Quantifying the Global Non-Revenue Water Problem

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Abstract: This paper provides a long overdue update on the global non-revenue water (NRW) estimates, initially published in a World Bank publication (Kingdom et al., 2006) more than 10 years ago. The authors use a similar approach based on latest data to estimate volumes of water lost by water utilities around the world. The conclusion of this study is that the 2006 estimates were extremely conservative and that realistic NRW estimates are significantly higher. The global volume of NRW has been estimated to be 346 million cubic meters per day or 126 billion cubic meters per year. Conservatively valued with only USD 0.31 per cubic meter, the cost/value of water lost amounts to USD 39 billion per year. Not only is this an enormous financial concern, elevated NRW detracts from water utilities, in a time of increasing scarcity and climate change, from reaching their goals of full service coverage, at a reliable level of service at an affordable price.

Keywords: Non-Revenue Water, NRW, Water Losses

Introduction

In 2006 Liemberger (together with Kingdom and Marin) calculated the volume of water lost around the word and the approximate cost of these water losses. Since then, the numbers were quoted in presentations and articles around the world. In 2010, Liemberger (together with Frauendorfer) published updated numbers for Asia, which clearly indicated that the assumptions for the 2006 estimates were far too conservative. The purpose of this paper is to calculate new estimates based on the latest available data and provide a new, reliable source of information.

Wyatt worked extensively on the analysis of the NRW situation in Latin America and the Caribbean (LAC), which will be published in a forthcoming Technical Guide on NRW by the Inter-American Development Bank. His extensive data set has been used to check and calibrate the global NRW model.

With this study, the authors like to highlight the seriousness of the global NRW problem. Chronic water losses have been the hallmark of water utilities in most parts of the world over recent decades. This may not have been a large concern during an era of assumed plenty. But the rapid growth of the world's towns and cities, coupled with the negative impact of climate change has meant that there is much less water available than it was in the past. If the world's volume of NRW was reduced by only one third, the savings would be sufficient to supply 800 million people[1].

The authors are providing all country data and data sources in the appendix of this paper so that the assumptions are transparent and might be improved by others who have access to good data for specific countries.

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[1] Assuming a per capita consumption of 150 liters per day

Methodology

General

WHO/UNICEF JMP (Joint Monitoring Program) is the custodian of global data on drinking water, sanitation and hygiene (WASH). Total country population with access to piped water supply has been extracted from WASH data.

Average per capita consumption has been determined on a country by country basis and the total volume of domestic water consumption has been calculated. A provisional volume of 30% had been added for non-domestic water use.

The total system input volume has been calculated using the assumed percentage of NRW which allowed then to calculate the volume of NRW:

P_S	Supplied population	
PCC	Per capita consumption	(l/c/d)
C_D	Domestic consumption	(m³/d)
C_{ND}	Non-domestic consumption	(m³/d)
C_T	Total consumption	(m³/d)
NRW	Non-revenue water	(m³/d)
SIV	System input volume	(m³/d)
%NRW	Non-revenue water	(% of SIV)

The different volumes are calculated as follows:

$$C_D = P_S \, x \, \frac{PCC}{1000}$$

$$C_{ND} = C_D \, x \, 0.3$$

$$C_T = C_D + C_{ND}$$

$$SIV = \frac{C_T}{1 - \%NRW}$$

$$NRW = SIV - C_T$$

which can then be brought into one equation:

$$NRW = \frac{P_S \, x \, \frac{PCC}{1,000} \, x 1.3}{1 - \%NRW} - P_S \, x \, \frac{PCC}{1,000} \, x 1.3$$

Per capita consumption

Main data sources are:

- IBNET
- IWA
- AWWA
- EU

Unfortunately for many countries no information, or at least no reliable information, could be found and the authors had to make estimates based on personal experience and data from countries with similar conditions. Details can be found in the appendix.

Level of NRW

IBNET was the most important source of information for the level of NRW expressed at a percentage of system input volume, but data quality is partly problematic. Some country data are based only on very few, or even only one, water utility and sometimes latest available data are already more than a few years old, notably in Latin America and the Caribbean but also in all other regions. But despite all of this, IBNET is the only global source for NRW data. For all the other countries which are not included in the IBNET data set, the authors had to make estimates based on personal experience and data from countries with similar conditions. Details can be found tin the appendix.

Calculating the value/cost of NRW

The cost or value of one cubic meter NRW for a water utility depends on a number of factors:

- The ratio between commercial (apparent) and physical (real) losses

- A reduction in commercial losses will lead to increased revenues – consequently commercial losses will be valued using the average tariff[2]

- Can a part recovered physical losses be sold to existing or new customers? In this case this portion of NRW can also be valued with the average tariff

- In case there is no unsatisfied demand, any reduction of physical losses will only lead to a reduction in variable water abstraction, treatment and distribution cost – and those will of course vary extremely depending on the water source – gravity supply of spring water on the one hand and desalination and/or pumping to high altitudes on the other hand.

- If additional water sources will be needed to meet the increasing demand, then the capital and operating cost of such future water sources will have a significant impact on the value of NRW.

Consequently it is very complex to calculate the average value of NRW on a country level. Specific studies are required – by location. Therefor an extreme simplification has been used to provide a country average value of NRW which represents a mix of variable production cost and average tariff.

A simple empirical formula has been developed which is based on the assumption that even in the poorest countries the value of a m3/d NRW will not be less than USD 0.2 and then it will increase in some relation to the countries per capita Gross Domestic Product (GDP).

$$Value\ of\ NRW\,(\text{USD/m3}) = \ln(per\ capita\ GDP)\ x\ 0.035$$

This formula means that NRW in the poorest countries is valued close to USD 0.20 (for example for Burkina Faso (Africa)) while the value would be USD 0.38 for the USA.

More research is needed to improve this method and try to calibrate with good country data.

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[2] It has become accepted practice in the USA that sewer service charges, if billed as a function of water volume consumed, as also included in the valuation of apparent losses.

Methodology used in Wyatt/IDB

As noted above, some of the input data were adopted from Wyatt/IDB, as they appeared more accurate than other sources. Also, country level results from Wyatt/IDB were used to cross-check the results of the methodology used in this paper.

The objective of the Wyatt/IDB effort was to assemble a Regional database of NRW variables and indicators, with the following considerations:

- Include all countries in the region, to the extent possible
- Focus on urban areas
- Assemble data from a sample of utilities in each country across and range of sizes and climatic conditions
- Utilize primary or secondary data which is internally consistent (cross-check calculated indicators and look at trends for inconsistencies)

Data was collected for 105 water utilities in 27 countries. Many of the smaller countries have single national water supplier, which facilitated data collection. Sources included water utility websites and annual reports, country studies and sector assessments, regulatory documents, IDB, CAF, CDB or World Bank loan preparation documents, primary data collection from field visits and lastly a large but somewhat out of date website/database developed in 2008 by the World Bank and IDB.

Data was collected on the following parameters:

- Situational: connections, mains length, median household income, water stress
- Operational: billed volume, continuity, pressure (some estimated), extent of micro-metering, burst rates, staff, complaints
- Financial: revenues, operating costs, tariffs, collection efficiency
- Water balance: approximate split of NRW components (some estimated)

Data was analyzed to determine the following parameters, which correspond well to this broader study:

Results and Discussion

The global volume of NRW has been calculated to be 346 million cubic meters per day or 126 billion cubic meters per year. To put this in some perspective, this annual volume is about 70% of the average flow of the Niger River – the principal River in West Africa, and nearly 50% of the average flow of the Ganges River in India. But more importantly, the aggregate NRW is 30% of water system input volumes across the world.

The newly introduced NRW indicator – liters/capita/day was computed by country and by region to understand the level of NRW, independent of country or region size. The introduction of this indicator was necessary because the normal operational water loss performance indicators, like NRW per service connection per day or per kilometre pipeline per day can't be used because data on network length or number of connections are in most cases not available on country level. The results for the different regions can be seen in Table 1. Details for each region on a county by country basis can be found in the appendix.

Table 1: NRW volume and cost/value per region

	Volume of NRW		Average level of NRW	Cost/value of NRW
	million m³/day	billion m³/year	Liters/capita/ day	billion USD/year
Sub-Saharan Africa	14.1	5.2	64	1.4
Australia and New Zealand	1.0	0.3	36	0.1
Caucasus and Central Asia	8.0	2.9	152	0.8
East Asia	53.0	19.3	42	6.2
Europe	26.8	9.8	50	3.4
Latin America and Caribbean	69.1	25.2	121	8.0
Middle East and Northern Africa	41.2	15.0	96	4.8
Pacific Islands	0.5	0.2	211	0.1
Russia, Ukraine, Belarus	9.5	3.5	65	1.1
South Asia	63.4	23.2	93	6.0
Southeast Asia	18.4	6.7	81	2.0
USA and Canada	40.7	14.8	119	5.7
Total	**346**	**126**	**77**	**39**

It does not come as a surprise that the regional differences are significant. The lowest NRW levels (36 l/capita/d) can be found in Australia, which is due to the big water loss reduction efforts that have been made during the last ten to fifteen years in the attempt to better cope with the long draughts. The Pacific Islands have the highest NRW level (211 l/capita/d) but data quality is limited and therefore this number is questionable. The average level of NRW in Latin America and the Caribbean (LAC) is 121 liters / capita/day.
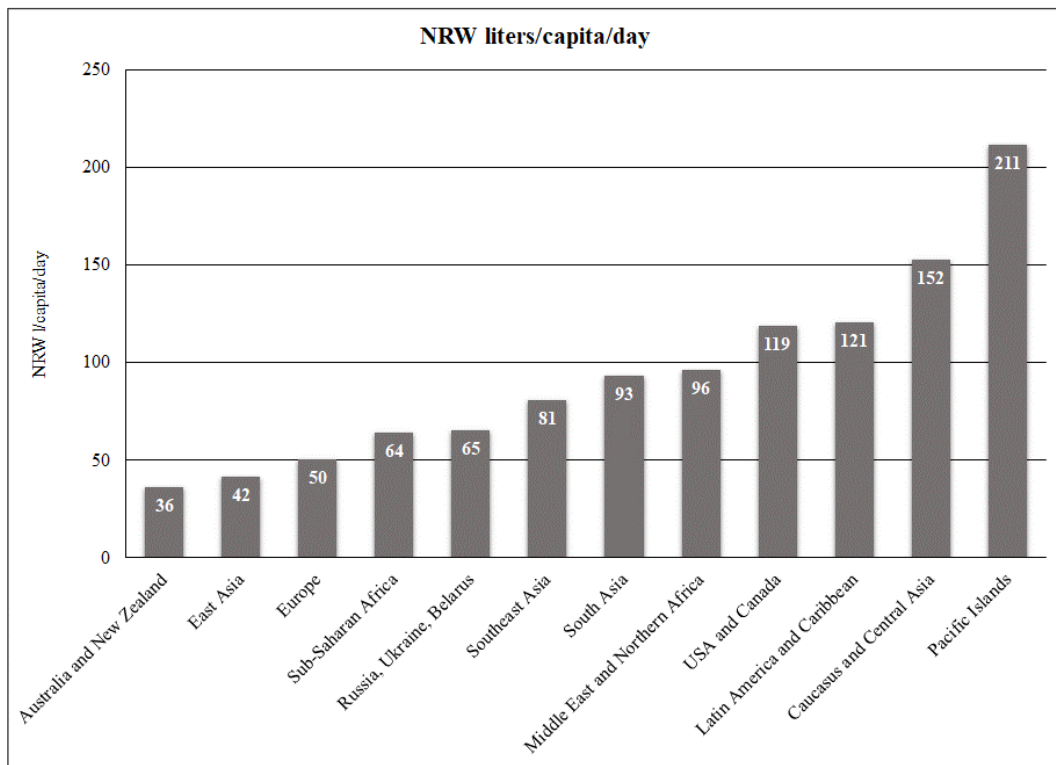
Figure 1: Regional NRW levels

A comparison of the model's results to actual country data from the Wyatt/IDB database shows an amazing correlation. The weighted average from the NRW model is 116 l/capita/day compared to 115 l/capita/day, this means the difference is only 1.1% (see Table 2).

However, it has to be noted that there are some countries with significant differences:

- Dominica – this is due to large consumption from cruise ships
- Jamaica – here clearly Wyatt's model is unrealistic
- Panama – the difference is not clearly understood. It is presumably doe to high commercial consumption
- St. Lucia – high consumption from cruise ships
- Suriname – not completely clear. This may have to do with the differences between urban consumption (Wyatt's model) and the impact of lower semi-urban and rural consumption.

Table 2: Comparison of the NRW model results to data from selected LAC countries

	Population	NRW in l/capita/d			NRW in 1000 m3/day			
		Model	Wyatt/IDB	% Difference	Model	Wyatt/IDB	Difference	% Difference
Argentina	43,019,152	183	189	2.7%	7,894	8,113	-219	-2.7%
Bahamas	369,918	98	98	0.5%	36	36	0	-0.5%
Barbados	278,577	286	300	4.8%	80	84	-4	-4.8%
Belize	297,949	37	37	-0.3%	11	11	0	0.3%
Bolivia	7,915,294	70	63	-9.9%	554	502	52	9.9%
Brazil	199,750,809	94	90	-5.4%	18,872	17,879	993	5.4%
Cayman Islands	51,572	53	52	-0.3%	3	3	0	0.3%
Chile	17,847,512	91	84	-7.4%	1,620	1,505	115	7.4%
Colombia	42,381,111	118	107	-9.4%	4,997	4,547	450	9.4%
Costa Rica	4,768,368	206	220	6.6%	982	1,048	-67	-6.6%
Dominica	54,444	69	240	110.5%	4	13	-9	-110.5%
Ecuador	13,833,220	173	174	0.6%	2,388	2,403	-15	-0.6%
El Salvador	5,367,444	106	104	-2.2%	568	556	12	2.2%
Guyana	506,840	254	305	18.3%	128	154	-26	-18.3%
Honduras	7,213,368	111	106	-3.8%	798	768	30	3.8%
Jamaica	2,259,016	192	338	54.9%	435	763	-329	-54.9%
Mexico	119,478,951	104	99	-5.0%	12,426	11,817	609	5.0%
Nicaragua	4,234,942	206	208	0.8%	874	882	-7	-0.8%
Panama	3,617,503	180	424	80.7%	651	1,532	-881	-80.7%
Paraguay	5,936,257	206	193	-6.2%	1,220	1,147	74	6.2%
Peru	5,936,257	94	97	3.7%	556	577	-21	-3.7%
Puerto Rico	3,465,481	349	357	2.3%	1,209	1,238	-29	-2.3%
St Lucia	176,678	186	279	40.1%	33	49	-16	-40.1%
St.Vincent and the Grenadines	101,763	94	94	-0.1%	10	10	0	0.1%
Suriname	364,343	69	142	68.7%	25	52	-26	-68.7%
Trinidad and Tobago	1,253,202	310	350	12.1%	389	438	-50	-12.1%
Uruguay	3,384,329	152	147	-3.5%	514	496	18	3.5%
Total Population	493,864,299							
Weighted Average NRW l/capita/day		116.0	114.7	-1.1%				
Total Volume, M m3/day					57,275	56,622	653	1.1%

The new model has now been used to run a simulation with 2005 data to compare the result with World Bank publication (Kingdom et al., 2006) which used 2005 data. The result shows a significant difference which can be explained by the conservative assumptions made in 2006 and the fact that the first model used the supplied urban population only while this model does not differentiate between urban and rural and includes all piped water supply systems. The difference to the model published by the Asian Development Bank (Liemberger and Frauendorfer, 2010) has similar reasons.

Table 3: Annual NRW volume – comparison to previous NRW models

billion m³ per year	2005		2009		2016
	WB publication	new model	ADB publication	new model	new model
World	48.6	97.5			126
Asia and Pacific Islands			28.7	47.2	64

Table 1 also provides estimates of the cost/value of the NRW, by region. Estimating the cost / value of global NRW has been as problematic in the previous models as it is

in this model. The global cost/value of NRW has been calculated to be USD 39 billion per year but the number can only be understood as rough estimate. However, it is a clear indication that the high levels of NRW have a massive negative financial impact on the water supply sector.

If global NRW was reduced by one third (115 million cubic meters per day), the annual financial benefit would be around USD 13 billion. Assuming average NRW reduction cost of USD 600 per m^3/d NRW reduction, the investment required to achieve this reduction would be USD 69 billion – a payback time of just over 5 years. This may sound too optimistic, and based on the authors' experience, payback times between 7 and 10 years are in many cases more realistic, it is still difficult to understand why water utilities and governments are so reluctant to invest in NRW reduction.

It is also important to note that the 115 million m^3/day would serve 800 million people, assuming and average consumption of 150 liters/capita/day. This could address the needs of customers who currently do not have service, expanding current coverage, or could serve the needs of future customers, allowing water source expansions to be postponed or cancelled.

The analysis in Wyatt/IDB indicated that of the 27 countries, 23 could have projects to significantly reduce NRW in the sample utilities, with a payback period of less than 10 years. In 16 of those countries, the payback period would be less than 5 years. The total cost of the projects would be about USD 10 billion. The countries with less favorable payback periods suffer from low tariffs. The resulting water savings could provide water to over 18 million new water connections, which could address current local coverage issues, and or cover urban growth for typically 8 to 10 years (assuming a 4% urban growth rate.

Conclusions

This new analysis of global levels of NRW shows that the current estimated volume is far higher than previously estimated. This is partly due to over conservative estimates used in previous estimates, as well as growth in population and expansion of water supply systems. The results of this study place the volume of NRW at 126 billion m^3/year, which has a financial cost/value of USD 39 billion/year.

The model has been found to provide very similar results to another study of NRW levels in Latin America – based on a sampling approach. Nonetheless more data and more accurate data would help refine the numbers.

Given climate change, expanding populations full coverage of improved water service is still a large global challenge. However, NRW can provide many benefits – including reduced operating costs increased revenues, better water resource efficiency and expanded water supply at a cost far lower than new water production facilities.

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Appendix

Africa

	supplied population	per capita consumption	Level of NRW	Volume of NRW	GDP per capita	Cost/value of NRW related to GBP	Annual cost/value of NRW
		l/d	%	m3/d	USD	USD/m3	million USD/year
Angola	5,754,772	80	40%	398,998	3,111	0.28	41.0
Benin	2,889,668	50	23%	56,931	789	0.23	4.9
Botswana	1,440,324	120	40%	149,794	6,788	0.31	16.9
Burkina Faso	2,707,197	50	19%	40,635	650	0.23	3.4
Burundi	833,890	113	40%	81,207	286	0.20	5.9
Cameroon	6,761,630	54	40%	312,865	1,033	0.24	27.7
Central African Republic	372,705	50	51%	25,509	382	0.21	1.9
Chad	1,360,398	50	40%	58,951	664	0.23	4.9
Comoros	494,486	50	40%	21,428	775	0.23	1.8
Congo	1,709,597	57	41%	89,700	1,528	0.26	8.4
Côte d'Ivoire	11,366,126	50	24%	231,900	1,526	0.26	21.7
Democratic Republic of the Congo	6,703,180	50	40%	290,471	445	0.21	22.6
Djibouti	406,153	50	40%	17,600	1,862	0.26	1.7
Equatorial Guinea	86,323	80	40%	5,985	8,333	0.32	0.7
Eritrea	979,919	50	40%	42,463	1,400	0.25	3.9
Ethiopia	15,410,872	75	40%	1,001,707	707	0.23	84.0
Gabon	1,195,779	117	23%	53,925	7,179	0.31	6.1
Gambia	900,947	50	17%	12,345	473	0.22	1.0
Ghana	7,363,645	50	52%	509,262	1,513	0.26	47.6
Guinea	3,584,686	50	31%	104,292	508	0.22	8.3
Guinea-Bissau	350,801	80	45%	29,850	620	0.23	2.5
Kenya	12,399,490	50	43%	603,805	1,455	0.25	56.2
Lesotho	531,686	53	29%	14,807	998	0.24	1.3
Liberia	166,360	50	49%	10,377	455	0.21	0.8
Madagascar	5,765,091	50	66%	727,419	401	0.21	55.7
Malawi	2,710,687	50	33%	86,508	301	0.20	6.3
Mali	5,611,623	59	28%	164,531	781	0.23	14.0
Mauritius	1,271,093	167	52%	296,525	9,628	0.32	34.7
Mayotte	203,293	80	40%	14,095	4,900	0.30	1.5
Mozambique	3,748,164	69	38%	206,769	382	0.21	15.7
Namibia	1,267,410	80	14%	21,938	4,140	0.29	2.3
Niger	2,520,759	51	16%	31,731	363	0.21	2.4
Nigeria	18,554,814	50	38%	738,259	2,178	0.27	72.5
Réunion	856,848	120	40%	89,112	23,501	0.35	11.5
Rwanda	1,510,694	50	41%	68,153	703	0.23	5.7
Senegal	9,003,117	55	33%	317,634	958	0.24	27.9
Seychelles	91,173	80	14%	1,551	15,076	0.34	0.2
Sierra Leone	718,379	50	40%	31,130	496	0.22	2.5
Somalia	2,044,470	50	60%	199,336	434	0.21	15.5
South Africa	40,132,776	270	27%	5,149,507	5,274	0.30	563.8
South Sudan	250,456	30	40%	6,512	759	0.23	0.6
Sudan	15,130,913	189	9%	352,513	2,415	0.27	35.1
Swaziland	593,515	77	40%	39,556	2,775	0.28	4.0
Togo	1,099,964	53	14%	12,284	578	0.22	1.0
Uganda	2,513,295	50	35%	88,391	615	0.22	7.3
United Republic of Tanzania	10,036,777	50	44%	504,535	879	0.24	43.7
Zambia	3,707,546	60	52%	316,424	990	0.24	27.9
Zimbabwe	4,582,905	81	52%	519,068	1,178	0.25	46.9
Total	**219,696,399**			**14,148,286**			**1,374**

Australia and New Zealand

	supplied population	per capita consumption	Level of NRW	Volume of NRW	GDP per capita	Cost/value of NRW related to GBP	Annual cost/value of NRW
		l/d	%	m3/d	USD	USD/m3	million USD/year
Australia	21,927,011	200	10%	651,538	49,928	0.38	90.0
New Zealand	4,528,526	212	20%	302,097	39,427	0.37	40.8
Total	**26,455,537**			**953,635**			**131**

Caucasus and Central Asia

	supplied population	per capita consumption	Level of NRW	Volume of NRW	GDP per capita	Cost/value of NRW related to GBP	Annual cost/value of NRW
		l/d	%	m3/d	USD	USD/m3	million USD/year
Armenia	2,955,370	83	83%	1,598,435	3,606	0.29	167.2
Azerbaijan	6,975,761	197	47%	1,557,923	3,877	0.29	164.5
Georgia	3,010,318	200	43%	581,827	3,854	0.29	61.4
Kazakhstan	13,218,644	118	28%	791,685	7,510	0.31	90.3
Kyrgyzstan	3,938,814	170	50%	886,664	1,077	0.24	79.1
Tajikistan	4,098,064	336	36%	1,007,458	796	0.23	86.0
Turkmenistan	2,988,858	120	40%	310,841	6,389	0.31	34.8
Uzbekistan	15,245,679	114	36%	1,258,488	2,111	0.27	123.1
Total	**52,431,507**			**7,993,320**			**806**

East Asia

	supplied population	per capita consumption	Level of NRW	Volume of NRW	GDP per capita	Cost/value of NRW related to GBP	Annual cost/value of NRW
		l/d	%	m3/d	USD	USD/m3	million USD/year
China	1,067,964,044	125	21%	44,688,202	8,123	0.32	5139.4
China, Hong Kong SAR	7,287,983	137	25%	431,149	43,681	0.37	58.9
China, Macao SAR	587,606	137	13%	15,569	73,187	0.39	2.2
Democratic People's Republic of Korea	22,614,190	80	40%	1,567,917	1,700	0.26	149.0
Japan	123,022,089	224	10%	3,971,685	38,894	0.37	536.2
Mongolia	752,817	252	22%	68,769	3,686	0.29	7.2
Republic of Korea	49,402,610	179	16%	2,234,970	27,539	0.36	291.9
Total	**1,271,631,340**			**52,978,262**			**6,185**

Europe

	supplied population	per capita consumption	Level of NRW	Volume of NRW	GDP per capita	Cost/value of NRW related to GBP	Annual cost/value of NRW
		l/d	%	m3/d	USD	USD/m3	million USD/year
Albania	2,490,362	72	67%	461,538	4,147	0.29	49.1
Andorra	70,473	120	40%	7,329	40,215	0.37	1.0
Austria	8,544,586	125	15%	244,894	44,177	0.37	33.5
Belgium	11,299,192	87	21%	330,871	41,096	0.37	44.9
Bosnia and Herzegovina	3,421,164	134	39%	374,940	4,709	0.30	40.5
Bulgaria	6,903,235	98	51%	929,420	7,351	0.31	105.7
Cape Verde	419,690	50	33%	13,644	2,998	0.28	1.4
Channel Islands	146,995	149	25%	9,491	62,000	0.39	1.3
Croatia	4,107,779	125	12%	93,742	12,091	0.33	11.3
Cyprus	1,165,300	230	17%	71,398	23,324	0.35	9.2
Czech Republic	10,319,594	83	18%	237,904	18,267	0.34	29.8
Denmark	5,669,081	128	7%	69,888	53,418	0.38	9.7
Estonia	1,263,019	107	40%	117,259	17,575	0.34	14.6
Faeroe Islands	48,199	120	40%	5,013	40,000	0.37	0.7
Finland	5,503,457	120	15%	151,507	43,090	0.37	20.7
France	64,395,345	147	15%	2,177,507	36,855	0.37	292.5
Germany	80,688,545	110	15%	2,030,621	41,936	0.37	276.1
Greece	10,833,653	97	25%	455,310	18,104	0.34	57.0
Greenland	54,360	120	40%	5,653	39,569	0.37	0.8
Hungary	9,739,620	84	32%	504,915	12,665	0.33	60.9
Iceland	329,425	120	15%	9,069	59,977	0.39	1.3
Ireland	4,635,733	149	25%	299,314	61,606	0.39	42.2
Isle of Man	84,497	149	25%	5,456	84,600	0.40	0.8
Italy	56,189,191	120	25%	2,921,838	30,527	0.36	385.4
Latvia	1,614,553	120	25%	83,957	14,118	0.33	10.2
Liechtenstein	37,531	120	40%	3,903	139,100	0.41	0.6
Lithuania	2,727,627	70	22%	70,677	14,880	0.34	8.7
Luxembourg	566,552	120	15%	15,597	102,831	0.40	2.3
Malta	418,670	120	25%	21,821	25,058	0.35	2.8
Monaco	37,731	120	15%	1,039	115,700	0.41	0.2
Montenegro	526,922	154	75%	313,701	6,701	0.31	35.3
Netherlands	16,924,929	126	5%	146,196	45,295	0.38	20.0
Norway	5,210,967	200	39%	858,099	70,812	0.39	122.4
Poland	36,513,707	119	17%	1,178,410	12,372	0.33	141.9
Portugal	10,339,926	161	18%	486,300	19,813	0.35	61.5
Republic of Moldova	2,429,591	100	42%	227,597	1,900	0.26	22.0
Romania	19,511,324	91	51%	2,371,970	9,474	0.32	277.5
San Marino	31,781	120	40%	3,305	59,500	0.38	0.5
Serbia	7,804,085	143	39%	933,149	5,348	0.30	102.3
Slovakia	5,068,731	83	32%	252,552	16,496	0.34	31.3
Slovenia	2,026,773	104	25%	91,677	21,305	0.35	11.7
Spain	46,095,599	141	25%	2,818,356	26,528	0.36	366.7
Sweden	9,779,426	145	40%	1,228,367	51,600	0.38	170.3
Switzerland	8,298,663	142	15%	270,289	78,813	0.39	38.9
TFYR Macedonia	1,921,213	128	61%	489,346	5,237	0.30	53.5
United Kingdom	64,715,810	149	21%	3,392,223	39,899	0.37	459.1
Total	**530,924,608**			**26,787,050**			**3,430**

Latin America and the Caribbean

	supplied population	per capita consumption	Level of NRW	Volume of NRW	GDP per capita	Cost/value of NRW related to GBP	Annual cost/value of NRW
		l/d	%	m3/d	USD	USD/m3	million USD/year
Anguilla	14,320	120	40%	1,489	12,200	0.33	0.2
Antigua and Barbuda	68,644	120	40%	7,139	14,353	0.34	0.9
Argentina	43,019,152	195	42%	7,893,740	12,449	0.33	950.9
Aruba	97,440	120	40%	10,134	25,300	0.35	1.3
Bahamas	369,918	146	34%	36,169	23,124	0.35	4.6
Barbados	278,577	180	55%	79,673	16,097	0.34	9.9
Belize	297,949	90	24%	11,008	4,811	0.30	1.2
Bermuda	61,884	150	40%	8,045	85,700	0.40	1.2
Bolivia (Plurinational State of)	7,915,294	100	35%	554,071	3,105	0.28	56.9
Brazil	199,750,809	112	39%	18,872,182	8,650	0.32	2185.6
British Virgin Islands	28,949	120	40%	3,011	42,300	0.37	0.4
Cayman Islands	51,572	184	18%	2,708	43,800	0.37	0.4
Chile	17,847,512	140	33%	1,620,196	13,793	0.33	197.3
Colombia	42,381,111	100	48%	4,996,833	5,806	0.30	553.2
Costa Rica	4,768,368	175	48%	981,771	11,825	0.33	117.6
Cuba	9,022,426	80	40%	625,555	7,602	0.31	71.4
Dominica	54,444	120	40%	5,662	7,144	0.31	0.6
Dominican Republic	8,396,571	120	40%	873,243	6,722	0.31	98.3
Ecuador	13,833,220	162	45%	2,387,856	5,969	0.30	265.2
El Salvador	5,367,444	122	40%	567,843	4,224	0.29	60.6
Falkland Islands (Malvinas)	2,602	120	40%	271	96,200	0.40	0.0
French Guiana	232,514	120	40%	24,181	20,000	0.35	3.1
Grenada	96,055	120	40%	9,990	9,469	0.32	1.2
Guadeloupe	464,901	120	40%	48,350	21,780	0.35	6.2
Guatemala	12,660,449	80	40%	877,791	4,147	0.29	93.4
Guyana	506,840	130	60%	128,484	4,457	0.29	13.8
Haiti	769,448	30	40%	20,006	740	0.23	1.7
Honduras	7,213,368	130	40%	797,915	2,361	0.27	79.2
Jamaica	2,259,016	148	50%	434,635	4,868	0.30	47.1
Martinique	395,866	80	40%	27,447	24,118	0.35	3.5
Mexico	119,478,951	120	40%	12,425,811	8,201	0.32	1430.6
Montserrat	4,949	80	40%	343	8,500	0.32	0.0
Nicaragua	4,234,942	115	58%	874,314	2,151	0.27	85.7
Panama	3,617,503	150	48%	651,151	13,680	0.33	79.2
Paraguay	5,936,257	205	44%	1,220,131	4,080	0.29	129.6
Peru	26,032,349	108	40%	2,436,628	6,046	0.30	271.0
Puerto Rico	3,465,481	165	62%	1,209,152	38,400	0.37	163.1
Saint Kitts and Nevis	55,016	120	40%	5,722	16,725	0.34	0.7
Saint Lucia	176,678	215	40%	32,844	7,744	0.31	3.8
Saint Vincent and the Grenadines	101,763	109	40%	9,569	7,030	0.31	1.1
Sao Tome and Principe	68,490	80	40%	4,749	1,756	0.26	0.5
Suriname	364,343	130	40%	41,049	6,484	0.31	4.6
Trinidad and Tobago	1,253,202	292	45%	388,555	15,377	0.34	47.9
Turks and Caicos Islands	23,335	80	40%	1,618	29,100	0.36	0.2
United States Virgin Islands	67,949	120	40%	7,067	36,100	0.37	0.9
Uruguay	3,384,329	120	49%	513,993	15,221	0.34	63.2
Venezuela (Bolivarian Republic of)	26,810,694	128	62%	7,412,326	13,800	0.33	902.6
Total	**573,302,895**			**69,142,419**			**8,012**

Middle East and Northern Africa

	supplied population	per capita consumption	Level of NRW	Volume of NRW	GDP per capita	Cost/value of NRW related to GBP	Annual cost/value of NRW
		l/d	%	m3/d	USD	USD/m3	million USD/year
Algeria	30,358,734	80	40%	2,104,872	3,844	0.29	222.0
Bahrain	1,363,465	257	40%	304,432	22,354	0.35	38.9
Egypt	88,309,817	122	24%	4,322,444	3,514	0.29	450.8
Iran (Islamic Republic of)	72,290,166	80	40%	5,012,118	4,958	0.30	544.8
Iraq	25,682,519	80	40%	1,780,655	4,610	0.30	191.9
Israel	8,064,036	120	15%	221,998	37,293	0.37	29.9
Jordan	6,539,533	54	36%	255,887	4,088	0.29	27.2
Kuwait	3,892,115	300	30%	650,539	28,975	0.36	85.4
Lebanon	4,999,209	120	40%	519,918	7,914	0.31	59.6
Libyan Arab Jamahiriya	2,586,716	120	40%	269,019	5,602	0.30	29.7
Mauritania	2,103,068	53	38%	88,155	1,078	0.24	7.9
Morocco	23,651,480	80	40%	1,639,836	2,832	0.28	166.5
Oman	3,940,364	308	35%	840,488	14,982	0.34	103.2
Palestine	2,558,231	30	32%	46,157	2,934	0.28	4.7
Qatar	2,159,353	300	30%	360,920	59,331	0.38	50.7
Saudi Arabia	30,856,206	235	40%	6,284,381	20,029	0.35	795.2
Syrian Arab Republic	15,052,340	80	40%	1,043,629	2,900	0.28	106.3
Tunisia	9,770,407	90	26%	402,247	3,689	0.29	42.2
Turkey	75,740,943	95	59%	13,425,887	10,788	0.33	1592.7
United Arab Emirates	7,234,001	300	30%	1,209,112	37,622	0.37	162.7
Yemen	11,186,178	59	33%	426,024	2,500	0.27	42.6
Total	**428,338,880**			**41,208,716**			**4,755**

Pacific Islands

	supplied population	per capita consumption	Level of NRW	Volume of NRW	GDP per capita	Cost/value of NRW related to GBP	Annual cost/value of NRW
		l/d	%	m3/d	USD	USD/m3	million USD/year
American Samoa	50,517	183	60%	17,642	11,542	0.33	2.1
Cook Islands	15,607	120	50%	2,435	12,300	0.33	0.3
Fiji	612,499	162	51%	137,136	5,153	0.30	15.0
French Polynesia	279,088	121	28%	16,891	17,000	0.34	2.1
Guam	168,844	240	55%	65,296	35,439	0.37	8.7
Kiribati	37,536	50	50%	2,440	1,449	0.25	0.2
Marshall Islands	5,811	50	30%	164	3,449	0.29	0.0
Micronesia (Fed. States of)	38,865	80	67%	8,114	3,200	0.28	0.8
Nauru	6,996	50	40%	303	7,821	0.31	0.0
New Caledonia	255,396	120	40%	26,561	31,100	0.36	3.5
Niue	1,399	80	7%	12	5,800	0.30	0.0
Northern Mariana Islands	45,370	80	70%	11,015	16,820	0.34	1.4
Palau	20,221	80	50%	2,145	13,626	0.33	0.3
Samoa	159,396	158	62%	53,579	4,028	0.29	5.7
Solomon Islands	276,566	177	62%	104,900	2,005	0.27	10.2
Tokelau	1,138	80	40%	79	1,000	0.24	0.0
Tonga	75,903	80	25%	2,696	3,689	0.29	0.3
Tuvalu	9,616	80	40%	667	3,084	0.28	0.1
Vanuatu	84,781	50	18%	1,226	2,861	0.28	0.1
Total	**2,145,549**			**453,302**			**51**

Russia, Ukraine, Belarus

	supplied population	per capita consumption	Level of NRW	Volume of NRW	GDP per capita	Cost/value of NRW related to GBP	Annual cost/value of NRW
		l/d	%	m3/d	USD	USD/m3	million USD/year
Belarus	8,468,538	117	27%	470,624	4,989	0.30	51.2
Russian Federation	108,324,457	145	25%	6,699,488	8,748	0.32	776.8
Ukraine	29,592,464	111	36%	2,354,707	2,186	0.27	231.3
Total	**146,385,460**			**9,524,819**			**1,059**

South Asia

	supplied population	per capita consumption	Level of NRW	Volume of NRW	GDP per capita	Cost/value of NRW related to GBP	Annual cost/value of NRW
		l/d	%	m3/d	USD	USD/m3	million USD/year
Afghanistan	3,968,029	50	41%	181,019	562	0.22	14.6
Bangladesh	22,945,576	92	23%	810,692	1,359	0.25	74.7
Bhutan	671,047	102	46%	75,419	2,804	0.28	7.6
India	568,564,072	94	41%	48,937,337	1,709	0.26	4,653.7
Maldives	156,177	80	40%	10,828	8,602	0.32	1.3
Nepal	13,609,820	50	40%	589,759	730	0.23	49.7
Pakistan	62,333,420	114	57%	12,243,095	1,468	0.26	1,140.5
Sri Lanka	7,785,396	131	31%	597,380	3,835	0.29	63.0
Total	**680,033,537**			**63,445,530**			**6,005**

Southeast Asia

	supplied population	per capita consumption	Level of NRW	Volume of NRW	GDP per capita	Cost/value of NRW related to GBP	Annual cost/value of NRW
		l/d	%	m3/d	USD	USD/m3	million USD/year
Brunei Darussalam	420,916	120	40%	43,775	26,939	0.36	5.7
Cambodia	3,339,899	80	7%	25,103	1,270	0.25	2.3
Indonesia	46,200,409	111	30%	2,904,030	3,570	0.29	303.5
Lao People's Democratic Republic	2,842,214	154	21%	149,920	2,353	0.27	14.9
Malaysia	28,218,685	227	34%	4,372,928	9,503	0.32	511.7
Myanmar	12,651,573	50	60%	1,233,528	1,275	0.25	112.7
Papua New Guinea	1,479,637	50	36%	53,421	3,500	0.29	5.6
Philippines	43,782,249	116	43%	4,887,893	2,951	0.28	498.9
Singapore	5,603,740	154	4%	43,604	52,961	0.38	6.1
Thailand	45,296,392	120	30%	3,028,387	5,908	0.30	336.0
Timor-Leste	494,790	30	60%	28,945	1,162	0.25	2.6
Viet Nam	37,063,327	115	23%	1,636,608	2,186	0.27	160.8
Total	**227,393,831**			**18,408,146**			**1,961**

United States and Canada

	supplied population	per capita consumption	Level of NRW	Volume of NRW	GDP per capita	Cost/value of NRW related to GBP	Annual cost/value of NRW
		l/d	%	m3/d	USD	USD/m3	million USD/year
Canada	25,157,949	280	15%	1,616,028	42,158	0.37	219.8
United States of America	317,594,357	379	20%	39,068,076	57,467	0.38	5469.6
Total	**342,752,306**			**40,684,104**			**5,689**

Per capita consumption data sources

Data source	Countries
IBNET	Albania, American Samoa, Armenia, Azerbaijan, Bahrain, Bangladesh, Belarus, Bhutan, Bosnia and Herzegovina, Brazil, Burundi, Cameroon, Congo, Costa Rica, Ecuador, Egypt, Fiji, French Polynesia, Gabon, Guam, Honduras, India, Indonesia, Jordan, Kazakhstan, Kyrgyzstan, Lao People's Democratic Republic, Lesotho, Lithuania, Malaysia, Mali, Mauritania, Mongolia, Montenegro, Mozambique, Namibia, New Zealand, Niger, Oman, Pakistan, Paraguay, Philippines, Republic of Moldova, Samoa, Senegal, Serbia, Singapore, Solomon Islands, Sri Lanka, Sudan, Swaziland, Tajikistan, TFYR Macedonia, Togo, Tunisia, Ukraine, Uruguay, Uzbekistan, Venezuela, Viet Nam, Yemen, Zambia, Zimbabwe
IWA www.waterstatistics.org	Australia, Belgium, Chile, China, China, Macao SAR, Cyprus, Denmark, Germany, Hungary, Japan, Mauritius, Netherlands, Norway, Poland, Republic of Korea, Romania, Russian Federation, Spain, Switzerland, United Kingdom
AWWA	United States of America, Canada
EU http://ec.europa.eu/eurostat /statistics- explained/index.php/Water _statistics	Austria, Bulgaria, Croatia, Czech Republic, Estonia, France, Greece, Malta, Portugal, Slovenia, Sweden, Turkey
Wyatt/IDB (specific utility information and estimates)	Cayman Islands, Jamaica, Nicaragua, Peru, Puerto Rico, Saint Lucia, Saint Vincent and the Grenadines, Trinidad and Tobago
Liemberger (mainly estimates, partly based on specific utility information)	Afghanistan, Algeria, Andorra, Angola, Anguilla, Antigua and Barbuda, Aruba, Bahamas, Barbados, Belize, Benin, Bermuda, Bolivia, Botswana, British Virgin Islands, Brunei Darussalam, Burkina Faso, Cambodia, Canada, Cape Verde, Central African Republic, Chad, Channel Islands, China, Hong Kong SAR, Colombia, Comoros, Cook Islands, Côte d'Ivoire, Cuba, Democratic People's Republic of Korea, Democratic Republic of the Congo, Djibouti, Dominica, Dominican Republic, Equatorial Guinea, El Salvador, Eritrea, Ethiopia, Faeroe Islands, Falkland Islands (Malvinas), Finland, French Guiana, Gambia, Georgia, Ghana, Greenland, Grenada, Guadeloupe, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Iceland, Iran, Iraq, Ireland, Isle of Man, Israel, Italy, Kenya, Kiribati, Kuwait, Latvia, Lebanon, Liberia, Libyan Arab Jamahiriya, Liechtenstein, Luxembourg, Madagascar, Malawi, Maldives, Marshall, Islands, Martinique, Mayotte, Mexico, Micronesia, Monaco, Montserrat, Morocco, Myanmar, Nauru, Nepal, Netherlands Antilles, New Caledonia, Nigeria, Niue, Northern Mariana Islands, Palau, Palestine, Panama, Papua New Guinea, Qatar, Réunion, Rwanda, Saint Kitts and Nevis, San Marino, Sao Tome and Principe, Saudi Arabia, Seychelles, Sierra Leone, Slovakia, Somalia, South Africa, South Sudan, Suriname, Syrian Arab Republic, Thailand, Timor-Leste, Tokelau, Tonga, Turkmenistan, Turks and Caicos Islands, Tuvalu, Uganda, United Arab Emirates, United Republic of Tanzania, United States Virgin Islands, Vanuatu, Western Sahara

NRW level data sources

Data source	Countries
IBNET	Afghanistan, Albania, American Samoa, Argentina, Armenia, Australia, Azerbaijan, Bahrain, Bangladesh, Belarus, Belgium, Benin, Bhutan, Bolivia, Bosnia and Herzegovina, Brazil, Bulgaria, Burkina Faso, Burundi, Cambodia, Cameroon, Cape Verde, Central African Republic, Chile, China, China, Macao SAR, Colombia, Congo, Costa Rica, Côte d'Ivoire, Croatia, Cyprus, Czech Republic, Denmark, Egypt, Fiji, French Polynesia, Gabon, Gambia, Georgia, Ghana, Guam, Guinea, Guinea-Bissau, Honduras, Hungary, India, Indonesia, Jordan, Kazakhstan, Kenya, Kiribati, Kyrgyzstan, Lao People's Democratic Republic, Lesotho, Liberia, Lithuania, Madagascar, Malawi, Malaysia, Mali, Marshall Islands, Mauritania, Mauritius, Micronesia, Mongolia, Montenegro, Mozambique, Namibia, Netherlands Antilles, New Zealand, Niger, Nigeria, Niue, Northern Mariana Islands, Norway, Oman, Pakistan, Palau, Palestine, Papua New Guinea, Paraguay, Philippines, Poland, Portugal, Republic of Korea, Republic of Moldova, Romania, Russian Federation, Rwanda, Samoa, Senegal, Serbia, Seychelles, Singapore, Slovakia, Solomon Islands, South Africa, Sri Lanka, Sudan, Suriname, Tajikistan, TFYR Macedonia, Togo, Tonga, Tunisia, Turkey, Uganda, Ukraine, United Kingdom, United Republic of Tanzania, Uzbekistan, Vanuatu, Venezuela, Viet Nam, Yemen, Zambia, Zimbabwe
AWWA	Canada, United States of America
Wyatt/IDB (specific utility information and estimates)	Bahamas, Belize, Cayman Islands, Guyana, Nicaragua, Panama, Puerto Rico,
Liemberger (mainly estimates, partly based on specific utility information)	Algeria, Andorra, Angola, Anguilla, Antigua and Barbuda, Aruba, Austria, Barbados, Bermuda, Botswana, British Virgin Islands, Brunei Darussalam, Chad, Channel Islands, China, Hong Kong SAR, Comoros, Cook Islands, Cuba, Democratic People's Republic of Korea, Democratic Republic of the Congo, Djibouti, Dominica, Dominican Republic, Equatorial Guinea, Ecuador, El Salvador, Eritrea, Estonia, Ethiopia, Faeroe Islands, Falkland Islands (Malvinas), Finland, France, French Guiana, Germany, Greece, Greenland, Grenada, Guadeloupe, Guatemala, Haiti, Iceland, Iran, Iraq, Ireland, Isle of Man, Israel, Italy, Jamaica, Japan, Kuwait, Latvia, Lebanon, Libyan Arab Jamahiriya, Liechtenstein, Luxembourg, Maldives, Malta, Martinique, Mayotte, Mexico, Monaco, Montserrat, Morocco, Myanmar, Nauru, Nepal, Netherlands, New Caledonia, Peru, Qatar, Réunion, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, San Marino, Sao Tome and Principe, Saudi Arabia, Sierra Leone, Slovenia, Somalia, South Sudan, Spain, Swaziland, Sweden, Switzerland, Syrian Arab Republic, Thailand, Timor-Leste, Tokelau, Trinidad and Tobago, Turkmenistan, Turks and Caicos Islands, Tuvalu, United Arab Emirates, United States Virgin Islands, Uruguay, Western Sahara