

The majority of the infrastructure asset value has been added in Eastern Asia (in particular China) where access to household connections has greatly expanded in the last decade (from 53 per cent to 70 per cent according to the WHO/UNICEF 2012) (see Appendix 4; Table A2)

In agreement with expenditures reported by ten countries (WHO 2012), we find spending in urban areas has substantially exceeded that in rural areas (US$572 billion versus US$170 billion) despite the rural population outnumbering the urban population (3.0 billion versus 2.3 billion) on aggregate across the 115 countries. As such, the disparity between spending levels in urban and rural areas is even greater on a per capita basis (US$25 versus US$6 per year, respectively). This disparity is particularly notable in the Caucasus and Central Asia and in SSA, regions where rural coverage lags far behind that in urban areas. In Southern Asia, however, estimated spending in rural areas is found to exceed that in urban areas. That the estimated costs are higher in rural areas may be misleading since the estimates of O&M costs in rural areas may be too high. For example, the WASHcost project found recurrent costs to be very low in rural areas and small towns and noted that there was a 'recurrent expenditure gap' (Burr et al. 2012). More generally, it is unclear how the observed recurrent expenditure gap would affect our estimates in both urban and rural areas—recurrent costs may be replaced by equal or greater increases in capital costs resulting from the need to replace failing infrastructure.

4 In what form is aid to water supply deployed?

Official development assistance (ODA) to water supply is provided through three main modalities: projects, technical assistance and sector budget support. Here we use the definition of the OECD Creditor Reporting System. Data show that financing for investment projects (76 per cent) dominates aid commitments to water and sanitation (OECD 2012a). In contrast, technical assistance (7 per cent) and sector budget support (9 per cent) have attracted relatively little support from donors. The remaining aid comprises pooled funding, mainly to specific programmes by international organizations. It is not possible to differentiate between aid that is used to finance infrastructure and aid that can contribute to institutional capacity, nor can we be sure to what extent general (non-sector-specific) budget support (of circa US$5 billion committed in 2010) is utilized to support water supply programmes and ministries.

The type of project and manner in which assistance is offered to countries varies greatly, with an important distinction to be drawn between aid channelled through core-country systems and donor-led interventions (WSP 2011). OECD data clearly show the dominance of projects: almost 92 per cent of all aid to water and sanitation between 2000 and 2010 (see Table 2). Of the limited amount of aid for which the channel has been reported to the OECD, a large proportion was through public sector institutions (63 per cent; Table 3). Even in the low-income countries,[10] the vast majority of funding is reported to have been channelled through the public sector. There are exceptions: aid to the public sector was lower (36 per cent) and comparable to the amounts provided to NGOs and multilaterals in Sudan; NGOs and civil society organizations received the majority of funding in Somalia. In several other countries, aid delivered through channels other than the public sector was dominant. These included: Zimbabwe, Timor-Leste, West Bank and Gaza Strip, Paraguay, Myanmar, Libya, Liberia, Kyrgyz Republic and Kiribati. Iraq and Bangladesh are recipients of large amounts of aid per capita to water and sanitation that is not delivered through public sector channels. Many of these countries are politically unstable and are classed as 'fragile states' according definitions used by the World Bank (See Appendix 14; Table 6).

The financial instruments include grants and concessional loans. Sizable loans near market rates provided by multilateral banks are important for the development of national water infrastructure, but are not classified as 'aid' (OECD 2012a). Although these are not analysed here, they may make an important contribution to financing of water service provision in some developing countries. The OECD estimates that these non-concessional loans, primarily by multilateral development banks, represent almost 40 per cent of total flow to the water and sanitation sectors (OECD 2012a).

10 See Appendix 14 for definitions.

Based on the OECD Creditor Reporting System we calculate that between 2000 and 2010, 49 per cent of ODA took the form of grants. For the small proportion of aid for which sufficient details were recorded, 33 per cent was for basic systems and 66 per cent for large systems[11]. Aid earmarked for basic systems may be more closely associated with provision of 'other improved' sources.[12] Approximately 16 per cent of aid to water and sanitation was tied or partially tied, a figure that appears to have decreased somewhat over the period (10 per cent in 2009/10).[13] The type of financing agency also can have a strong influence—multilateral organizations have specific policies that can prevent countries from obtaining aid or limit aid to a certain type. For example, within the World Bank, the International Development Agency (IDA) provides concessional loans to countries meeting certain criteria, whereas the International Bank of Reconstruction and Development (IBRD) provides loans at commercial rates.

We do not consider the contribution of aid that has not been reported by OECD in this analysis as its magnitude and allocation patterns are not well established. Data are increasingly available, but remain incomplete, for non-traditional donors such as China, Brazil and Arab States through the Aiddata project (Tierney et al. 2011). Even less information is currently available for NGO or foundation aid to water. Funding from charities and foundations is thought to be small in comparison to bilateral and multilateral aid, and it may also be provided to the same countries (Koch et al. 2009). As an example, WaterAid reported providing US$30 million in assistance to water and sanitation in 2010 (WHO 2012), approximately 0.5 per cent of total reported by OECD.

Table 2: Disbursements to water and sanitation between 2000 and 2010, by type of aid

	2000-03		2004-07		2008-10		2000-10	
Type of aid	US$m	%	US$m	%	US$m	%	US$m	%
Sector budget support	167	8	200	3	385	3	752	3
Core support to NGOs, other private bodies, PPPs & research institutes	0	0	52	1	126	1	178	1
Contributions to specific-purpose programmes and funds managed by international organizations (multilateral, INGO)	0	0	0	0	376	3	376	2
Basket funds/pooled funding	0	0	0	0	87	1	87	0
Project-type interventions	1,911	92	7,270	97	13,087	90	22,267	92
Donor country personnel	0	0	0	0	410	3	410	2
Other technical assistance	0	0	0	0	142	1	142	1
Scholarships/training in donor country	0	0	0	0	7	0	7	0
Administrative costs not included elsewhere	0	0	0	0	2	0	2	0
Total reported	2,078	100	7,522	100	14,621	100	24,220	100
Type of aid not reported	7,514	-	8,335	-	2,682	-	18,531	-
Total aid reported to OECD	9,592	-	15,857	-	17,303	-	42,751	-

Source: Authors' calculations based on OECD-CRS, sector code 140.

11 Although these definitions are intended to be based solely on the type of supply, for further details and definitions of 'basic' and 'large' systems, refer to: www.euwi.net/files/CRS_Guidance_for_the_use_of_ Water_and_Sanitation _Purpose_Codes.pdf

12 Improved sources other than household connections, namely standpipes, boreholes, protected dug wells, protected springs and rainwater.

13 Untied aid is official development assistance for which the associated goods and services may be fully and freely procured by the recipient country.

Table 3: Disbursements to water and sanitation between 2000 and 2010, by channel

Channel	2000-03		2004-07		2008-10		2000-10	
	US$m	%	US$m	%	US$m	%	US$m	%
Public sector institutions	92	100	939	61	2,345	72	4,409	69
NGOs and civil society	0	0	268	4	911	7	1,179	6
PPPs and networks	0	0	40	1	51	0	90	0
Multilateral	0	0	426	3	1,654	10	2,081	5
Other[1]	0	0	1,655	27	1,022	8	2,677	14
Total Reported	92	-	6,145	-	13,018	-	19,255	-
Type of aid not reported	9,500	-	9,712	-	4,285	-	23,497	-
Total aid reported to OECD	9,592	-	15,857	-	17,303	-	42,751	-

Note: [1]Other includes research institutions and universities.

Source: Authors' calculations based on OECD-CRS, sector code 140.

5 Which countries benefit from aid to water supply and is aid to water allocated commensurate to need?

Perhaps the most important assessment of aid allocation to water and sanitation is the Global Analysis and Assessment of Sanitation and Drinking-Water (GLAAS), first published by WHO in 2008 and updated biennially (WHO 2012). Analyses focused on specific regions, for example the report prepared for the Africa Working Group of the European Union Water Initiative (Fonseca and Diaz 2008), also highlight which countries have benefitted from aid.

It is evident that ODA to water supply is not distributed in proportion to relative need, expressed as the proportion of the population without access to basic water facilities (Figure 2). This finding is in agreement with analyses of overall and social sector aid, neither of which were found to favour poorer countries (Baulch 2006; Baulch and Tam 2013). In particular, large per capita disbursements are noted for small island states (on average US$1.6 per capita, compared with US$0.25 across all developing countries) and some countries involved in conflicts with an international presence (especially Iraq). Other factors such as sharing an official language, religious affiliations or colonial ties are also known to be important determinants of aid allocation (Barthel 2013; Raschky and Schwindt 2012). Policies of either donors or recipients to limit aid dependency will also have a strong influence on levels of aid. Clearly, aiming for a lower level of aid dependency in the water sector will result in lower per capita aid in lower income countries.

There are several countries with low levels of improved source coverage that received low levels of ODA per capita. Countries with very low levels of aid per capita, despite improved source coverage below 75 per cent in 2000, included Libya and Myanmar, with less than

Table 4: Top aid recipients to water supply 2000-10, by three metrics

Rank	Total aid		Aid per capita		Aid per unserved
1	China	($1690m)	Tonga	($11.00)	Various[1]
2	Iraq	($1210m)	Samoa	($10.80)	Jordan
3	India	($990m)	West Bank and Gaza	($8.10)	West Bank and Gaza
4	Vietnam	($640m)	Cape Verde	($7.30)	Grenada
5	Morocco	($560m)	St. Vincent & the Grenadines	($7.00)	Maldives

Notes: [1]Several countries with very few unserved (1% or less) received aid. Of these, the following received US$1 of more per capita: Lebanon, Macedonia, Mauritius, Serbia, Tonga, Turks and Caicos Islands; [2]Based on OECD data, assuming two-thirds of aid to water and sanitation is earmarked for water.

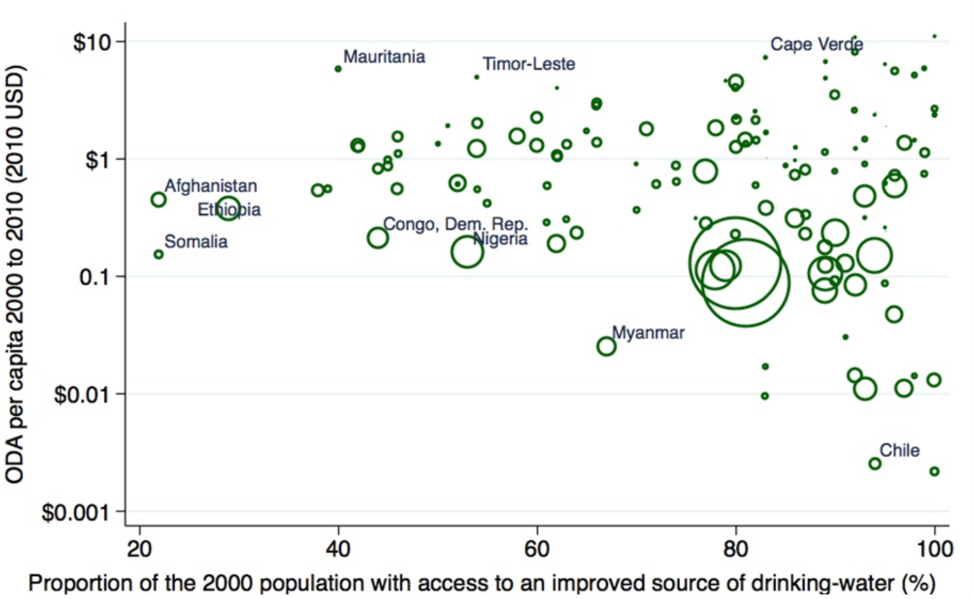
Source: OECD-CSR.

US$0.1 per capita, and Afghanistan, Cameroon, Central African Republic, Republic of Congo, Democratic Republic of Congo, Ethiopia, Liberia, Nigeria, Somalia, Sudan and Togo, which received less than US$0.5 per capita. Several of these are countries that have made very little progress during 2000-10 and most are fragile states, with challenging environments in which to improve public and private services (WSP 2011).

Multiple factors are known to influence donor priorities. In a survey of 20 external support agencies, the majority of donors cited the relevance and significance of their contribution and an established in-country presence as being important criteria in addition to need when selecting priority countries (WHO 2012). The first of these may suggest that larger countries will, in general, receive less aid—donors do not want to be 'a drop in the ocean'. These factors are reflected in disproportionate aid allocations: high and sustained levels of funding to some countries ('donor darlings') at the expense of others ('donor orphans'). The aid data collected by OECD bear this out. Twenty countries[14] with a population of less than one million in 2000 received 1.1 per cent of ODA between 2000 and 2010 despite having less than 0.2 per cent of the unserved population (over five times the average per capita unserved). Countries with populations of <10 million received 21 per cent of all ODA with an unserved population of 4.4 per cent of the total (4.8 times the average per capita unserved).

There may be virtuous cycles whereby successful investments lead to more donor financing which in turn lead to further successful investments. This is challenging to assess based on the available data. It is however clear that having received high levels of aid increases the chances of obtaining higher levels in later years – aid follows aid (Table 5). Of the countries

Figure 2: Comparison of improved source coverage with levels of overseas development assistance to water supply per capita per year between 2000 and 2010



Note: ODA data from OECD (disbursements) based on 2/3 for water and coverage data from WHO/UNICEF. Circle area is proportional to 2010 population.

Source: Authors' illustration based on OECD (2012b) and WHO/UNICEF (2012).

14 The Bahamas, Barbados, Belize, Bhutan, Cape Verde, Comoros, Djibouti, Equatorial Guinea, Fiji, French Polynesia, Grenada, Guam, Guyana, Maldives, Samoa, Sao Tome and Principe, Solomon Islands, Suriname, Tonga, Vanuatu.

Table 5: Chances of receiving high levels of aid depending on previous levels of aid received.

Aid levels					
2000-04	2005-09	Improved water source	No. of countries	Odds ratio	P (chi-2)
Top half	Top half	<75%	49	12	0.0002
Top quartile	Top quartile			29	<0.00001
Top half	Top half	50-75%	34	6	0.0496
Top quartile	Top quartile			10.5	0.0021
Top half	Top half	<50%	15	12	0.1013
Top quartile	Top quartile			4	0.2049

Note: Odds ratios and Chi squared test calculated using Stata 12 SE.

Source: Authors' calculations based on OECD (2012b) and WHO/UNICEF (2012).

Table 6: Concentration index for official development assistance to water and sanitation per capita

Period	Grants and loans	Grants	Loans
1991-94	-0.205	0.347	-0.423
1995-2000	-0.044	0.234	-0.030
2001-05	0.148	0.294	0.344
2006-10	0.225	0.420	0.259

Note: The concentration index can be a measure of the equitable targeting of resources. Here we rank countries by improved source coverage and ODA per capita. A value above 0 and approaching 1 indicates that a large share of ODA is targeted at countries with low levels of coverage. A value below 0 suggests that more aid is provided to countries with higher coverage levels. See Appendix 1.6 for details.

Source: Authors' calculations based on aid data from the OECD (2012b) and coverage data from the WHO/UNICEF (2012).

with improved source coverage below 75 per cent in 2000, those receiving levels of ODA per capita in the top half of aid recipients between 2000 and 2004 were 12 times more likely to be in the top half of aid recipients between 2005 and 2009; countries in the top quartile were 29 times more likely to remain in the top quartile.

One might expect this trend to be due to countries with lower levels of coverage receiving more aid, however the odds ratios do not appear to be due solely to aid being concentrated in countries with lower levels of coverage. In fact, on average countries with coverage rates between 50 and 75 per cent received more aid per capita than countries with less than 50 per cent coverage (42 per cent more, on average).[15] Without adequate monitoring and evaluation, this effect and the associated 'herding' (Frot and Santiso 2009) might equally take place in countries where little progress is being made and/or costs are high. However, we find that the correlation weakens over time. Moreover, using a concentration index (see A5 in the Appendix), we find that ODA is becoming more concentrated in the countries with the lowest levels of coverage (Table 6); donors do appear to be adapting and focusing their aid, especially loans, to target countries with lower coverage levels.

The inability of some of the countries most in need to absorb funds that are committed by donors is perceived to be a major challenge (WHO 2012). There can be wide a gap between levels of funds committed and disbursed (OECD 2012a). In the most recent GLAAS report, an index for 'absorptive capacity' was developed. Although only available for 2010 and for 54 countries, the index appears to highlight differences between countries: those with the lowest value of the index, i.e., those with low absorptive capacity, received on average half as

[15] Average aid was US$0.0204 compared with US$0.0148 per capita based on the 2005 population.

much aid per capita between 2000 and 2010 compared with other recipient nations included in the survey (Table 7). Improving absorptive capacity will require investment in institutional capacity (in policy, planning, training). If these investments are not made, for example developing strategic plans or addressing capacity issues, potential aid recipients are unlikely to receive aid, or use it effectively, for infrastructure projects. Wider recognition that this support is required will be needed to achieve closer alignment between donors and recipients, and to ensure that absorptive capacity increases. Such investments appear to be a low priority for many donors, as reflected by the limited funding for sector budget support or technical assistance. Moreover, we cannot be sure to what extent such funding is used for the purposes of increasing absorptive capacity. The limited ability to track such financing is itself a problem—the effectiveness cannot be monitored or evaluated, nor can donors be confident that it is making a significant and positive contribution.

An alternative explanation for the lack of absorptive capacity is the unpredictability of aid disbursements.[16] Unpredictable disbursements would influence the ability of a recipient country to both plan for and spend such funds. This is particularly the case in infrastructure sectors where substantial investment is required in the planning stages, as was noted in a public expenditure review in Tanzania (van den Berg et al. 2009). Increasing the predictability of aid in order to allow for longer-term planning is one of the main focuses of the Paris Declaration on Aid Effectiveness (Anon 2005).

Table 7: Index of absorptive capacity and average aid per capita during the period 2000 to 2010

Absorptive capacity index	No. of countries	Average ODA per capita (weighted)	Average ODA per capita (unweighted)
High	13	7.2	13
Medium	25	7.1	16
Low	17	3.2	7

Note: Aid per capita determined using the 2005 population; weighted average using 2005 population.

Source: GLAAS (WHO 2012) and OECD (2012b).

6 How much does aid contribute to spending in water supply?

Having estimated the amount spent during the last decade, we now turn to examining the extent to which aid has financed water service provision in developing countries. Based on OECD data, we find that a reported $26.6 billion was provided to water and sanitation in developing countries between 2000 and 2010. In 2010 alone, $6.9 billion of assistance was provided (OECD 2012b). Although the overall amount of ODA committed to water and sanitation has increased substantially since 2000, aid to water and sanitation has not kept up with other social sectors, including education and healthcare (OECD 2012a), and it has fallen as a proportion of total ODA (Figure 3) despite water and sanitation being explicit targets of international policy including the MDGs.

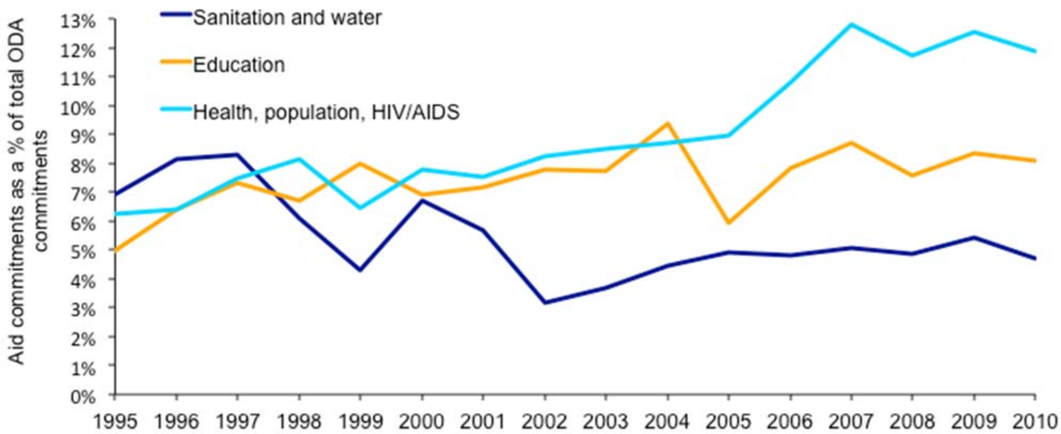
The total contribution of aid to water supply[17] for all developing regions is estimated at US$17.7 billion between 2000 and 2010, just less than 2.5 per cent of total spending. Of this,

[16] The timing of financing is also thought to be important. Funding that is offered late in the budgetary year may be less readily absorbed than that offered earlier in the budgetary year.

[17] It had not been possible to differentiate between ODA targeted at water and sanitation separately until 2010. The results presented in the Global Analysis and Assessment of Sanitation and Drinking-Water (WHO 2012) suggest that approximately two-thirds of ODA to water and sanitation is spent on water supply. In this analysis

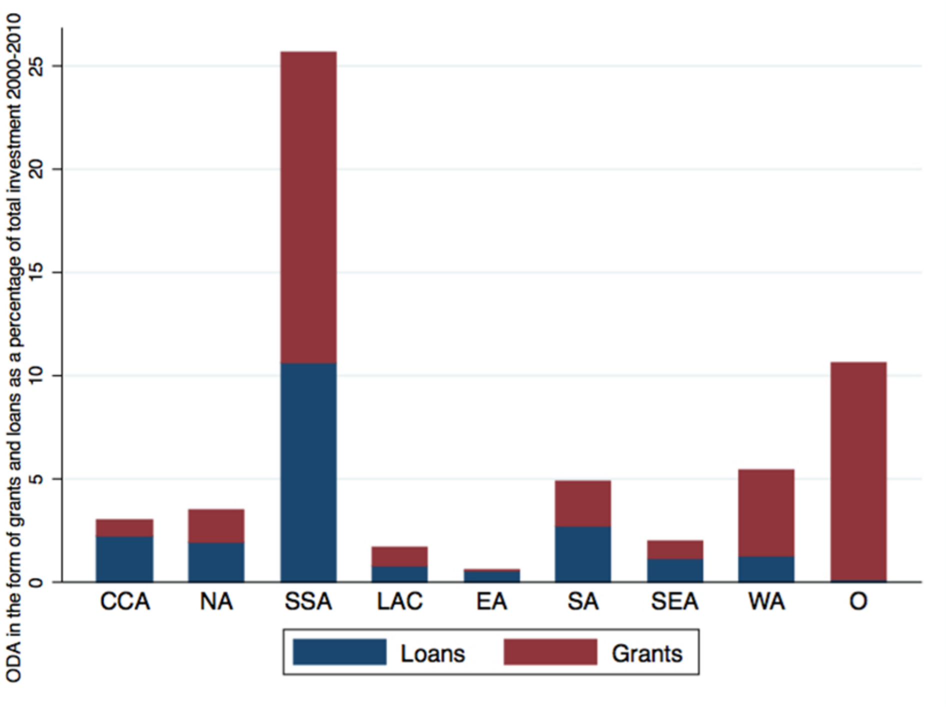
31 per cent was allocated to SSA and 10 per cent to Southern Asia. As shown in Figure 4, the contribution of aid to total spending was high in SSA (around 25 per cent) and Oceania (11 per cent), but lower in other developing regions (<10 per cent). Countries in Oceania almost exclusively received grants. Grants were also the majority of aid in Western Asia and SSA.

Figure 3: ODA commitments to water and sanitation, education and health as a proportion of sector allocable aid



Source: Global analysis and assessment of sanitation and drinking water (WHO 2012).

Figure 4: ODA received in the form of grants and loans as a proportion of expenditure on water supply between 2000 and 2010, by MDG regions



Note: See Figure 1 for the Millennium Development Goal regions.
Source: Based on OECD (2012b) and WHO/UNICEF (2012).

In a small number of countries, ODA was close to or exceeded the levels of spending based on our expenditure modelling (see A2 in the appendix). For example, in Mozambique ODA

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we exclude aid not reported by OECD-CRS, but include the disbursements from foundations and non-DAC members reporting to OECD-CRS. Further details are provided in section A5 in the Appendix.

totalled US$3.2 billion whereas total investment derived from the cost figures was US$2.7 billion. This may suggest that the costs of service provision have been substantially underestimated in these countries, perhaps due to underestimating the required level of rehabilitation and replacement of infrastructure (especially after the civil war in Mozambique), or as a result of inefficiencies in the channelling of aid. This may also be a reflection of cost estimates being based on a limited number of studies in each country that took place in settings where costs are particularly low.

Based on the contribution of aid to overall spending in each country and the amount of progress made in the country, it is possible to estimate the extent to which aid infrastructure investments have contributed to progress during the MDGs. Since ODA has, to a certain extent, been concentrated in countries that have made larger gains or have managed to maintain coverage levels despite high population growth, approximately 14 per cent of the MDG progress in developing countries could be attributed to aid (130 million beneficiaries out of a total of 936 million; see A6 in the appendix). A more detailed analysis could base the estimate on the financial contribution of aid to expanding basic access. A survey of 11 external support agencies indicates that approximately 57 per cent of ODA is dedicated to 'new services' (WHO 2012), whereas we estimate that new coverage was only 19 per cent of total spending between 2000 and 2010 (see A3 in the appendix). This might suggest that a larger proportion of new coverage could be attributed to aid. However, not all of the ODA is devoted to expanding coverage, with many of the larger loans being for 'large systems' which may not be new service or may not be reaching those who are using unprotected sources of drinking water. It is also possible that a large proportion of aid to water results in abandoned investments. Since it is not possible to differentiate between aid for service level improvements and expanding basic access, we did not attempt such a calculation.[18]

As with other sectors, the impacts of aid are not limited to financing, and their influence on the composition and effectiveness of other forms of investment can be important (Celasun and Walliser 2008). One of the major limitations of currently available data is that they do not distinguish between aid that is used to finance infrastructure investments and that to support institutional strengthening, planning and policy. Such investments may improve the sustainability of water infrastructure and the effectiveness of the sector as a whole, and consequently they could be more effective than investment in infrastructure (Anand 2013). This is the rationale behind initiatives such as Sanitation and Water for All,[19] which aims to raise water and sanitation as national priorities and support the development of strategic plans for the sector. Unfortunately, multi-country data are not available to directly evaluate the impacts of such investments.

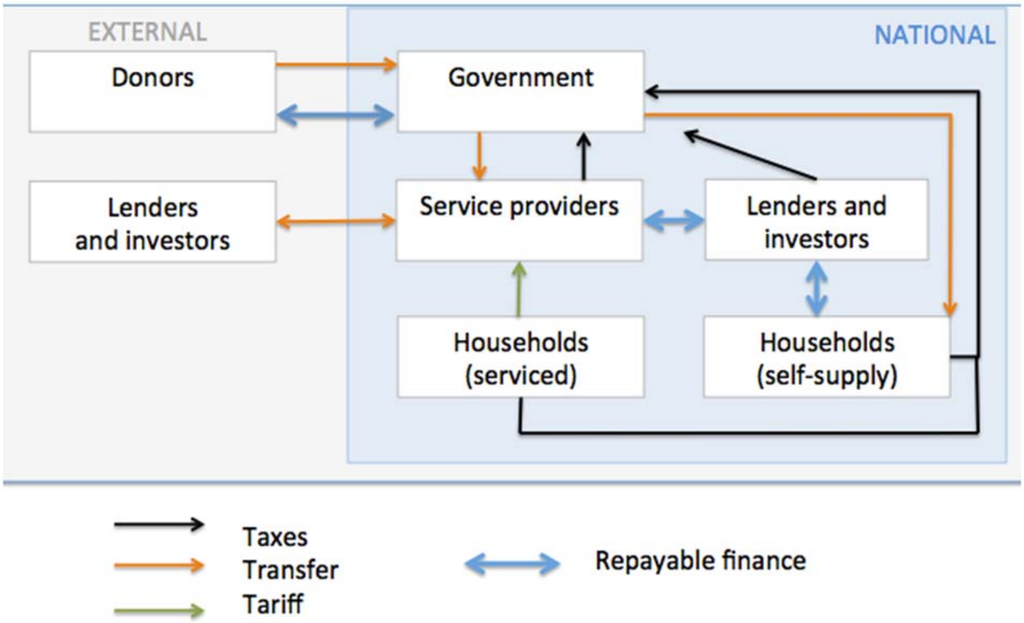
The remaining spending comes primarily from public expenditures and household contributions in the form of taxes, tariffs and private or community investments known as 'self-supply' (Figure 5). The relative contribution of households is not well understood, but is thought to be substantial. For example, studies conducted in SSA estimate that household contributions are typically one-third of total expenditure in water service provision (WSP

[18] Given that financing of water systems is comes from many sources and infrastructure investments represent only one of many contributions, it is questionable whether donors should claim to have reached such large number of beneficiaries by providing financing solely for new coverage.

[19] Sanitation and Water for All (SWA) is a partnership of governments, donors, civil society and multilateral organizations which aims to ensure that all people have access to basic sanitation and safe drinking water. More information is available from: www.sanitationandwaterforall.org

2011). Data from four countries collected by WHO (2012) suggest that households contribute anywhere from 30 to 61 per cent of overall spending and the majority of operational expenditures (>80% per cent).[20]

Figure 5: Financing for water service provision, a simplified diagram illustrating taxes, transfers, tariffs and repayable finance



A number of other transactions are possible, including direct donor financing to microfinance institutions or to either local or international NGOs, and government transfers to serviced households (or tax credits).

Source: Authors' adaptation from WHO (2012).

There is considerable and heated debate on the importance, appropriateness and desirability of private sector participation in water and sanitation in developing countries. Some argue that it has a limited role[21] and may distract from efforts to achieve sustainable financing of services via taxation (Hall and Lobina 2012). Others point to the claimed efficiency gains that can be achieved by private sector participation (Gassner, Popov Pushak 2009). It should be stressed that the private sector can provide repayable financing and may achieve gains in efficiency in the delivery of services and collection of tariffs (cost recovery), but cannot be expected to strive for universal access or progressive realization of the Human Right to Water unless contracted, incentivized or required to do so. The poor can be hard to reach and often need assistance to afford water services, requiring interventions that are part of public policy (WUP 2003). Aid could have important roles in both assisting countries to achieve sustainable financing and ensuring that equity goals are attained.

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[20] GLAAS survey (WHO 2012). Household contributions were: Iran (61 per cent), Bangladesh (36 per cent) Thailand (32 per cent) and Lesotho (30 per cent). In the three countries reporting household contribution to operational expenditure, in all three cases this exceeded 80 per cent.

[21] Global data available through the World Bank (2012) appear to suggest that private participation in the water sector is at low levels in most low- and middle-income countries (for example, approximately US$0.03 per capita per year in India). In China and Brazil, the levels are higher (US$0.64 and US$1.4 and per year per 2010 capita) but still represent less than 5 per cent of total spent between 2000 and 2010. However these data by no means capture the full extent of 'private' sector involvement.

7 Is more aid to water supply associated with greater progress?

7.1 Initial assessment

As an initial exploration, it is useful to examine countries that have made the greatest progress[22] during the MDG period. Did these countries receive high levels of aid per capita? Of countries making the most progress (Table 8), several have received large per capita amounts of aid, especially Cape Verde, Swaziland and Malawi. However, the levels do not relate directly to the amount of progress made in either improved sources or household connections. As an example, Afghanistan has made the most progress in improved source coverage, despite receiving less aid per capita than Lao PDR, Malawi, Cambodia and Swaziland. Similarly, ODA per capita in Cape Verde is an order of magnitude higher than in other countries making the substantial progress in household connections, but the amount of progress made does not scale with per capita ODA.

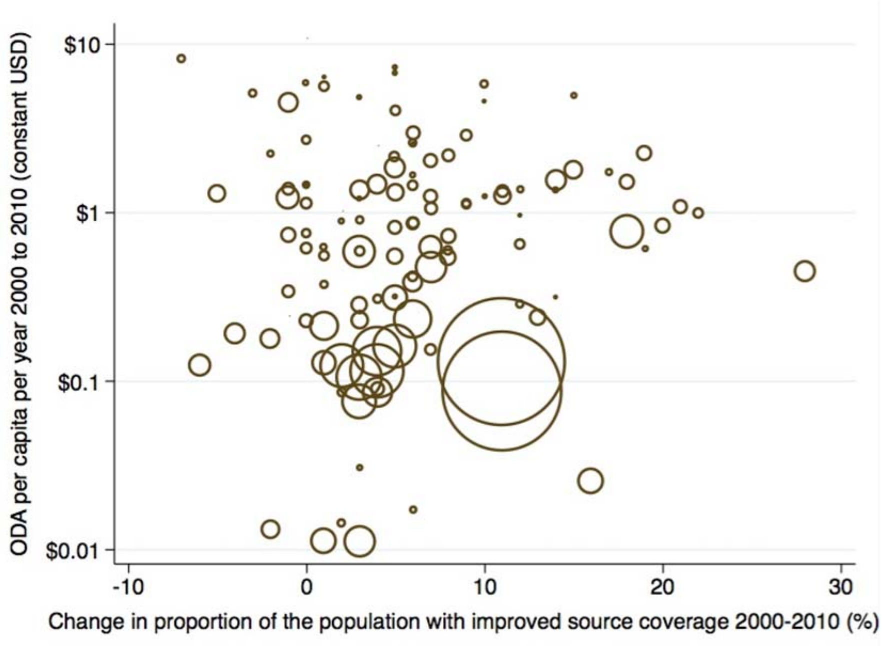
Table 8: Countries making the most progress in increasing access to improved water sources and household connections (2000 to 2010) related to ODA per capita

Improved sources			Household connections		
Country	Progress (Δ%)	ODA per capita	Country	Progress (Δ%)	ODA per capita
Afghanistan	28	$0.45	Cape Verde (25%)	25	$7.26
Lao PDR	22	$0.98	Egypt (18%	18	$0.59
Malawi	21	$1.07	China (17%)	17	$0.13
Cambodia	20	$0.83	Belize (16%)	16	$0.95
Swaziland	19	$2.20	Somalia (15%)	15	$0.15

Note: Burkina Faso is also reported as increased access by 19% (ODA p.c. US$2.25)—our order is based on unrounded figures based on survey data that put progress in Swaziland marginally above that of Burkina Faso

Source: WHO/UNICEF (2012) and OECD (2012b).

Figure 6: Comparison of aid per capita between 2000 and 2010 and progress during the same period (difference in the per cent of the population with improved source)



Source: Authors' illustration based on WHO/UNICEF (2012) and OECD

22 'Progress' can be measured using a variety of metrics and there are several competing issues in the choice of a suitable measure for progress. See discussion on page 22 for further details.

As a second exploratory approach, we visually investigate the association between aid and progress by plotting aid per capita over the period 2000 to 2010 against progress between during the same time (Figure 6). As can be seen from Figure 6, there is no obvious trend and this suggests that the relationship between aid and progress is either complex or there is no causal link.

7.2 Previous studies of the association between aid and progress

Few studies have investigated the association between aid and progress in the water and sanitation sectors. Botting et al. (2010) find that there was a strong correlation between the amount of aid received and relative progress in the proportion of people using improved sources for a limited number of developing countries (n=48). They use Spearman's rank correlation coefficient to measure how well the ranking of countries by aid per capita is related to progress, defined as the absolute change in percentage coverage. They find a significant correlation coefficient of 0.35 ($p=0.014$) between ODA per capita and progress. According to their study, the chances of a country making the top two-thirds of progress was eight times [95% CI: 1.8 - 35.9] higher for countries receiving the top tercile of aid per capita between 2000 and 2006. However, when adjusted for GDP, government health expenditure and land area the odds were lower (2.3) and not statistically significant.

Using OLS regression to model public service production functions, Wolf (2007) finds that the share of aid to water and sanitation was not associated with percentage coverage once adjustment was made for factors including GDP per capita. When adjustment was also made for federalism at the state or provincial level, the share of total ODA to water and sanitation was found to be negatively associated ($p<0.1$) with coverage. The negative coefficient might be explained by noting that donors take water sector coverage (compared to other aid priorities including educational attainment and health service coverage) into account when allocating aid within a given country. The interaction term between aid and control over corruption was positively associated ($p<0.1$). The study also included a measure of aid volatility (not sector specific), the extent to which aid varies between years. They note that aid volatility was significantly and positively associated with coverage of improved water, a result for which a satisfactory explanation could not be given.

7.3 Empirical analysis

Since both of the above assessments are based on OLS and grouped correlations, neither address concerns about endogeneity and omitted variables, nor do they provide convincing evidence of a causal link between aid and progress. We take advantage of the longitudinal nature of the aid and coverage data to compare levels of aid per capita with the extent of progress made between 2000 and 2010. There are several important issues: How to measure progress? How to measure aid (what mechanisms to assess)? What variables to control for? And finally, which econometric model to choose?

Measuring progress

First we determined that the relationship between ODA per capita and changes in coverage of improved sources was stronger than the relationship with changes in household connections coverage or reductions in the use of surface water by examining Spearman's correlation coefficients.[23] Based on these findings, we focus our assessment on the improved sources only and do not provide results disaggregated by source type. For the dependent variable in our models, we chose to use a simple metric: the proportion of people with access to an improved source (per cent). The models therefore assess whether countries receiving more aid made greater strides in increasing the coverage of improved sources.

Measuring aid

The composition of aid may be more important that the volume. Aid is thought to have two main mechanisms in which it can positively influence the development trajectory:[24]

— Infrastructure investments. This funding can supplement government and household spending to improve services and increase coverage, either in the early stages of the development trajectory, when costs are high and incomes low, or immediately post-conflict or post-disaster. Generally the majority of this funding is for capital costs, with the expectation that governments and households will cover recurrent costs. Infrastructure investments also cover rehabilitation and replacement of supplies. As a country progresses and the attention shifts to improving levels of service and service quality, government sources of infrastructure investment take over, which may include non-concessional loans.

— Catalytic aid. This includes smaller, more strategic grants focused on improvements in institutional capacity: planning, budgeting and management, with a particular focus on sustainability of projects and the development of an 'enabling environment'.[25] The aim of this aid is to improve a country's ability to use the resources and financing available to it and to attract other resources (including infrastructure investment aid).

The first of these mechanisms is much easier to assess, and the volume of aid gives a good proxy. For this analysis, we use aid per capita as our measure of aid. Unfortunately, given the lack of suitable data, we were unable to consider catalytic aid in this analysis.[26] In our model, aid per capita is lagged by five years to account for the delay between disbursements and resulting service provision.

Control variables

Many of the important variables that one would wish to control for are known to be inter-related (Dondeynaz, Carmona Moreno and Céspedes Lorente 2012). We used a correlation matrix and variance inflation factors[27] to identify variables that were not strongly related to one another and only included those variables for which sufficient observations were

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23 Spearman's correlation coefficients between aid per capita (2000-09) and increases in coverage of improved sources (0.278, p=0.0014), household connections (0.022, p=0.8) and reductions in the use of surface water (0.201, p=0.0434).

24 These two categories can be complementary and may of course be interrelated. Infrastructure investments can increase capacity, whether or not this as an explicit aim.

25 The explicit target of non-project and catalytic aid, investments to promote an enabling environment are those that seek to provide the environment in which sustainable water services can be delivered.

26 Future analyses could seek to explore the differences in these two mechanisms, potentially by classifying aid based on the donor's priorities in terms of infrastructure vs. sector budget support and technical assistance.

27 Implemented in Stata 12SE using the *collin* and *correlate* functions (results not shown). Any factors with a coefficient greater than 0.75 or variance inflation factor of greater than ten was investigated.

available (Table A5). Preference was given to variables for which the theoretical argument for a relationship is strongest. We included:[28]

- Economic indicators. The logarithm of GDP purchasing power parity per capita (*lngdp*); the proportion of GDP from natural resources (*natres*); household expenditure per capita PPP (*houseexp*).
- Governance Indicators. World governance indicators government effectiveness (*goveff*) political stability (*polstab*) and voice and accountability (*voice*).
- Demographic indicators. The proportion of the population living in urban areas (*pop_urb*); the total population in a country (*pop_tot*) and population density (*pop_den*).

We also included improved sanitation in one model, to illustrate the close relationship between progress in increasing access to water and sanitation. Due to the limited availability of timeseries data, it was not possible to control for a number of potentially important variables, including the availability of water resources and the different technology choices made by countries. We also avoided compound indicators such as the human development index (HDI) and UN-Habitat indicator for the urban population living in slums,[29] preferring instead to use the underlying data (Dondeynaz, Carmona Moreno and Céspedes Lorente 2012). Two interaction terms (aid and GDP, aid and government effectiveness) were included as we anticipated a greater effect of aid in lower-income countries and in countries with stronger and more effective institutions.

Models

Covering 20 years and 114 countries, the panel is short but strongly balanced. General method of moments models are no longer perceived to be a panacea in the analyses of aid and growth because these models can be unstable and result in biased estimates for short panels (Arndt, Jones and Tarp 2013). Similarly, the dataset may be too limited temporally for more sophisticated models based on likelihood (e.g., limited information maximum likelihood) and this remains an active area of econometric research (Akashi and Kunitomo 2012). We therefore selected the well-established fixed effects model[30] to investigate the relationship between aid and progress. Fixed effects models help to reduce confounding by unobserved or omitted country-specific variables (Angrist and Pischke 2008: 392). Our model takes the form:

$$y_{it} = \sum_j \beta_j \cdot X_{it,j} + \beta_{ODA} \cdot X_{i,t-5,ODA} + \alpha_i + \epsilon_{it}$$

where y_{it} is the improved source coverage level (in per cent) for country *i* at time *t*, β_j are the regression coefficients for the *j*th explanatory variable, $X_{it,\ j}$. Lagged aid per capita and its coefficient are respectively, $X_{i,t-5,ODA}$ and β_{ODA}. The country fixed effects are α_i and ϵ_{it} is

28 Note that the fixed effects model takes starting level of improved source coverage into account as a country fixed effect.

29 UN Habitat's slum population indicator relies on data from JMP to assess water and sanitation coverage in urban areas. It is therefore also excluded from our analysis to avoid this circularity. See MDG indicator 7.10 for further details: www.mdgs.un.org/unsd/mdg/Metadata.aspx?IndicatorId=0&SeriesId=710.

30 This choice was made on the basis of a Hausman test (chi2 = 51.7, p<0.0001), implemented in Stata 12SE using the *hausman* function with the *sigmamore* option.

the residual (or error term). For the interaction terms, we replace X_{it} with the products of the explanatory variables.

Table 9: Panel regression using country fixed effects models to elucidate the relationship between aid and progress in increasing access to improved sources

Model number	I	II	III	VI	V	VI
laggedaidpc	0.0672 (1.48)	0.0310 (1.25)	0.00777 (0.13)	0.0255 (0.42)	0.0368 (0.63)	0.0132 (0.20)
lngdp		25.60*** (7.50)	31.19*** (5.85)	23.01*** (3.74)	23.85*** (3.89)	13.62* (2.24)
natres			-0.0119 (-0.35)	-0.00961 (-0.31)	-0.0162 (-0.59)	-0.00929 (-0.41)
houseexp			-0.00062** (-2.88)	-0.00050 (-1.89)	-0.00048* (-2.03)	-0.00022 (-1.27)
govexp			-0.0381 (-0.42)	-0.0243 (-0.30)	-0.00507 (-0.07)	-0.00770 (-0.12)
pop_tot				0.0161 (0.97)	0.0144 (0.91)	0.00553 (0.30)
pop_urb				0.470* (2.40)	0.440* (2.25)	0.0308 (0.15)
pop_den				-0.00060 (-0.96)	0.000043 (0.06)	0.00025 (0.32)
goveff					-1.176 (-1.12)	-1.292 (-1.40)
polstab					-0.424 (-0.76)	-0.590 (-1.05)
voice					0.898 (0.90)	1.207 (1.26)
san_imp						0.491*** (5.24)
_cons	79.50*** (1238.7)	-10.54 (-0.88)	-27.60 (-1.50)	-23.35 (-1.33)	-25.33 (-1.46)	0.576 (0.03)
N	1411	1334	888	888	807	802
Adjusted R-sq	0.006	0.323	0.419	0.470	0.477	0.582

Note: Robust standard errors; t-statistics in parentheses; * p<0.05, ** p<0.01, *** p<0.001
Source: Author's calculations.

Descriptive statistics for the included variables are provided in the appendix (A8; Table A6). The empirical analysis of longitudinal data (Table 9) provides support to the interpretation of Figure 6; we find no significant effect of volume of aid on improved source coverage over time (or 'progress'). This is consistent across all models. The unadjusted fixed effects estimate (Model I) has a very low adjusted R^2 value indicating very limited correlation between aid and water coverage. Adjusted estimates indicate that there is no evidence for a causal relationship between aid and water coverage (Models II-VII). Variables that are most associated with water coverage are gross domestic product (Models I to V) and sanitation coverage (Model VII). The association between water and sanitation suggests that countries that prioritize water coverage also make substantial progress in increasing access to basic sanitation facilities. Surprisingly, none of the governance indicators (or the interaction terms, results not shown) between these indicators and levels of aid were found to be significant.

In assessing the relationship between aid and progress, there are a number of key methodological challenges. Issues include:

(i) There can be a long lag between disbursements and the installation and use of water infrastructure and this varies depending on the type of project. Large infrastructure projects or programmes may take eight to ten years, whereas a smaller infrastructure project may take less than three years. Although technical assistance and budget support may be spent within a year or two after a commitment is made, its impact might not be apparent from coverage figures for over a decade. We have simplified this by assuming a lag of five years. Since the ODA data only capture a small proportion of aid in decades prior to 2000, such analyses might have to be based on the assumption that patterns of aid during the last decade (2000-10) resemble those of the previous decade (1990-2000).[31]

(ii) The extent to which unobserved variables confound the assessments of the relationship between aid and progress is difficult to gauge. Examples of potential confounders include levels of household spending and cost recovery. The number of control variables that could be included in our model was restricted by the availability of timeseries data. There is therefore considerable chance of omitted variable bias; future studies could attempt to address this by the selection and use of suitable instrumented variables (Angrist and Krueger 2001).

(iii) Aid is delivered in a variety of forms; *aid per capita* therefore simplifies a much more complicated picture. The reasons for providing development assistance differ substantially; in countries recovering from natural disasters or conflict, large amounts of financing are dedicated to rehabilitation and re-establishment of service. Such spending is not necessarily captured by measures of 'progress' based solely on changes in coverage between years. Furthermore, in countries such as Morocco, coverage levels are high and aid is primarily used for service quality improvements such as improving the continuity of piped supplies; this would suggest that analyses not only ought to take the starting coverage into account, but also level of service and service quality.

(iv) Aid can be f*ungible* (Chatterjee, Giuliano and Kaya 2012). Although aid may be labelled for water projects, it may not to be additional to what would otherwise have been spent. Without a counterfactual we cannot be sure to what extent sector-specific aid is above and beyond what would have been spent in its absence. Conversely, in recipient countries where a limited share of aid is earmarked for water projects, governments may supplement this by adapting their spending plans accordingly. A related issue is that aid to other sectors can influence the costs of service provision or the effectiveness of sector-specific aid to water.

(v) Reported aid flows may not be representative and there can be discrepancies between different datasets, especially at the country level (Van de Maele, Evans and Tan-Torresa 2013).

(vi) The low precision of household survey data and their relative infrequency, especially in the first few years after the MDG baseline in 1990, has required the JMP to use statistical tools to smooth data and interpolate and extrapolate trends. A linear regression of coverage reported by household surveys and censuses over

31 The findings from our concentration index would suggest that such an assumption might be unrealistic.

time is used.[32] As the availability of data increases, alternative regressions that better reflect progress might be used. Two possible adaptions are the use of the logistic function (Yerg, Bain and Bartram 2013) or multilevel modelling (Wolf, Bonjour and Pruss-Ustun 2013). It may also be possible to adjust estimates to compensate for declining household size (Bartram, Elliott and Chuang 2012). Alternatively, it is conceivable that the underlying survey data could be used, although the variability may present difficulties for longitudinal analysis.

(vii) Progress has been measured in a number of different ways, including increases in: the proportion of the population with access to improved sources; the number of people with access to improved sources; percentage increases in the proportion of people with access to improved sources (Botting et al. 2010); and the proportion of the urban growth covered (WSP 2011). The proportion of the (WHO/UNICEF 2012) current population that gained access since 1995 has also been used (Wolf, Bonjour and Pruss-Ustun 2013). Recently, an alternative metric based on the log odds ratio has been proposed (Anderson and Langford 2013). Each of these metrics can be used to highlight different aspect of the progress that has been made during the MDG period; analysis based on each measure could potentially lead to different conclusions (for an illustration of these effects, see Figure A1 in Appendix 7).

Whilst the findings of this empirical assessment cast some doubt over the influence of aid on water and sanitation provision, and these are consistent with previous analyses, it should be emphasized that there are many reasons why such an effect might not be observed (Anand 2013). In particular, volume of aid is not a proxy for the catalytic effect aid could potentially have on a country's water service trajectory. It is also possible that the 'micro-macro paradox'[33] in the relationship between aid and growth (Arndt, Jones and Tarp 2013; Mosley 1986) also applies to water service provision. We recommend that future assessments focus on the 'micro' data, for example by conducting a systematic review of the effectiveness of aid projects to water supply. A recent example that could be applied to water and sanitation is the recent systematic review of aid to the maternal and reproductive health sector (Taylor et al. 2013).

Lastly, we caution that the above analyses are based on comparisons made between countries and are therefore a coarse means of assessing the role of aid in water service provision. They have not taken into account the extent of (or progress in reducing) inequalities within countries, for example between rural and urban dwellers, the richest and the poorest, or between ethnic groups, inequalities that are known to be substantial in many countries (WHO/UNICEF 2011). An index to monitor these has recently been proposed (Luh, Baum and Bartram 2013). Though the data are imperfect, we find that neither the outcome component parts of this index (reductions in urban to rural and piped on premises to 'other improved' disparities) nor reductions in surface water use are related to levels of aid per capita or aid as a proportion of overall spending. Details of these calculations are provided in the Appendix 9. These preliminary findings may point to a limited impact of aid on equity but further work is needed to understand the relationship between aid and equity.

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[32] Further information about the JMP methodology is available on from wssinfo.org

[33] The 'micro-macro' paradox refers to the inability to establish any significant correlation between aid and economic growth (at the macro level) whereas donor agencies and evaluations of aid projects regularly report successes. See Mosley (1986) for further details.

8 Why are some countries making limited progress?

During the MDGs, access to improved sources has increased substantially and most countries are catching up; in terms of access to improved sources of drinking water, countries have converged (Neumayer 2003).[34] Although the MDG target at the global level was met five years early (WHO/UNICEF 2012), many countries lag far behind and are not making enough progress to reach universal access in the foreseeable future. At least 21 countries[35] would not achieve basic access by 2050 if current rates of progress were maintained. In a further seven countries,[36] access in urban areas has failed to keep up with urban population growth; unless this trend is reversed in these countries, urbanization may result in an overall decline in urban coverage between now and 2050. This raises the question of why these countries are failing to catch up. What other factors influence the coverage levels that have been attained?

Many factors are known to be associated with higher levels of coverage and greater progress in water service provision. In this section, we highlight a few of the factors that appear to have a strong influence and draw on the findings of the Country Status Overviews (WSP 2011) which identified wealth, state fragility and natural resource use as important determinants of the amount of progress made in SSA.

First and foremost, income level appears to have a very strong influence on both levels of coverage and service. Perhaps one of the greatest 'surprises' of the successes during the MDG period has been the extent to which countries strove for piped water on premises, rather than expanding access to the lower cost options such as boreholes and standpipes. Figure 7 illustrates a clear trend for increasing coverage of household connections with GDP per capita; coverage is seen to follow an 'S-curve'. A similar pattern is observed for other measures of state capacity (Anderson and Langford 2013) and appears to take place for individual countries over time (Yerg, Bain and Bartram 2013). This pattern is by no means restricted to water services and has been identified for other technologies and forms of infrastructure, including transport (Grübler 1990). This trend is likely in part influenced by households' willingness to pay for higher service levels and ability to do so as wealth has increased; a recent World Bank study suggests that there is a substantial untapped demand for higher level water services (World Bank 2013). For all improved sources in low-income countries, there is greater variability in levels of basic access, with some countries considerably outperforming others for the same level of GDP (see Figure 7).

The interpretation of trends from Figure 7 requires substantial caution: Anderson and Langford (2013) note that *changes* in state capacity were not nearly as well correlated with *changes* in coverage of improved sources. It is easy to see how high expectations about likely

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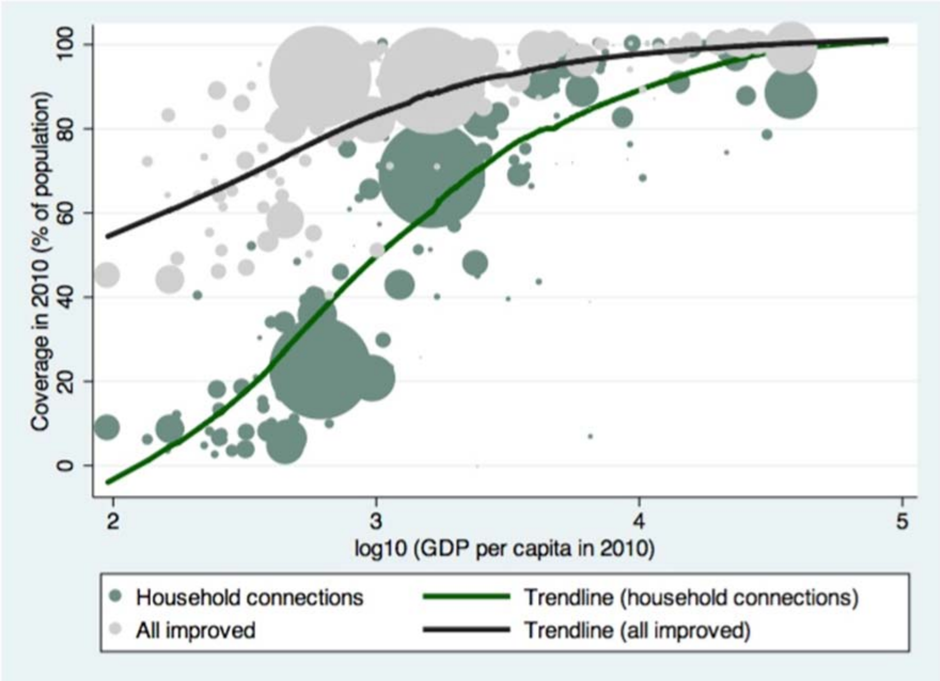
[34] Although convergence appears to have taken place for improved sources, we do not find this for household connections; a concentration index for household connections is not significantly different in 2000 and 2010 (see Appendix A10).

[35] Countries with <75 per cent coverage and not 'on-track' for universal coverage by 2050 (in bold if reported coverage has declined): **Angola**, Burundi, Central African Republic, Chad, Congo, Congo, Haiti, Lesotho, Madagascar, Mozambique, Niger, Nigeria, Papua New Guinea, **Rwanda**, Sierra Leone, Somalia, **Sudan**, Tajikistan, **Tanzania**, Togo, **Yemen**. Due to limited household survey data, the status of Libya is unclear and has not been included. For methods see Appendix A11

[36] Algeria, Djibouti, Gabon, Lesotho, Uzbekistan, West Bank and Gaza, Palau. For methods see Appendix A11.

Figure 7: Coverage of household connections and other improved sources is higher in richer countries



Note: Trendlines based on an unweighted Lowess smooth**.** Filled circles are proportional to each country's population in 2010.

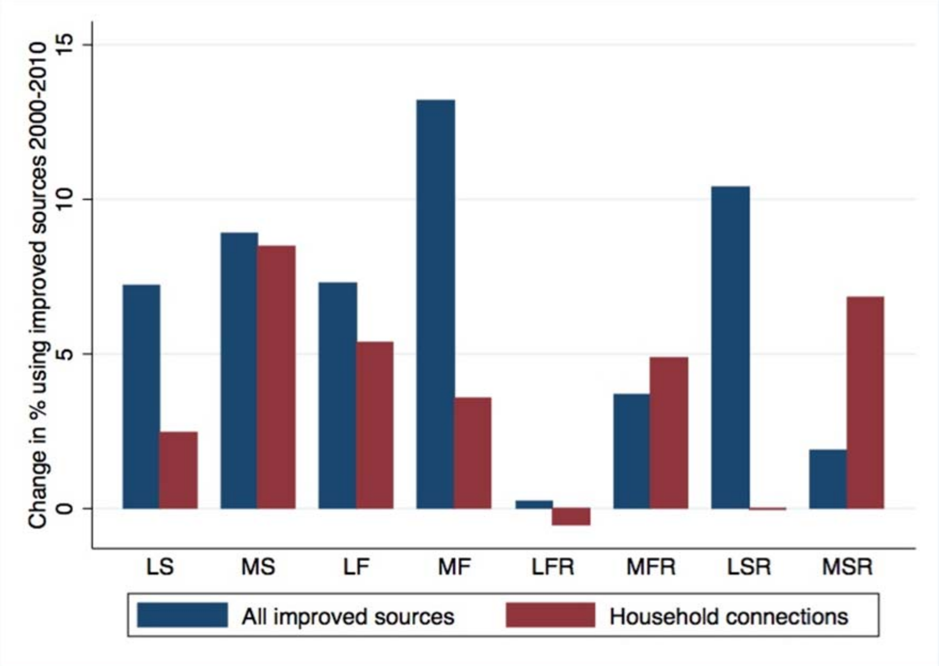
Source: Authors computation based on WHO/UNICEF data on water supply coverage and World Bank GDP per capita data.

progress might be reached based on comparisons of state capacity and *level* of coverage rather than *trends*. Our longitudinal analysis (Table 9) is suggestive of a strong positive relationship between GDP and improved source coverage and would thus appear to support an optimistic interpretation of Figure 7.

In addition to GDP per capita, previous analyses of progress in SSA point to the importance of state fragility and natural resources use (WSP 2011). Exploring this relationship for all developing countries, we find that the patterns differ considerably from those of SSA (see Figure 8a). In particular, countries that are middle-income, fragile and resource-rich (a category not covered by the WSP reports) have made substantial progress. As shown in Figure 8b, these were also the group that received the highest per-capita levels of aid (US$3). As in sub-Saharan Africa, low-income, resource-rich and fragile countries have made the very least progress. This is despite having received aid totalling around US$0.5 per capita over the period. Double this level of aid was noted for low-income stable and middle-income stable and resource-rich countries, though this was predominantly grants in low-income countries and large loans in middle-income countries—an effect that appears to be reflected in their relative progress in improved sources and household connections.

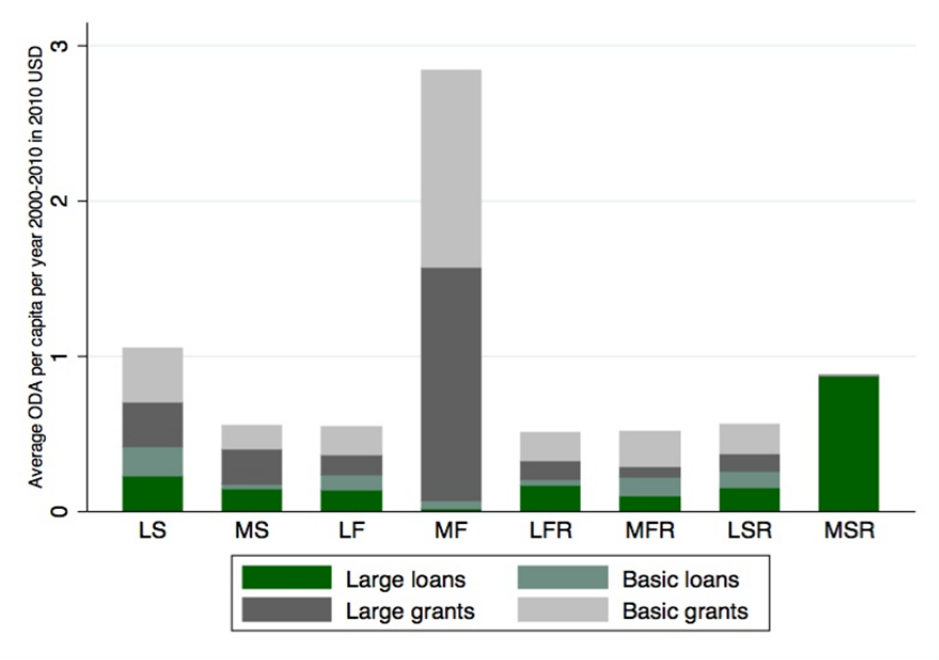
Authors have emphasized the importance of a variety of factors other than GDP on coverage levels, in particular government effectiveness (Krause 2009; Wolf 2007). Since the factors that influence a country's progress are interrelated (Dondeynaz, Carmona Moreno and Céspedes Lorente 2012), a variety of different groupings could 'explain' why some countries are lagging. One promising approach may be to utilize water and sanitation country clusters, 'natural' groupings of countries based on their water and sanitation sectors' performance which are derived using hierarchical cluster analysis (Onda et al. 2013). These could provide a tool to assist donors in targeting their aid and understanding the factors that influence its effectiveness. A further approach, which provides potentially more actionable information, is the service delivery pathway developed by the WSP of the World Bank (WSP 2011).

Figure 8a: Comparison of progress in increasing access to improved water supplies and household connections, by country grouping based on three characteristics: income, natural resources use and fragility



Note: Country classification: L–low-income or M–middle-income; S–stable or F–fragile; R–Resource rich.
Source: Authors' computation based on WHO/UNICEF and country classification (section A14/Appendix).

Figure 8b: Comparison of ODA per capita to water supply, by country grouping based on three characteristics: income, natural resources use and fragility



Note: See note to Figure 8a for country classification
Source: Authors' computation based on WHO/UNICEF, OECD and country classification (Appendix A14).

9 What are the long-term goals for water services and how much would it cost to sustain universal coverage?

Household connections offer substantial benefits over community supplies. These can include a reduction in the burden of collecting and transporting water,[37] greater quantities of water and potentially a lower risk of contamination. There is a greater willingness to pay and higher demand for household connections, as illustrated by the relationship with GDP. As such, household connections can and arguably should be considered a realistic goal for water policies.[38] In rural, sparsely populated areas, small service providers or private supplies are likely to dominate as they do in high-income countries. As demonstrated by the world's two most populous nations, there are two very different approaches that can be taken in rural areas: private wells, primarily boreholes, have dominated progress in India, whereas China has almost exclusively sought piped water on premises.[39] In urban and peri-urban areas, the benefits of connection to a well-regulated municipal supply generally outweigh those of other options, as long as high levels of service are sustained at reasonable cost.

It is commonly argued that a focus on higher service levels may come at the expense of the poor (and usually rural) within a country (Anand 2013). We do not find evidence to suggest that countries making greater progress in household piped service did so at the expense of overall coverage in rural areas. In fact, progress in household connections may be positively correlated with rural coverage: the Spearman rank correlation coefficient was 0.18 ($p=0.06$; Appendix A11). This might suggest that once there is political will to address water service provision, progress can be made on all fronts. In unequal countries, urban provision may stagnate or even decline as unserved peri-urban and slum areas expand. Further investigations would be required to confirm this finding and explore the relationship between progress in piped services on premises and equity targets such as increasing coverage in the poorest quintile.

How much would it cost to sustain universal coverage? Required spending as a proportion of 2010 GDP for each MDG region is shown in Table 9 (see Appendix A12 for details) and contrasted with three scenarios for universal coverage: (i) basic access, whereby all of the currently unserved population are provided with the lowest cost improved source, (ii) current technology mix and (iii) universal access to household connections. These levels are contrasted with those for 2017 GDP per capita projections based on data from the IMF and an assumed inflation rate of 5 per cent. Although crude, such projections illustrate that the costs

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[37] Household survey data show that this burden falls disproportionately on women and children. It is estimated that in 25 countries alone, they spend at least 20 million hours each year (WHO/UNICEF 2011).

[38] Historical evidence, including progress during the MDGs, is suggestive of a clear trend for increases in household connections which may suggest that such a target is not infeasible as countries' capacity to fund water service provision increases with economic growth.

[39] According the JMP's estimates (WHO/UNICEF 2012), the coverage of piped water on premises in rural areas of China increased from 12 to 45 per cent between 1990 and 2010. Although private wells and boreholes are not distinguished in the JMP reports, the categories are included in some early surveys and can be estimated by combining information about the primary source with the distance to collect water. The India National Family Health Surveys and Demographic and Health Survey (DHS) in 1993 indicate that approximately 44 per cent of the rural population used boreholes, 39 per cent of which were private. In the most recent survey available through the DHS Measured (2005/06), the proportion of the rural population using boreholes is much higher (56 per cent) and that the proportion of community to private wells supplies are included as categories in some surveys in India or can be inferred from the distance to source. These suggest that 44.1 per cent of these are on premises. All data taken from JMP country files (wssinfo.org).

of universal coverage and higher levels of services will decrease, as growth is expected to exceed inflation in most developing regions, making water services relatively less expensive in the long run. It should be noted that GDP in many countries is thought to be substantially reduced by lack of investment in water supply, sanitation and hygiene; our estimates may therefore overestimate the longer-term share of a country's wealth needed to sustain water infrastructure.[40]

We find that spending over the MDG period (2000-10) varies considerably between regions. It is very low in Southern Asia (which in population terms is dominated by India) and high in Western Asia, Northern Africa, and the Caucasus and Central Asia. Levels are comparable in Latin America and the Caribbean, Eastern Asia, and Sub-Saharan Africa despite very different levels of coverage and types of service. As a benchmark, the Human Development Report (HDR) in 2006 proposed that:

> In low-income countries with limited coverage and high levels of poverty, a benchmark indicator is public spending on water and sanitation of about 1 per cent of GDP (depending on per capita income and the ratio of revenue to GDP), with cost-recovery and community contributions providing an equivalent amount (UNDP 2006).

Universal coverage using the current technology mix is achievable within 1 per cent of current GDP in all regions except for North Africa, Western Asia and the Caucasus and Central Asia. It is highest in Caucasus and Central Asia and Western Asia (2.1 and 1.8 per cent, respectively) and lowest in Southern Asia (0.3 per cent).

Household connections are comparatively more expensive and would require a much larger percentage of GDP than was spent during the MDG period, even in 2017. Using the HDR as a benchmark, we find that household connections would cost less than the suggested 2 per cent of GDP in all regions except SSA, the Caucasus and Central Asia and Oceania.

The amount spent can also be compared with estimated spending in high-income countries, which was found to range from 0.35 to 1.2 per cent of GDP for water and sanitation (Cashman and Ashley 2008). If we assume that half of this was for water supply, it would range from 0.18 to 0.6 per cent of GDP for water supply. This suggests that spending on water might decrease as a proportion of GDP as countries become wealthier. Spending on water can also be contrasted with government expenditures on health (1.1–8.4 per cent) and education (3.2–14 per cent) (WHO 2012), other infrastructure sectors such as transport (0.7 per cent in Africa) (Foster and Briceño-Garmendia 2010) or total spending on telecoms in developing countries (2.5–4.5 per cent) (infoDev/ITU 2013).

Our estimates are higher than those of some previous studies: For example, the African Infrastructure Country Diagnostic finds that water and sanitation received 0.5 per cent of GDP (Foster and Briceño-Garmendia 2010) and public expenditure reviews in 15 countries suggest that 0.39 per cent of GDP was invested in water and sanitation (van Ginneken, Netterstrom and Bennett 2011). The most recent GLAAS report finds that the median

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40 Analyses by the Water and Sanitation Programme of the World Bank, suggest that GDP is reduced by 3.9 per cent in Africa and 3.9 to 6.4 per cent in Southern Asia. For more information see Sanitation and Water for All Economic Briefings available at: www.sanitationandwaterforall.org/hlm2012statementscommitmentsandevidence.html.

government expenditure was 0.7 per cent for both water and sanitation. However, these estimates do not include contributions from households that may account for the differences in these estimates.

Hutton (2013) estimates the cost of achieving universal coverage by 2015, putting the figure for new coverage at US$33 billion and the amount required for operations and maintenance and replacement of infrastructure at US$550 billion. Since our analysis is based on the same underlying unit costs, we also find that new coverage is relatively small proportion of the cost. This may suggest that aid has a role to play in financing critical investments when national resources are sufficient to maintain services but not expand them. As suggested by the levels of spending in upper-middle and high-income countries and a comparison of across countries (Figure A3), there may be a 'peak' in the level of spending on water supply as a proportion of GDP;[41] this also points to the need for critical infrastructure investments.

Table 9: Spending during the Millennium Development Goal period (2000-20) compared with levels required to sustain universal access as a per cent in 2010 and projected 2017 GDP

MDG region	Spending as a proportion (%) of GDP in2010 (and projected spending in 2017 in brackets)			
	MDG period	Universal coverage[1]		
		Basic	Current mix	Household connections
Caucasus and Central Asia	1.4	2.0 (1.7)	2.1 (1.7)	3.3 (2.8)
Northern Africa	1.0	1.1 (1.1)	1.1 (1.1)	1.6 (1.5)
sub-Saharan Africa	0.6	0.8 (0.7)	0.9 (0.8)	3.2 (2.8)
Latin American and the Caribbean	0.6	0.8 (0.7)	0.8 (0.7)	1.1 (1.0)
Eastern Asia	0.7	0.8 (0.5)	0.9 (0.6)	1.3 (0.8)
Southern Asia	0.3	0.3 (0.3)	0.3 (0.3)	0.8 (0.6)
South-eastern Asia	0.9	0.9 (0.7)	0.9 (0.7)	2.6 (2.0)
Western Asia	1.3	1.6 (1.3)	1.8 (1.5)	2.6 (1.9)
Oceania	0.5	0.9 (0.8)	0.8 (0.7)	2.8 (2.2)

Note: [1] Based on annualized capital and recurrent costs (Hutton 2012), does not account for the costs of expanding access. Refer to Appendix A12 for further details.

Source: Authors' calculations based on Hutton (2012) and WHO/UNICEF (2012).

10 Summary and conclusions

In this paper, we sought to examine a variety of questions about financing in the water sector and the role of aid within sector financing.

We used published figures to estimate the costs of building and maintaining water services, to estimate how much was spent during the period 2000 to 2010 and to compare this to calculate the proportion of GDP that would be needed to sustain universal access. In total, US$800 billion was spent on water supplies between 2000 and 2010. This comprised contributions from households, governments and donors. As a proportion of GDP, spending between 2000 and 2010 was found to range from 0.3 per cent to 1.4 per cent between regions for basic access. However, the cost of sustaining universal coverage based on the current technology mix would be higher. The costs of service provision vary considerably between countries for

41 GDP may be a poor measure of wealth for lower-income countries due to the existence of large informal economies. As a consequence some of this decline in spending as a proportion of GDP may be an artefact of formalization of the economy rather than actual increases in wealth. Nevertheless, such changes might be expected to result in increased tax revenues and greater ability of public financing (if not household contributions) to pay for water services.

the same technology. Although much of this variability may be due to differences in service levels, available water resources and settlement sizes, this suggests that: (i) there is much room for optimization and cost-reduction and (ii) there is a role for technical assistance.

The majority of aid is delivered in the form of ‘projects’, primarily through the public sector. There are several countries where NGOs and civil society dominate—primarily the fragile states. Aid is not allocated proportionate to the number of people with basic access to water supplies, however an aid concentration index shows that donors have increasingly focusing on those countries with lower levels of improved source coverage. On aggregate, a total of US$17.7 billion was provided in donor assistance between 2000 and 2010, accounting for an estimated 2.4 per cent of total spending in developing countries. Infrastructure investment contributes a substantial proportion to overall financing in SSA (25 per cent) and Oceania (10 per cent), but is lower for all other regions (<10 per cent). A longitudinal analysis using fixed effects models found no detectable effect of the volume of aid on progress—we emphasize a number of methodological challenges that may prevent an effect from being observed. In particular, the assessment (by necessity) has focused on aid for infrastructure investments but has not assessed the role of ‘catalytic aid’. A review of the effectiveness of aid projects at the ‘micro’ level that differentiates between these aid mechanisms is warranted.

Household connections are the most desirable type of water supply and this is clear from the extent to which many countries have increased access to this type of supply, most notably China. Encouragingly, we did not find evidence to suggest that striving for household connections occurs at the expense of those without basic access. One possible interpretation is that once there is sufficient political will and resources to expand piped supplies, basic access is also a political priority. Sustaining universal coverage of household connections was estimated at between 0.8 and 3.2 per cent of GDP in 2010—but would decrease as countries’ economies grow. To address this infrastructure investment ‘peak’, there will continue to be a role for aid and loans at or near commercial rates. Our modelling also indicates that the costs of ‘abandoned’ infrastructure may be important; funding agencies and recipient countries should strategically consider the likely development trajectory for the lifespan of water supply projects and weigh the costs and benefits of higher levels of service.

As the ultimate goal of universal access is approached, the importance of sustaining progress and retargeting aid at countries with the lowest levels of coverage will increase. Donors and recipients will have to find innovative ways to address the challenges in countries that made limited progress during the MDGs.

Appendix

A1 Facility type breakdown

Published coverage data (WHO/UNICEF 2012) distinguish between piped on premises and other improved sources, but do not provide further disaggregation of improved sources by facility type at the country level. For this analysis, we estimated the proportion of 'other improved' sources that are boreholes and standpipes. Based on household survey and census data, the JMP has calculated trends for each MDG region. We used these unpublished results in our analysis as follows: (i) for each MDG region, we established the proportion of the population using boreholes and standpipes for any given year. These proportions were then applied to the published country level estimates of population using 'other improved sources' (WHO/UNICEF 2012). Where the regional proportion of boreholes and standpipes exceeded the proportion of the population using other improved sources in a given country, we used the ratio of standpipes to boreholes. Where the regional proportion was less than the proportion using other improved sources, the remaining proportion was allocated to 'other', and comprises protected wells, protected springs and rainwater. For some countries the household connection to other improved ratio is not available in 2010. Where possible, we used the most recent available estimate for this ratio and applied this to the 2010 improved coverage estimate.

A2 Cost calculations

Costs are based on two studies (Hutton 2012; WHO/UNICEF/WSSCC 2000). The more recent study provides country-level unit costs in the form of annualized capital costs and annual recurrent costs (both 2010 USD) for two types of technology: piped on premises and 'wells', based on the cost of boreholes. For piped water on premises and boreholes, we used the figures provided by Hutton (2012) to derive the unit capital cost, based on the annualized capital cost and a cost of capital of 8 per cent. The earlier study provides regional estimates of the cost of a wider variety of technologies, including boreholes, standpipes and protected dug wells. The ratios of these costs are used to derive country-level estimates of the unit capital cost for standpipes (based on the piped on premises to standpipe ratio) and protected dug wells (based on the dug well to borehole ratio). We applied the costs of protected dug wells to 'other' water sources. Annual recurrent costs for these technologies were based on 10 per cent of the capital cost.

A3 Spending and asset valuation

Based on the technology breakdown and unit costs, total spending was calculated in four components: new coverage, rehabilitation and replacement, operations and maintenance and programme costs.

- *New coverage***.** Calculated by multiplying any increases in the population using a particular source type in urban or rural areas between 2000 and 2010 by the unit cost. In doing so, we assumed that these population increments are not served.
- *Rehabilitation and replacement***.** We assumed that in 2000 expected lifespans of each technology were uniformly distributed. We further assumed that water supplies that reach the end of their lifespan must be replaced at full cost.
- *Operations and maintenance*. For boreholes and piped supplies on premises we used annual and recurrent costs from Hutton (2012). For standpipes, boreholes and 'other' we applied a rate of 10 per cent of the capital cost per year.

— *Programme costs.* Acknowledging that programme costs are poorly understood and may often be much higher, as a best guess we applied these at a rate of 20 per cent.

These calculations are heavily dependent on the unit costs from the WHO Global Cost-Benefit analysis (Hutton 2012). Since individual data are only available for some countries and for these they may be based on individual studies within one region, the cost estimates must be considered only as order of magnitude estimates.

Table A1: Estimated spending between 2000 and 2010 on water supply in developing countries in billions of dollars (constant 2000 USD), by MDG regions

MDG regions	Rehabilitation and replacement	New coverage	Operations and maintenance	Programme costs	Total
Caucasus and Central Asia	5.4	1.3	6.4	2.6	15.7
North Africa	12.2	7.6	15.9	7.1	42.8
Sub-Saharan Africa	11.5	9.1	12.7	6.7	39.9
Latin America and the Caribbean	55.8	24.6	77.2	31.5	189.1
Eastern Asia	97.3	68.4	122.0	57.6	345.3
Southern Asia	9.0	5.7	27.2	8.4	50.3
South-east Asia	24.3	20.3	27.3	14.4	86.3
Western Asia	23.5	18.9	34.2	15.3	91.9
Oceania	0.2	0.1	0.3	0.1	0.8
Total	239.3	156.0	323.2	143.7	862.2

Source: Authors' calculations based on Hutton (2012) and WHO/UNICEF (2012).

A4 Value of infrastructure

The value of water supply infrastructure was calculated based on the amount invested in rehabilitation or replacement and new coverage minus:

— *Depreciation*: Linear depreciation was calculated based on technology lifespan.

— *Abandoned investment*: Calculated by multiplying any decreases in the population using a particular source type between 2000 and 2010 by half the unit cost.

Table A2: Estimated change in value of water supply assets between 2000 and 2010 in developing countries in billions of dollars (constant 2000 USD), by MDG regions

Region	Rehabilitation and replacement	New coverage	Depreciation	Abandoned investment	Change in value
Caucasus and Central Asia	5.4	1.3	5.7	0.6	0.4
North Africa	12.2	7.6	13.8	3.8	2.2
Sub-Saharan Africa	11.5	9.1	13.3	4.5	2.7
Latin America and the Caribbean	55.8	24.6	61.4	12.3	6.7
Eastern Asia	97.3	68.4	111.0	34.2	20.5
Southern Asia	9.0	5.7	10.3	2.9	1.6
South-east Asia	24.3	20.3	28.7	10.2	5.7
Western Asia	23.5	18.9	28.1	9.4	4.9
Oceania	0.2	0.1	0.3	0.1	0.0
Total	239.3	156.0	272.6	78.1	44.7

Source: Authors' calculations based on Hutton (2012) and WHO/UNICEF (2012).

A5 Aid concentration index

We used the concentration index (Kakwani, Wagstaff and van Doorslaer 1997) as a measure of the extent to which aid was targeted at countries that were most in need of external financing for water service provision. For a given period, countries were ranked by their 'need' (defined as the proportion of the population without access to an improved source of drinking water at the middle of the period) and by ODA-WSS per capita. We used the population at the middle year to determine the ODA per capita and to weight the index by country population. The concentration indices were calculated using the DASP toolkit in Stata (Araar and Duclos 2007). This type of index is also known as the Suits' Index (Baulch and Tam 2013).

A6 Aid calculations and attributing progress to aid

Data on official development assistance (ODA) was obtained from the OECD (OECD 2012a). We calculated the amount of aid for 'water' based on the sum of all disbursements with purpose codes for 'large' or 'basic' water and sanitation systems for a given year.[42] In order to estimate the contribution to water, we used the results from GLAAS that suggest that approximately two-thirds of ODA is directed at water service provision. Attempts to distinguish between sanitation and water supply in earlier years were made based on text searches of the project descriptions, however these were not sufficiently specific.

To attribute progress during the last decade to ODA, we divided the total ODA-WS by the total spending calculated in (4). These proportions were then multiplied by the proportion of the population gaining access to an improved source of drinking water over the period to estimate the per cent of progress and number of beneficiaries that could be attributed to aid.

A7 Longitudinal analysis of the relationship between aid and progress

Longitudinal analysis was implemented using the *xtreg* command in stata 12SE. Variance inflation factors and correlation coefficients were used to assess multicolinearity between control variables. The reasons for excluding several variables are provided in Table A5.

Descriptive statistics for the variables used in the fixed effects models are given in Table A6.

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[42] OECD purpose codes are:
- 14020: Water supply and sanitation, large systems
- 14021: Water supply, large systems;
- 14022: Sanitation, large systems;
- 14030: Basic drinking water supply and basic sanitation;
- 14031: Basic drinking water supply;
- 14032: Basic sanitation.

Table A3: Explanatory variables for the panel regression analysis

Type	Variable short	Description	Source	Included?
Aid	ODA-WSS[1]	Received funding in the form of grants or concessional loans for large or basic systems.	OECD-DAC	Yes
Economy	GDP-PPP p. c.	Gross domestic product, purchasing power parity per capita (constant 2005 international $)	WB	Yes
Economy	Natural resources rents (%)	% of GDP derived from natural resources	WB	Yes
Economy	Household consumption expenditure p. c.	Household consumption PPP (constant 2005 USD)	WB	Yes
Economy	Health expenditure	Health expenditure	WB	Yes
Government	Central government expenditure	Expenditure as a % of GDP	WB	Yes
Government	WGI–GE	WGI–Government Effectiveness (general government effectiveness	WB	Yes
Government	WGI–PSAV	WGI-Political stability and absence of violence	WB	Yes
Government	WGI–CC	WGI–Control of corruption	WB	No, correlated to WGI-GE
Government	WGI–WG	WGI–Regulatory quality	WB	No, correlated to WGI-GE
Government	WGI–RL	WGI–Rule of law	WB	No, correlated to WGI-GE
Government	WGI–VA	WGI–Voice and accountability	WB	Yes
Population	Urban population	% of the population living in urban areas	UNPD/WB	Yes
Population	Slum (%)[4]	% of the urban population living in informal settlements	UN Habitat	No, based on improved source coverage
Population	Population density	No. of people per sq. km of land area	UNPD/WB	Yes
Watsan	Technology choice	Ratio of increase in piped to other improved	Authors' calculations based on WHO/UNICEF	Yes
Watsan	Agricultural irrigated land (%)	% of total agricultural land that is irrigated	FAO/WB	No, data only for 5 yrs
Watsan	Domestic freshwater	% of freshwater used for domestic purposes	FAO/WB	No, data only for 5 yrs
Watsan	Freshwater	Freshwater resources p.c.	FAO/WB	No, data only for 5 yrs
Watsan	Renewable water resources	Renewable internal freshwater resources p.c. (m^3)	FAO/WB	No, data only for 5 yrs
Watsan	Improved sanitation	% coverage of improved sanitation,	WHO/UNICEF	Yes

Note: [1]Disbursed funding either in grant or loan form. Does not include general budget support, cross-cutting expenditures or other official flows. Includes concessional loans. Loans are considered 'concessional' if there is a grant element of at least 25 per cent (defined as the difference between market rates, taken as 10 per cent, and the loan rates over the anticipated repayment period).

Source: Compiled by the authors.

Table A4: Descriptive statistics from regression analysis

Variable	Obs (all years)	Obs (2005)	Mean	Std dev.	Min.	Max.
wat_imp	1411	129	79.6	18.0	22.0	100.0
laggedaidpc	1596	133	1.4	3.7	0.0	94.5
lngdp	1385	127	3.5	0.5	2.4	4.9
natres	1402	129	13.2	22.2	0.0	214.5
householdexppc	913	119	3536.9	4524.5	158.4	38406.1
govexp	1274	123	14.7	6.6	2.0	63.8
pop_tot	1463	133	39.1	151.0	0.1	1337.8
pop_urb	1463	133	48.0	22.7	8.2	100.0
pop_den	1463	133	166.5	575.9	1.6	7252.4
goveff	1316	132	-0.4	0.7	-2.5	2.4
polstab	1315	132	-0.4	0.9	-3.3	1.4
voiceandaccount	1317	132	-0.5	0.8	-2.2	1.4

Source: Authors' calculations.

A8 Influence of choice of metric on progress

Figure A1 shows that the metric used to assess progress leads to a very different picture of which countries have made the most progress during the MDGs. It compares the following measures of progress:

Absolute change in %:

$$c_{2010} - c_{2000}$$

% change in %:

$$\frac{c_{2010} - c_{2000}}{c_{2000}}$$

% of the unserved served:

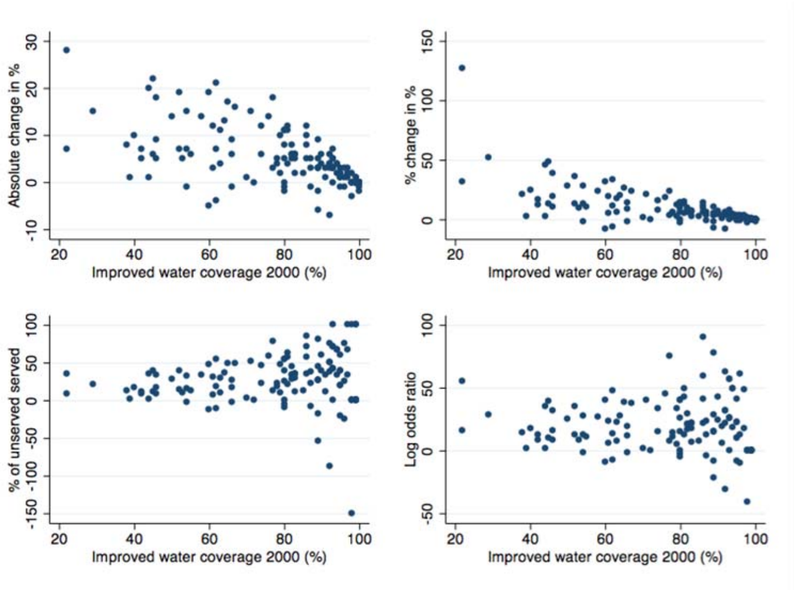
$$\frac{c_{2010} - c_{2000}}{1 - c_{2000}}$$

Log odds ratio:

$$log_{10}\left(\frac{c_{2010}(1 - c_{2010})}{c_{2000}(1 - c_{2000})}\right)$$

where c_y is the proportion of the population using an improved source in year y.

Figure A1: Comparison of different metrics that can be used to measure progress in increasing access to improved sources between 2000 and 2010



Source: Authors' computations based on WHO/UNICEF (2012).

A9 Aid and equity

Aid is often considered to be pro-poor and greater amounts (or a greater proportion of total spending) might therefore be associated with decreases in the number of people using surface waters. We assessed this association by exploring reductions in surface water use and using an outcome index combining progress in reducing both urban rural service level disparities (described in more detail by Luh, Baum and Bartram 2013). Given the non-linearity observed in all cases, Spearman's rank was chosen to assess the relationship between these metrics and levels of aid per capita.

For surface water, we restricted the analysis to countries with reported use of this source type by greater than 5 per cent of the 2000 population. We calculated the change in the proportion using surface waters between 2000 and 2010 and compared this with aid per capita. For total ODA per capita, we found that there is no association for the 61 countries included in the assessment (-0.1289, p =0.32). For the outcome component of the equity index (n=55), there was no significant association with either aid per capita (-0.0534, p=0.70) or aid as a proportion of overall spending (-0.698, p = 0.64).

A10 Coverage concentration index

Countries were ranked based on coverage for one of three measures—the proportion of the population using: household connections, improved sources or surface waters. Countries were also ranked by their GNI per capita (World Bank 2012). The concentration index was then calculated based on these rankings using the DASP toolkit in Stata (Araar and Duclos 2007). The results show that the concentration index for improved sources has decreased over time—an indication that there has been convergence—whereas piped on premises has remained more or less constant over the period, suggesting that the increases have not primarily been in low-income countries. As the number of people using surface waters has decreased globally, the concentration index has become increasingly negative, indicating that surface water users are increasingly concentrated in the lowest income countries.

Table A5: Changes in the concentration index for coverage of water sources, by type

Water	Year	Concentration index	95% Confidence interval	
Improved	1990	0.098	0.071	0.125
Piped on premises		0.305	0.210	0.401
Surface		-0.328	-0.498	-0.157
Improved	1995	0.079	0.048	0.109
Piped on premises		0.312	0.209	0.415
Surface		-0.253	-0.487	-0.020
Improved	2000	0.067	0.037	0.098
Piped on premises		0.311	0.208	0.414
Surface		-0.305	-0.524	-0.086
Improved	2005	0.062	0.032	0.093
Piped on premises		0.308	0.197	0.420
Surface		-0.434	-0.595	-0.273
Improved	2010	0.053	0.021	0.084
Piped on premises		0.306	0.190	0.421
Surface		-0.479	-0.615	-0.344

Source: Authors' calculations based on data from the WHO/UNICEF.

A11 Coverage projections

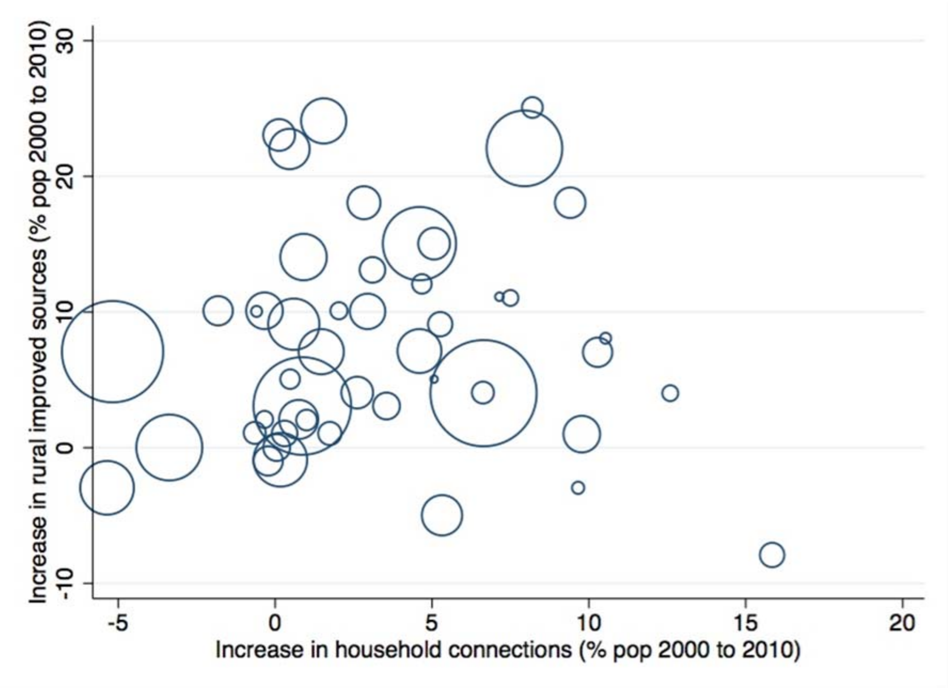
To estimate coverage in 2050 based on current trends, we combined linear extrapolation of the JMP data with population projections from the UN (UNPD 2011). Separate estimates were made for the urban and rural populations based on extrapolation of the linear part of the JMP regression. The population proportions were multiplied to estimate the total coverage of improved sources. If these estimates were greater than or equal to 95 per cent in 2050, a country is considered to be 'on-track'.

As they are extrapolations based on a linear trend, the coverage projections should be handled with caution. One might expect progress to slow as universal coverage is approached, since the remaining population may be financially and politically more difficult to reach. This analysis is therefore optimistic, as it assumes that countries would be able to maintain current rates of progress.

A12 Pursuing household connections

It is thought that the pursuit of household connections might have been at the expense of equity targets such as reducing the gap between urban and rural coverage levels. We calculated the Spearman's rank correlation coefficient between progress in increasing access to household connections and improved sources in rural areas (Figure A1). We also calculate this coefficient for aid per capita and the outcome indices from an Equity Index (Luh, Baum and Bartram 2013). This index compares countries in terms of their progress in reducing the disparity in piped on premises to other improved sources and the urban/rural coverage ratio. In addition, we also calculated the rank coefficient using a measure of sector-specific aid dependency (ODA between 2000 and 2009 divided by estimated spending during the period).

Figure A2: Comparison of increase in household connections and increase in improved sources in rural areas (Circles are proportional to 2010 population.)



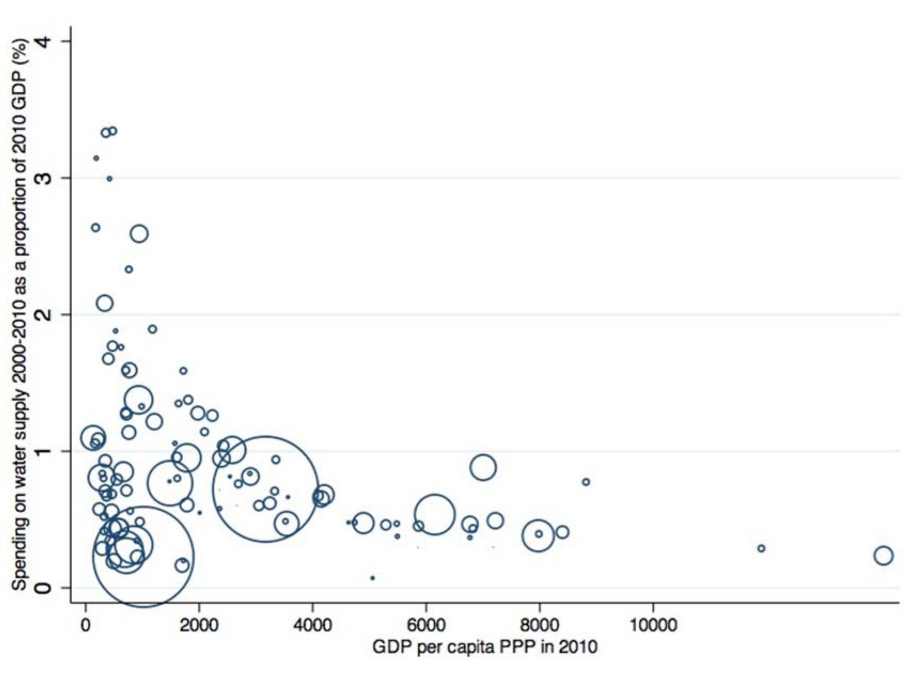
Source: Authors' illustration based on WHO/UNICEF (2012).

A13 Spending as a proportion of GDP

We calculated estimated spending during the MDG period as a proportion of 2010 GDP. We also calculated the costs to maintain universal access for three scenarios as a proportion of 2010 and 2017 GDP, using forecasts from the World Economic Outlook database (IMF 2012). GDP in 2017 was adjusted using an assumed inflation rate of 5 per cent. These scenarios are: (i) basic access whereby all of the currently unserved population are provided with the lowest cost improved source, (ii) current technology mix and (iii) universal access to household connections. For these calculations we use annualised costs based on the WHO Cost benefit study (Hutton 2012) or 10 per cent of capital costs.

Spending as a percentage of GDP decreases with country wealth as shown in Figure A3 below.

Figure A3: Spending during the Millennium Development Goals as a proportion of GDP per capita is high for many low-income countries



Source: Authors' illustration.

A14 Country classification based on fragility, natural resource dependence and income level

Table A6: Country classification stability, natural resource use and income- level

Low-income stable (n=18)	Bangladesh Benin Burkina Faso Cambodia Cameroon Ethiopia	Kenya Kyrgyz Republic Lesotho Madagascar Mozambique Nepal	Niger Rwanda Senegal Tajikistan Tanzania Uganda
Low-income fragile (n=16)	Afghanistan Central African Republic Comoros Côte d'Ivoire Eritrea[1] The Gambia	Guinea-Bissau Haiti Kiribati[1] Malawi Pakistan	Sierra Leone Somalia Timor-Leste Togo Zimbabwe
Middle-income stable (n=38)	Argentina Armenia Belize Bhutan Botswana Brazil Cape Verde China Colombia Costa Rica Dominican Republic El Salvador Fiji	Georgia Guatemala Honduras India Indonesia Jamaica Jordan Lebanon Mauritius Mexico Morocco Namibia Nicaragua	Panama Paraguay Philippines Samoa South Africa Suriname Swaziland Thailand Tunisia Turkey Uruguay Vanuatu
Middle-income fragile (n=8)	Djibouti Grenada Maldives	Sao Tome & Principe Sri Lanka Tonga	Myanmar West Bank & Gaza
Low-income stable, resource rich (n=7)	Zambia Ghana Lao PDR	Mali Nigeria	Papua New Guinea Vietnam
Low-income fragile, resource rich (n=10)	Burundi Chad Democratic Republic of Congo	Iraq Guinea Liberia	Mauritania Sudan Republic of Yemen
Middle-income stable, resource rich (n=20)	Algeria Azerbaijan Bolivia Chile Cuba Ecuador Arab Republic of Egypt	French Guiana Gabon Guyana Kazakhstan Libya Malaysia Peru	Republic of Moldova Saint Lucia Syrian Arab Republic Turkmenistan Uzbekistan Venezuela
Middle-income, fragile, resource rich (n=6)	Angola Republic of Congo	Republic of Korea Mongolia	Islamic Republic of Iran Solomon Islands

Classification based on: *Fragile*, countries with a Country Policy and Institutional Assessment (CIPA) score between 2005 and 2010 of less than 3.2 or, for countries where no assessment has been made, based on fragile states index of greater than 90; *resource rich*, countries deriving greater than 10 per cent of GDP from natural resources. Djibouti, Suriname, Myanmar and West Bank and Gaza based on best estimate; and, income-level where countries are classified using the World Bank atlas method with <US$1000 (low-income), <US$10,000 GNI (middle-income). Based on 2009 or 2008 GNI if 2010 not available. Not classified: Guadeloupe, Guam and French Polynesia.

[1]Coverage data missing for these countries.

Source: Authors' calculations based on data from the World Bank (2012) and WHO/UNICEF (2012).

Acronyms and abbreviations

CIPA	Country Policy and Institutional Assessment
DHS	demographic and health survey
IDA	International Development Agency
IBRD	International Bank of Reconstruction and Development
GDP	gross domestic product
GNI	gross national income
GLAAS	Global Analysis and Assessment of Sanitation and Drinking-Water
HDI	human development index
JMP	WHO/UNICEF Joint Monitoring Programme
MDG	Millennium Development Goals
ODA	official development assistance
OLS	ordinary least squares
O&M	operations and maintenance
OECD	Organisation for Economic Co-operation and Development
OECD-CRS	creditor reporting system (of the OECD)
PPP	purchasing power parity
SSA	sub-Saharan Africa
UNICEF	United Nations Children’s Fund
USD	United States dollars
UNPD	United Nations Population Division
WSP	Water and Sanitation Programme (administered by the World Bank)
WaSH	water sanitation and hygiene
WHO	World Health Organization
WSSCC	Water Supply and Sanitation Collaborative Council

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