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www.worldwaterweek.org

Centre for Global Development

Institute of Public Health and Environmental Engineering

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Impacts of improving services to the poor on City Water Demand

Barbara Evans

b.e.evans@leeds.ac.uk

Links between services for the poor and bulk water supply

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Heather Pursehouse

Nicholas Roxburgh

Matthias Jaworski

Andrew Sleigh

David Kimani

Samson Ngugi

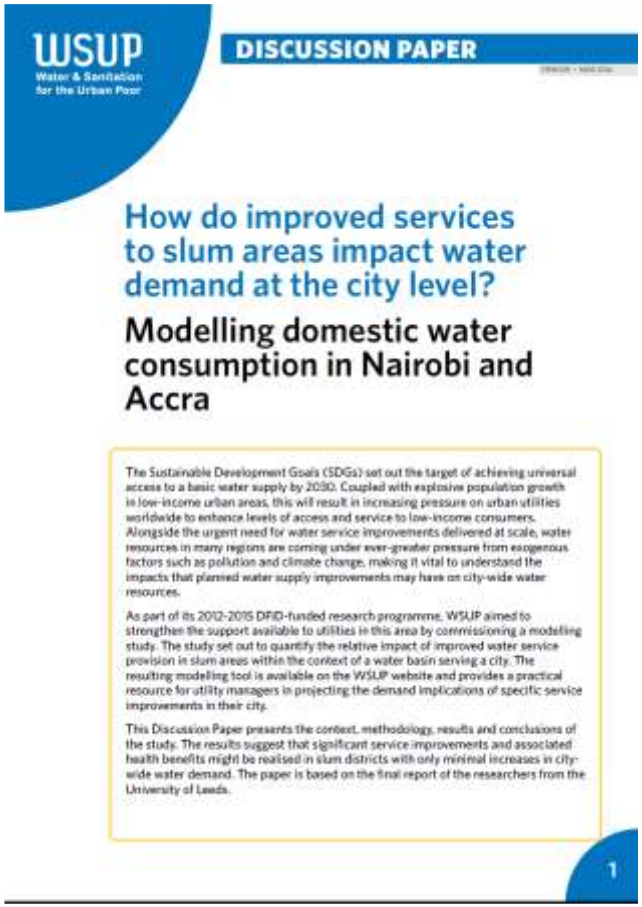
Habiba Ibrahim

Paul Karuri

Barbara Evans

Guy Norman

Sam Drabble



WSUP
Water & Sanitation for the Urban Poor

DISCUSSION PAPER

How do improved services to slum areas impact water demand at the city level?

Modelling domestic water consumption in Nairobi and Accra

The Sustainable Development Goals (SDGs) set out the target of achieving universal access to a basic water supply by 2030. Coupled with explosive population growth in low-income urban areas, this will result in increasing pressure on urban utilities worldwide to enhance levels of access and service to low-income consumers. Alongside the urgent need for water service improvements delivered at scale, water resources in many regions are coming under ever-greater pressure from exogenous factors such as pollution and climate change, making it vital to understand the impacts that planned water supply improvements may have on city-wide water resources.

As part of its 2012-2015 DFID-funded research programme, WSUP aimed to strengthen the support available to utilities in this area by commissioning a modelling study. The study set out to quantify the relative impact of improved water service provision in slum areas within the context of a water basin serving a city. The resulting modelling tool is available on the WSUP website and provides a practical resource for utility managers in projecting the demand implications of specific service improvements in their city.

This Discussion Paper presents the context, methodology, results and conclusions of the study. The results suggest that significant service improvements and associated health benefits might be realised in slum districts with only minimal increases in city-wide water demand. The paper is based on the final report of the researchers from the University of Leeds.

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A fairly ‘simple’ framework

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Water supply is…	Predictable		Unpredictable	
	Available > x days per week	Available < x days per week	Available > x days per week	Available < x days per week
At home	Highest level of service			
In the yard				
Delivered to home				
Carried to home				Lowest level of service

Increasing accessibility

Increasing reliability

Methods

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- Secondary data review
- Primary data collection (household surveys and focus groups)
- Use of existing GIS-based consumption mapping (Nairobi) GWOPA and IFRA
- Modelling overall demand and future changes based on scenario planning

Water source type drives consumption

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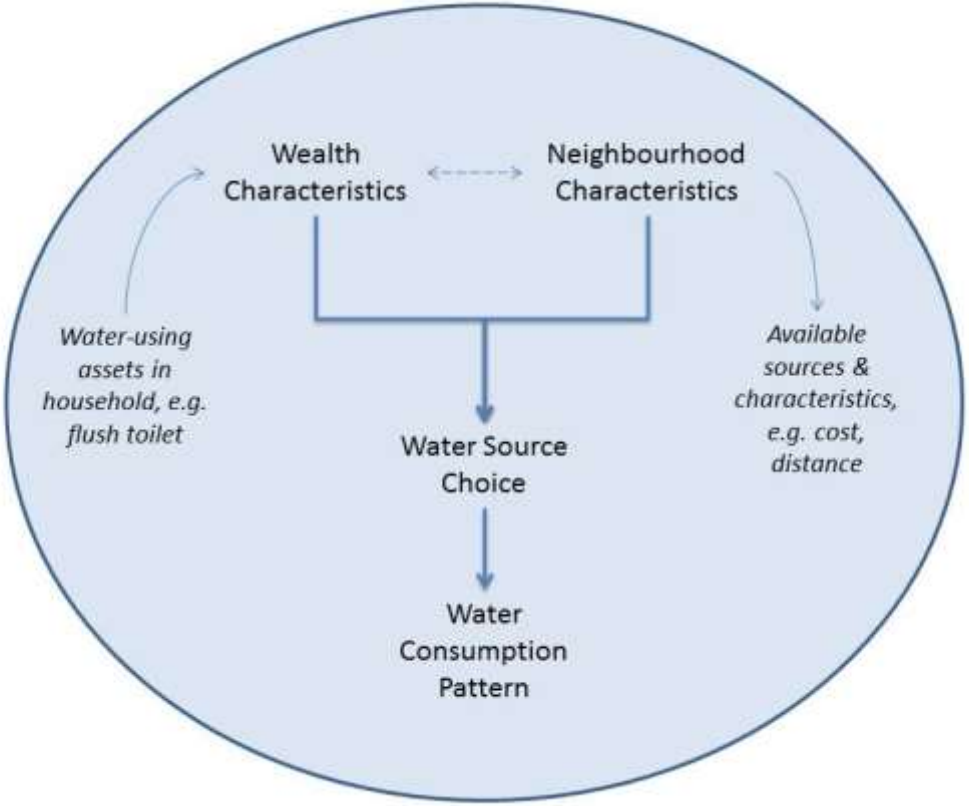

Key results

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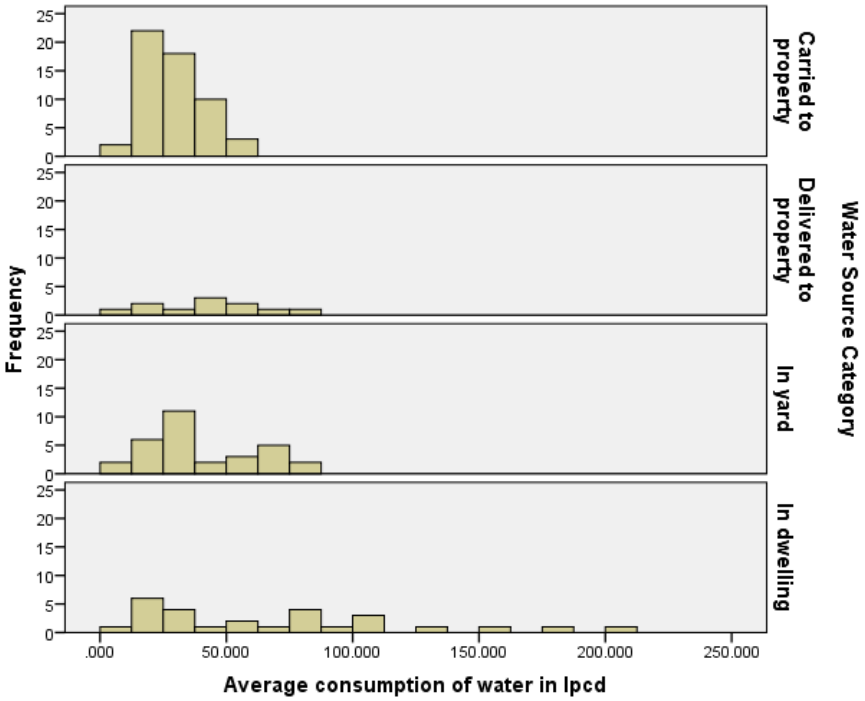
Water Access Source		Mean (lpcd)	Median (lpcd)	Standard Deviation (lpcd)	N in sample
Carried to property		27.8	25.0	12.2	55
Delivered to property		43.5	45.7	22.4	11
In yard	<= 4 days per week	33.2	28.6	19.7	21
	> 4 days per week	50.9	58.6	21.5	10
In dwelling		69.0	60.0	52.3	27



So what do we mean by scenarios?

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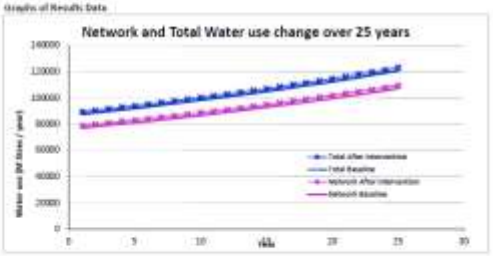
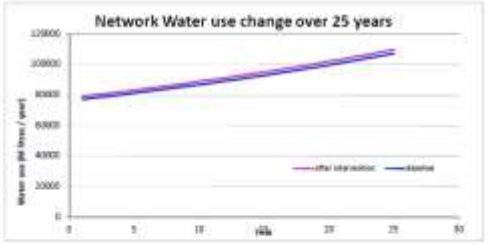
- Increasing accessibility
- Increasing reliability (predictability and/or hours of service)
- Reducing losses
- Geographical targeting

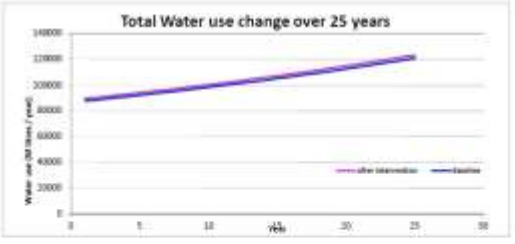
Population and service level

							Level of service - Select only one in each row				
Ward name	Sub name	Leakage rate	Pop. Growth rate	Population	Delivery Technology	Water Origin	In dwelling	In plot	Delivered to property	Carried to property	Quality of data comment
Embakasi	a	Medium	Moderate	245956	Mechanised	Water Company Network	Reliable > 4 days				
Embakasi	b	Medium	Moderate	494420	Mechanised	Water Company Network		Reliable > 4 days			
Embakasi	c	Medium	Moderate	8777	Mechanised	Water Company Network			Reliable > 4 days		
Embakasi	d	High	Moderate	216268	Mechanised	Water Company Network				Reliable > 4 days	
Embakasi	e	Medium	Moderate	53864	Mechanised	Groundwater	Reliable 24/7				
Embakasi	f	Low / Target	Moderate	3267	Unmechanised	Surface/Rain water				Reliable > 4 days	
Embakasi	g	Low / Target	Moderate	1799	Unmechanised	Surface/Rain water		Unreliable < 4 days			
Makadara	h	Medium	Moderate	53146	Mechanised	Water Company Network	Reliable > 4 days				
Makadara	i	Medium	Moderate	139248	Mechanised	Water Company Network		Reliable > 4 days			
Makadara	j	Medium	Moderate	2285	Mechanised	Water Company Network			Reliable > 4 days		
Makadara	k	High	Moderate	56300	Mechanised	Water Company Network				Reliable > 4 days	
Makadara	l	Medium	Moderate	1585	Mechanised	Groundwater	Reliable 24/7				
Makadara	m	Low / Target	Moderate	725	Unmechanised	Surface/Rain water				Reliable > 4 days	
Makadara	n	Low / Target	Moderate	421	Unmechanised	Surface/Rain water		Unreliable < 4 days			
Central	o	Medium	Low	63976	Mechanised	Water Company Network	Reliable < 4 days				
Central	p	Medium	Low	197704	Mechanised	Water Company Network		Reliable > 4 days			
Central	q	Medium	Low	1465	Mechanised	Water Company Network			Reliable > 4 days		
Central	r	High	Low	36092	Mechanised	Water Company Network				Reliable > 4 days	
Central	s	Medium	Low	1803	Mechanised	Groundwater	Reliable 24/7				
Central	t	Low / Target	Low	1036	Unmechanised	Surface/Rain water				Reliable > 4 days	
Central	u	Low / Target	Low	93	Unmechanised	Surface/Rain water		Unreliable < 4 days			
Kasarani	v	Medium	Rapid	158378	Mechanised	Water Company Network	Reliable > 4 days				
Kasarani	w	Medium	Rapid	350279	Mechanised	Water Company Network		Reliable > 4 days			
Kasarani	x	Medium	Rapid	1758	Mechanised	Water Company Network			Reliable > 4 days		
Kasarani	y	High	Rapid	43317	Mechanised	Water Company Network				Reliable > 4 days	
Kasarani	z	Medium	Rapid	9269	Mechanised	Groundwater	Reliable 24/7				
Kasarani	aa	Low / Target	Rapid	3474	Unmechanised	Surface/Rain water				Reliable > 4 days	
Kasarani	ab	Low / Target	Rapid	926	Unmechanised	Surface/Rain water		Unreliable < 4 days			
Purnwani	ac	Medium	Low	76774	Mechanised	Water Company Network	Reliable > 4 days				
Purnwani	ad	Medium	Low	156348	Mechanised	Water Company Network		Reliable > 4 days			
Purnwani	ae	Medium	Low	916	Mechanised	Water Company Network			Reliable > 4 days		
Purnwani	af	High	Low	22571	Mechanised	Water Company Network				Reliable > 4 days	
Purnwani	ag	Medium	Low	2556	Mechanised	Groundwater	Reliable 24/7				
Purnwani	ah	Low / Target	Low	988	Unmechanised	Surface/Rain water				Reliable > 4 days	
Purnwani	ai	Low / Target	Low	383	Unmechanised	Surface/Rain water		Unreliable < 4 days			
Dagoretti	aj	Medium	Moderate	42043	Mechanised	Water Company Network	Reliable > 4 days				
Dagoretti	ak	Medium	Moderate	107258	Mechanised	Water Company Network		Reliable > 4 days			
Dagoretti	al	Medium	Moderate	2565	Mechanised	Water Company Network			Reliable > 4 days		
Dagoretti	am	High	Moderate	63196	Mechanised	Water Company Network				Reliable > 4 days	
Dagoretti	an	Medium	Moderate	140701	Mechanised	Groundwater	Reliable 24/7				
Dagoretti	ao	Low / Target	Moderate	2210	Unmechanised	Surface/Rain water				Reliable > 4 days	
Dagoretti	ap	Low / Target	Moderate	490	Unmechanised	Surface/Rain water		Unreliable < 4 days			
Kibera	aq	Medium	Moderate	68489	Mechanised	Water Company Network	Reliable > 4 days				
Kibera	ar	Medium	Moderate	202650	Mechanised	Water Company Network		Reliable > 4 days			
Kibera	as	Medium	Moderate	3103	Mechanised	Water Company Network			Reliable > 4 days		
Kibera	at	High	Moderate	76465	Mechanised	Water Company Network				Reliable > 4 days	
Kibera	au	Medium	Moderate	20949	Mechanised	Groundwater	Reliable 24/7				
Kibera	av	Low / Target	Moderate	1523	Unmechanised	Surface/Rain water				Reliable > 4 days	
Kibera	aw	Low / Target	Moderate	1198	Unmechanised	Surface/Rain water		Unreliable < 4 days			

Graphs of Results Data







Year	Baseline				After Intervention			
	Total Population	Total Water use (Ml litres/yr)	Network Water use (Ml litres/yr)	Energy Use (GWh/yr)	Total Population	Total Water use (Ml litres/yr)	Network Water use (Ml litres/yr)	Energy Use (GWh/yr)
1	3139094	87717	77244	10541	3139094	89588	79095	10811
2	3178206	88808	78222	10770	3178206	90677	80092	10944
3	3214029	89817	79210	10002	3214029	91807	81108	10980
4	3252582	91048	80237	10040	3252582	92959	82147	19622
5	3291881	92204	81276	10481	3291881	94134	83206	10868
6	3331945	93381	82336	10728	3331945	95332	84287	10118
7	3372792	94582	83418	10979	3372792	96554	85390	10379
8	3414443	95807	84522	20235	3414445	97801	86518	20654
9	3456917	97056	85650	20497	3456917	99072	87669	20930
10	3500235	98331	86801	20763	3500235	100366	88839	21171
11	3544417	99632	87977	21035	3544417	101691	90037	21447
12	3589484	100959	89178	21312	3589484	103041	91260	21729
13	3635460	102313	90404	21595	3635460	104419	92509	22016
14	3682367	103695	91656	21884	3682367	105824	93785	22310
15	3730229	105106	92936	22179	3730229	107259	95088	22609
16	3779069	106546	94243	22479	3779069	108725	96419	22914
17	3828912	108017	95578	22785	3828912	110218	97778	23226
18	3879785	109518	96942	23098	3879785	111744	99168	23544
19	3931712	111050	98336	23418	3931712	113302	100588	23868
20	3984721	112616	99761	23744	3984721	114893	102038	24199
21	4038840	114214	101217	24077	4038840	116517	103521	24537
22	4094097	115847	102708	24417	4094097	118176	105038	24883
23	4150521	117514	104227	24764	4150521	119871	106584	25235
24	4208143	119216	105783	25118	4208143	121602	108167	25595
25	4266994	120958	107373	25480	4266994	123370	109785	25963

Results tables

Before intervention

Populations

Access		Reliability: Periodic: Reliable > 4 days	Reliable < 4 days	Unreliable > 4 days	Unreliable < 4 days	Constant: Reliable 24/7
Access	In dwelling	642781	63976	0	0	230827
	On plot	1450201	197704	0	9310	0
	Delivered to property	20869	0	0	0	0
	Carried to property	527426	0	0	0	0

Total population 3139994

Water used

Access		Reliability: Periodic: Reliable > 4 days	Reliable < 4 days	Unreliable > 4 days	Unreliable < 4 days	Constant: Reliable 24/7
Access	In dwelling	76646148	7074693	0	0	28242562
	On plot	105779367	9512602	0	345200	0
	Delivered to property	1030278	0	0	0	0
	Carried to property	12820207	0	0	0	0

Total water used 240321156 litres / day

87717 M litres/yr

Energy

Access		Reliability: Periodic: Reliable > 4 days	Reliable < 4 days	Unreliable > 4 days	Unreliable < 4 days	Constant: Reliable 24/7
Access	In dwelling	15726229	1414999	0	0	6472709
	On plot	21155973	1902520	0	0	0
	Delivered to property	216056	0	0	0	0
	Carried to property	2596759	0	0	0	0

Total energy 50798145 kWh/day

AFTER intervention

Populations

	Reliability: Periodic: Reliable > 4 days	Reliable < 4 days	Unreliable > 4 days	Unreliable < 4 days	Constant: Reliable 24/7
In dwelling	642781	63976	0	0	230827
On plot	1450201	732780	0	9310	0
Delivered to property	0	0	0	0	0
Carried to property	18219	0	0	0	0

Total population 3130094

Water used

	Reliability: Periodic: Reliable > 4 days	Reliable < 4 days	Unreliable > 4 days	Unreliable < 4 days	Constant: Reliable 24/7
In dwelling	86349224	8013744	0	0	34006008
On plot	89812482	20517840	0	146080	0
Delivered to property	0	0	0	0	0
Carried to property	257771	0	0	0	0

Total water used 207705729 litres / day

75813 M litres/yr

Energy

	Reliability: Periodic: Reliable > 4 days	Reliable < 4 days	Unreliable > 4 days	Unreliable < 4 days	Constant: Reliable 24/7
In dwelling	15726229	1414999	0	0	6472709
On plot	21155973	5099459	0	0	0
Delivered to property	0	0	0	0	0
Carried to property	0	0	0	0	0

Total energy 51812209 kWh/day

Outcomes for eastern Nairobi

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Households selected for service improvement	Service improvement	Impact on city water demand	Number of households
Households carrying water or getting water delivered	Yard tap (<4 days per week) with low reliability	0.6%	350,000
	As above with high reliability	3%	
All households without a household connection	Household connection	15%	1.5 million

Conclusions

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Marginal service improvements which have a significant social value to households may not have a major impact on bulk water demand

Understanding user behaviours can help to identify service improvements that are preferential for utility service providers

Simple modelling tools can provide a strong basis for assessing options but rely on reasonably strong household data from households which are not yet ‘formal’ customers