MANAGING WATER DEMAND IN EUROPE

Case studies on price elasticity – domestic sector

June 2017

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1. Germany

Berlin Wasserbetriebe

Preliminary overview

Preliminary overview	
Region	City of Berlin, Berlin
Operator and type of authority	Operator: Berliner Wasserbetriebe (public agency – Anstalt des öffentlichen Rechts) Authority: Senate Department for Urban Development and the Environment of the City of Berlin (Senatsverwaltung für Stadtentwicklung und Umwelt)
Geographical coverage	The whole city of Berlin
Area (km²)	Roughly equals the urban area of Berlin[1]: 891.7 km² [2]
Sector	Domestic sector
No. Of municipalities	1 municipality managed by the operator
No. of customers	3.4 million customers in Berlin in 2009[3] (roughly 256,000 houses connected[4])
Type of data available	Consumption data, population, population density, income per capita, rainfall, average temperatures, household size, water price. Yearly data for varying years.
Proposed focus of the case study	assessment of elasticity on the whole study area
Source	Berliner Wasserbetriebe, Amt für Statistik Berlin-Brandenburg

1. Water service description

1a	Name of the service: Berliner Wasserbetriebe
1b	Location (MS, Region): Germany, City of Berlin
1c	Type of authority: Municipality
1d	Management type: Public management (before 1999 and since 2013); Public-Private (between 1999 and 2013)
1e	Water Competences: Supply, Treatment and Abstraction

[1] Only 3 Mio. m3/a (1,5% of total water abstraction) is delivered to areas outside of Berlin. Therefore for the following socio-economic indicators, data for the City of Berlin is used. Furthermore, the total amount of water abstracted by BWB is used. Möller & Burgschweiger 2008: Wasserversorgungskonzept Berlin.

[2] Amt für Statistik Berlin-Brandenburg (2016): Statistiken. https://www.statistik-berlin-brandenburg.de/Statistiken/inhalt-statistiken.asp

[3] Berliner Wasserbetriebe 2009: Geschäftsbericht 2009

[4] Möller & Burgschweiger 2008: Wasserversorgungskonzept Berlin

1f	Sanitation service: Yes
1g	Number of Municipalities under authority: 1

2. Contextual information

	Description of housings and population
2a	Population in the area of authority: 3 469 800 in 2014[5]
2b	Population density: 3 891.3 inhabitants/km² in 2014[6]
2c	Household's income - in euros per capita (mean or distribution):[7] 17,594 € per capita in 2013[8] (data for 2000-2013)
2d	Share of individual houses: detached houses: 7.5%, detached and semi-detached houses: 9.8 % (2011)[9]
2e	Share of permanent housings: no data found

	Climatic information
2f	Number of days with rainfalls during spring and summer: **Year** 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 **Nb days** 65 94 74 83 90 82 67 86 71 78 **Year** 2007 2008 2009 2010 2011 2012 2013 2014 **Nb days** 82 77 80 76 72 80 65 84 *Data from National Climatic Data Center - Station Berlin Tempelhof (http://www.ncdc.noaa.gov)*
2g	Number of days with a temperature above 28°C **Year** 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 **Nb days** 21 15 27 16 19 21 39 13 16 34 **Year** 2007 2008 2009 2010 2011 2012 2013 2014 **Nb days** 16 21 21 28 16 18 18 28 *Data from National Climatic Data Center - Station Berlin Tempelhof (http://www.ncdc.noaa.gov)*

[5] Amt für Statistik Berlin-Brandenburg (2016): Statistiken. https://www.statistik-berlin-brandenburg.de/Statistiken/inhalt-statistiken.asp

[6] https://www.statistik-berlin-brandenburg.de/statistiken/inhalt-statistiken.asp

[7] Amt für Statistik Berlin-Brandenburg (2015): Statistischer Bericht. Einkommen und Einnahmen sowie Ausgaben privater Haushalte im Land Berlin 2013

[8] Statistische Ämter des Bundes und der Länder (2014): Volkswirtschaftliche Gesamtrechnung: Verfügbares Einkommen je Einwohner in Deutschland nach Bundesländern http://www.vgrdl.de/VGRdL/tbls/tab.jsp?rev=RV2014&tbl=tab14&lang=de-DE

[9] Amt für Statistik Berlin-Brandenburg (2015): Statistischer Bericht. Fortschreibung des Wohngebäude und Wohnungsbestandes in Berlin am 31. Dezember 2014.

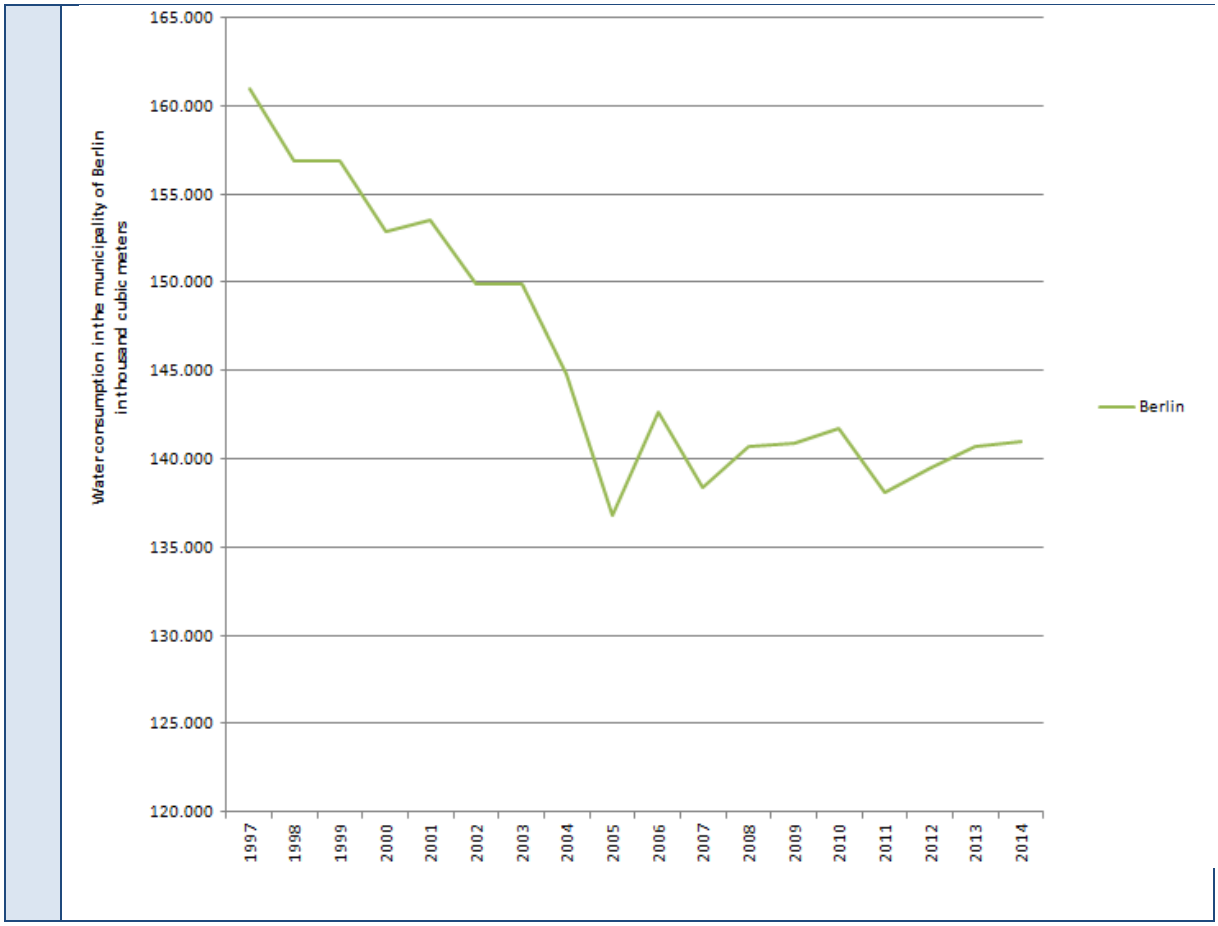
	Other descriptors of housings and population - *To be discussed*
2h	Population age (mean or distribution): available for 2014[10]
2i	Average household size: in 2014 – 1,963,200 households in total 1.8 persons per household in 2014[11]
2j	Average house size: 73 m² in 2014[12] for flats
2k	Share of houses with lawn: no data found
2l	Share of houses with swimming pool: no data found
2m	Share of houses with private well: no data found
2n	Equipment rate for main water saving devices (rainwater tank, flow reducers, dual-flush toilets): no data
2o	Equipment rate for main water consuming devices (shower vs. tub, washing machine, dishwasher) no data

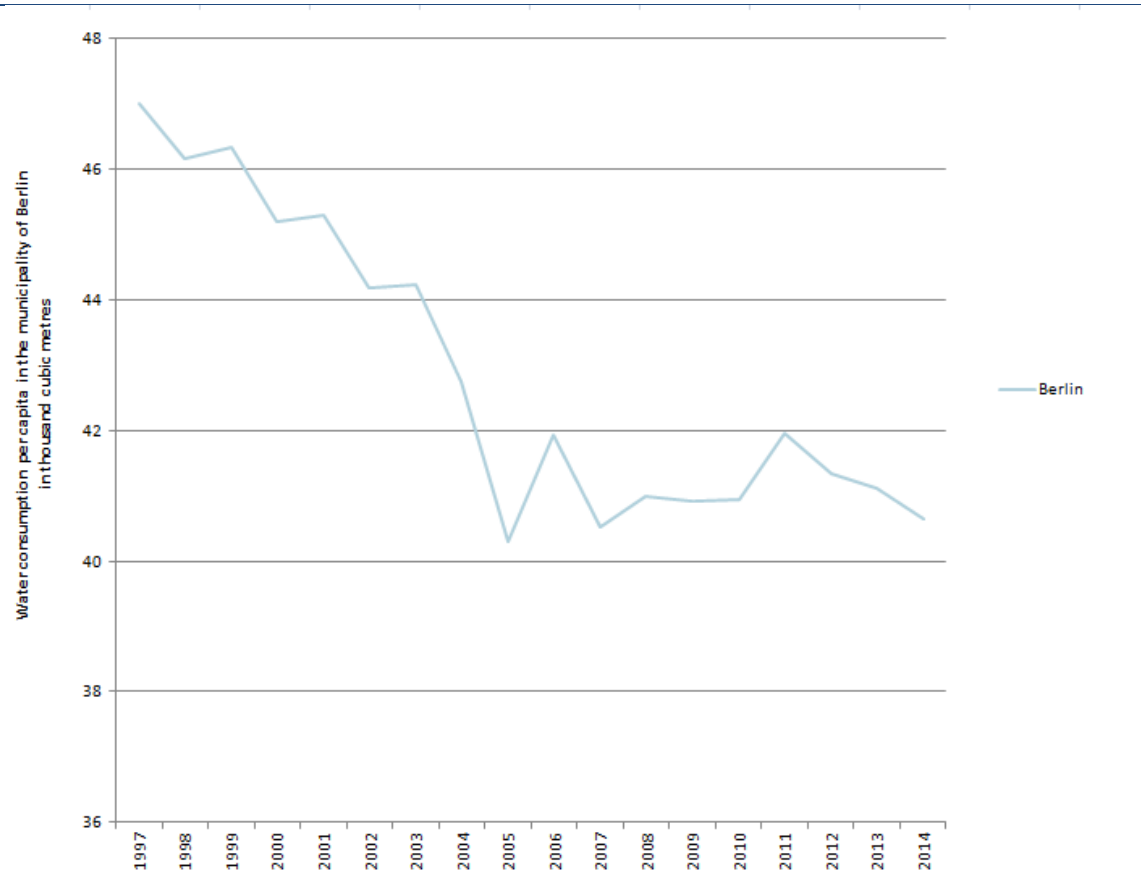
3. Water consumption and price

	Water Consumption data
3a	Water consumption - volume charged: 1997-2014 (missing data for 1997 and 2003, for 1997 used data from 1996, for 2003 used data from 2002) [13]

[10] Amt für Statistik Berlin-Brandenburg: Statistisches Jahrbuch Berlin 2015, 01 Gebiet und Bevölkerung, Bevölkerung am 31. Dezember 2014 nach Altersjahren, Geschlecht und Familienstand, p. 42 ff.
[11] Amt für Statistik Berlin-Brandenburg (2015): Statistisches Jahrbuch Berlin 2015 (1,8 is also mentioned in the Statistisches Jahrbuch Berlin 2006)

[12] Amt für Statistik Berlin-Brandenburg (2015): Statistischer Bericht. Fortschreibung des Wohngebäudeund Wohnungsbestandes in Berlin am 31. Dezember 2014 (S. 10)
[13] http://kompetenzwasser.de/fileadmin/user_upload/pdf/downloads/Wassersparen/20100304_DVGW_03-10_20_Jahre_Wiedervereinigung.pdf; http://www.bwb.de/content/language1/html/204.php


Water consumption in the municipality of Berlin in thousand cubic meters
165.000
160.000
155.000
150.000
145.000
140.000
135.000
130.000
125.000
120.000
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
Berlin

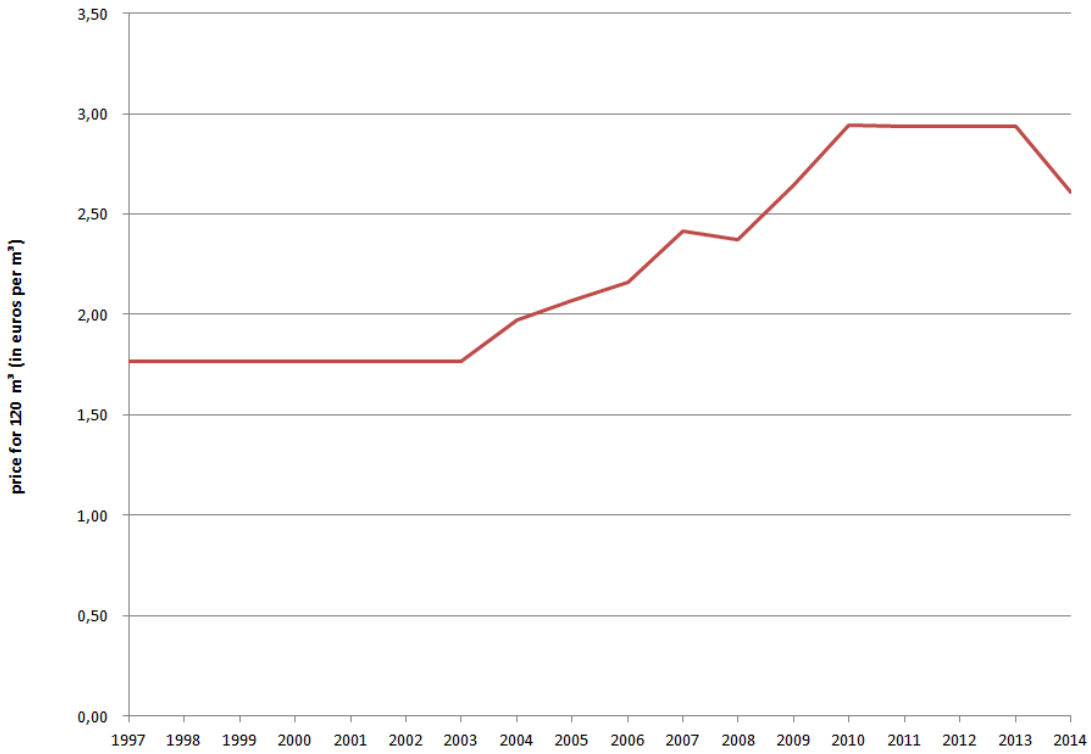
	
3 b	Number of account holders: no data
3c	Population supplied: 3.4 million customers in Berlin in 2009[14]
3 d	Rate of connection to sanitation network: 99.6 %[15]
3e	Individual meters (only for houses, for all housings, a mix, other): For new built houses, there is an obligation by national law for the installation of warm water meters per flat/house. Cold water meters per flats are also compulsory for new buildings in Berlin[16]. But there is not a regulation for existing buildings. That results in a mix of meters per flat/house, per apartment building, etc.

	Water Price data
3f	Structure tariff (existence of a fixed part, per-unit volume charge, block prices, free allowance): fixed part and per-unit volume charge, fixed part introduced in 2007

[14] Berliner Wasserbetriebe 2009: Geschäftsbericht 2009

[15] Statistisches Bundesamt (2016): Öffentliche Abwasserentsorgung nach Ländern 2013, Gemeinden mit öffentlicher und privater Abwasserentsorgung. https://www.destatis.de/DE/ZahlenFakten/GesamtwirtschaftUmwelt/Umwelt/UmweltstatistischeErhebungen/Wasserwirtschaft/Tabellen/Abwasserentsorgung_2013.html

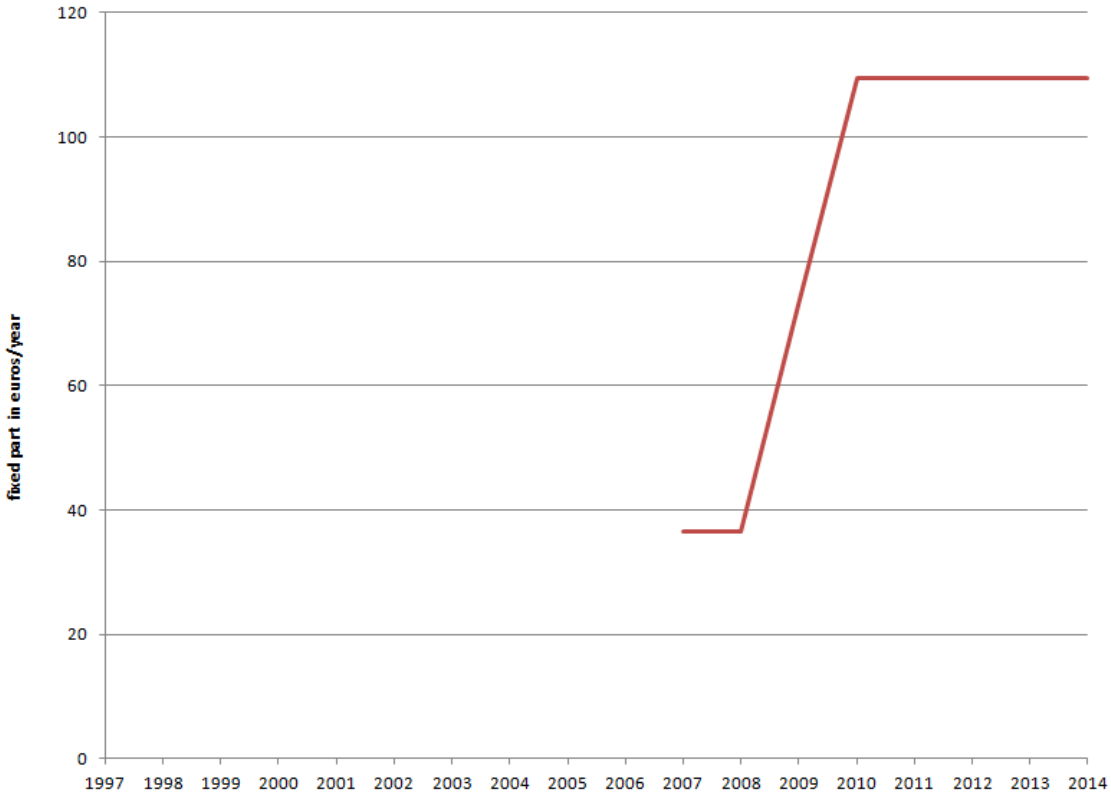
[16] Senatsverwaltung für Stadtentwicklung Berlin (2011): Bauordnung für Berlin (BauO Bln). http://www.stadtentwicklung.berlin.de/service/gesetzestexte/de/download/bauen/BauOBln.pdf



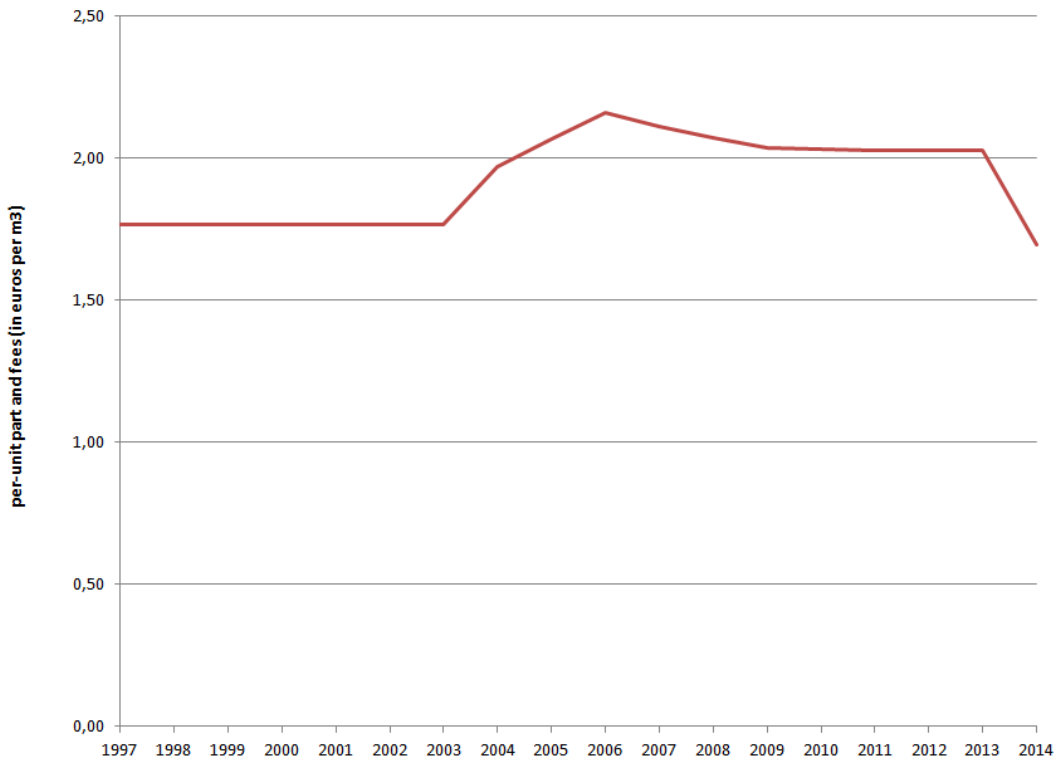
3g	Fixed part - Water (if variable with diameter, domestic meters are generally 15mm): for water meter in size $QN_{2,5}$[17]: 0,30 Euro per day (2014)[18]

[17] $QN_{2.5}$ is the smallest water meter, which is used for 2.5 m^3/h - normally suitable for private flats or houses. 70% of BWBs costumers have a $QN_{2.5}$ water meter. (Source: BWB (2007): Grundlagen der Tarifkalkulation. Dokumentation.)

[18] BWB Tarifblatt for the different years, 2014: http://www.bwb.de/content/language1/downloads/Tarifblatt_2014.pdf



3h	Per-unit volume charge (or charges if block prices) – Water: Detail water supply available for 1997-2014

	
3i	Fees – Water: water abstraction charge on groundwater (payed by water supplier to regional authority): 0,31 Euro/m^3 (highest charge in Germany)[19]
3j	Taxes – Water: No
3k	Fixed part – Sanitation: fixed part introduced in 2007, for water meter in size $QN_{2,5}$: 0,30 Euro per day (2014)[20]
3l	Per-unit volume charge – Sanitation: Split into waste water fee and rainwater fee, detail available for 1997-2014[21]
3 m	Fees – Sanitation: waste water effluent charge (payed by water suppliers to regional authority and passed on to the customers)
3n	Taxes – Sanitation: No
3o	Existence of other specific tariffs (lawn, other): No
3p	Existence of a social tariff - If yes, conditions and price: No

4. Other information

[19] Branchenbild (2015): ATT, BDEW, DBVW, DVGW, DWA und VKU (2015): Branchenbild der deutschen Wasserwirtschaft. Wirtschafts- und Verlagsgesellschaft. Bonn.

[20] BWB Tarifblatt for the different years, 2014: http://www.bwb.de/content/language1/downloads/Tarifblatt_2014.pdf

[21] http://kompetenzwasser.de/fileadmin/user_upload/pdf/downloads/Wassersparen/20100304_DVGW_03-10_20_Jahre_Wiedervereinigung.pdf; http://www.bwb.de/content/language1/html/204.php

4a	Changes in the water service management or in the water price structure during the last years: - In 1999, the Berliner Wasserbetriebe is turned into a public-private partnership - In 2012/2013, the state of Berlin repurchases of all shares of the Berliner Wasserbetriebe - In 2012, the Federal Cartel Office enforces a water price reduction
4b	Motivations of changes Regarding the water service management, important changes are the partial privatisation of the Berliner Wasserbetriebe (BWB) in 1999 and the re-municipalisation in 2013. In 1999, the State of Berlin integrated the BWB into a private sector holding model. Two companies, RWE and Veolia (formerly known as Vivendi) each held 24.95 percent equity interest in the group. The State of Berlin held 50.1 percent.[22] Main motivation of the partial privatisation was to lower the burden on public budgets.[23] The contract between the State of Berlin, RWE and Veolia specified that water prices would not increase until December 31, 2003. From 2004 on, prices increased and led to protests by the public. In 2011, a referendum asked for the disclosure of agreements of the partial privatization and demanded re-municipalisation of the water utilities.[24] In October 2012, the State of Berlin acquired the shares held by RWE and in November 2013 it acquired the shares held by Veolia, thereby increasing its share from 50.1 % to 100 %. Prices remained at their high level, as the Senate needed to repay the credit and lending rates for the repurchase. However, the Federal Cartel Office (Bundeskartellamt) intervened. The Federal Cartel Office is an independent competition authority whose task is to protect competition in Germany. The protection of competition is a key regulatory policy objective in a market economy. According to its decision, the price for drinking water in Berlin had to be decreased by 14 percent. The wastewater price had to be decreased by 6 percent.[25]
4c	Other comments One reason for the high prices is seen in the profit transfer to the two private companies. In fact, the contract between the State of Berlin, RWE and Veolia included a profit guarantee for the private companies.[26] Another reason is seen in the water abstraction charge (WAC), which is highest in Berlin in comparison to other federal states in Germany. Aiming to protect the available amount and quality of groundwater in Berlin, the charge is at 0.31 € per m³ with 6,000 m³ per year being free of charge. It has to be paid by the utilities and is passed on to the consumers via the final water price. It has been

[22] Berliner Wasserbetriebe (n.d.): Structure and Development. URL: http://www.bwb.de/content/language2/html/8368.php, accessed February 15, 2016.

[23] Werle, Hermann (2005): Zwischen Gemeinwohl und Profitinteresse. Erfahrungen bei der Teilprivatisierung der Wasserwirtschaft in Berlin. Brot für die Welt, Stuttgart.

[24] Thomsen, Jan (2012): Senat will das Wasser zurück. Berliner Zeitung, 17.07.2012. URL: http://www.berliner-zeitung.de/berlin/rekommunalisierung-der-berliner-wasserbetriebe-senat-will-das-wasser-zurueck,10809148,16636818.html

1. [25] Nehls, Anja (2015): Erfolgreiche Rekommunalisierung. Warum die Wasserbetriebe wieder den Berlinern gehören. Deutschlandradio Kultur, 08.09.2015. URL: http://www.deutschlandradiokultur.de/erfolgreiche-rekommunalisierung-warum-die-wasserbetriebe.976.de.html?dram:article_id=330502

[26] Werle, Hermann (2005): Zwischen Gemeinwohl und Profitinteresse. Erfahrungen bei der Teilprivatisierung der Wasserwirtschaft in Berlin. Brot für die Welt, Stuttgart.

	calculated that the WAC accounts for about 13.8 percent of the overall water price in Berlin (including for drinking and waste water).[27] In general, per capita water consumption in Berlin has fallen since 1989.[28] This mirrors the overall trend for Germany: water consumption per inhabitant per day decreased since 1990 by 17 % (based on water consumption of households and small businesses). Main reasons for this development are seen in behavioral changes of water consumers as well as in technical advancements. Households increasingly use modern equipment such as water efficient appliances (e.g. dishwashers, washing machines, low-flow showerheads) and water fittings.[29] In general, the awareness for efficient water use is high in Germany, about one third of the inhabitants are consciously saving water.[30] Further reasons for a reduced water demand especially, in Eastern Germany including Eastern part of Berlin, after the German reunification (in 1990) a lot of housings and flats were re-constructed or newly built in the 1990s and 2000s and with this water-efficient equipment such as fittings / toilet flush were installed.[31] The trend of declining water consumption by households in Berlin has led to problems related to the sewer system. Due to the low amount of wastewater going though the system, debris remains in the system, potentially leading to putrefaction. This in turn leads to odour nuisance and corrosion of the pipes. A countervailing measure commonly practiced by the water utilities is to pump freshwater through the sewer system in order to rinse the pipes.[32,33] As Berlin's number of inhabitants is growing, the sewer system needs to be expanded. In 2014 alone, the city's population has grown by 44,000 inhabitants. In the same year, 19.7 kilometers of new water pipes have been installed. Apart from new installations, the BWB renewed about 50 kilometers of the sewer system.[34]
4d	Other water demand management instruments & years when these have been established and implemented (e.g. example specific restrictions for a given year when there is drought)

[27] Schwalbach, Joachim; Schwerk, Anja & Smuda, Daniel (2011): Bewertung der Rekommunalisierung der Berliner Wasserbetriebe. Kurzgutachten. Humboldt-Universität zu Berlin, IHK Berlin.

[28] Abgeordnetenhaus Berlin (2008): Kleine Anfrage. Grundwasserentnahmeentgelt – Preistreiber statt sinnvoller Umweltschutz? URL: http://www.stiftung-naturschutz.de/fileadmin/img/pdf/Kleine_Anfragen/ka16-12434.pdf

[29] BDEW (2015): Wasserfakten im Überblick. Mai 2015. https://www.bdew.de/internet.nsf/id/C125783000558C9FC125766C0003CBAF/$file/Wasserfakten%20-%20%C3%96ffentlicher%20Bereich%20Mai%202015.pdf, accessed: 19 November 2015.

[30] http://www.lvz.de/Leipzig/Lokales/86-Liter-pro-Kopf-Leipzig-liegt-beim-Wasserverbrauch-unter-Bundesdurchschnitt

[31] http://statistik-dresden.de/archives/3678

[32] Guthke, Janina (2009): Berlin spart Wasser – und stinkt. Der Tagesspiegel, 04.08.2009. URL: http://www.tagesspiegel.de/berlin/geruchsbelaestigung-berlin-spart-wasser-und-stinkt/1572422.html

[33] Umweltbundesamt (2014): Wassersparen in Privathaushalten: sinnvoll, ausgereizt, übertrieben? Fakten, Hintergründe, Empfehlungen. UBA, Dessau-Roßlau

[34] Berliner Wasserbetriebe (2014): 2014. Das Jahr in Zahlen. URL: http://www.bwb.de/content/language1/downloads/BWB-Zahlen_und_Fakten_2014_eBook.pdf

5. Regression analysis

Analysis conducted and descriptive statistics

Two models were tested:

- One where the mean delivered volume per household is regressed on the average price a household will pay for a yearly consumption of 120m^3 of drinking water (the price includes both fixed and variable costs for drinking water).
- A second model, which in addition to price also includes all other variables we had: income per capita, share of individual houses (detached houses), the number of hot days and the number of rainy spring and summer days. The regression returned high p-values for the additional variables, suggesting the latter were not significant. For this reason, only the results of the first model are shown below.

All data are at the municipality level (1 municipality) and for the period 1997-2014. Both models are performed using an ordinary least squares (OLS) estimator. In both regressions, price and water consumption were log-transformed.

Values of water consumption and water price for the period 1997-2014 are given in the template, as well as climate variables and values at a municipality scale of median income and share of individual houses. In Tableau 8 the summary statistics of variables are presented.

Table 1: Descriptive statistics

Variable	Description	Mean	Median	Std.dev	Var	Min	Max	N
price.120	Average price per cubic meter for a 120 m3 consumption	2,24	2,11	0,486	0,24	1,76	2,95	18
vol.cap	Average delivered volume per capita	42,88	41,93	2,30	5,31	40,29	47,00	18
income.cap	Per capita income	16042	15872	1003	1006633	14881	17594	18
p.houses	Share of individual houses (detached houses)	0,07	0,07	0,0005	0,0000002	0,07	0,08	18
hot.days	Number of days with a temperature above 28°C	22	20	7	50	13	39	6546
rainy.days	Number of rainy days during spring and summer	78	79	8	66	65	94	3312

Model 1 - Results

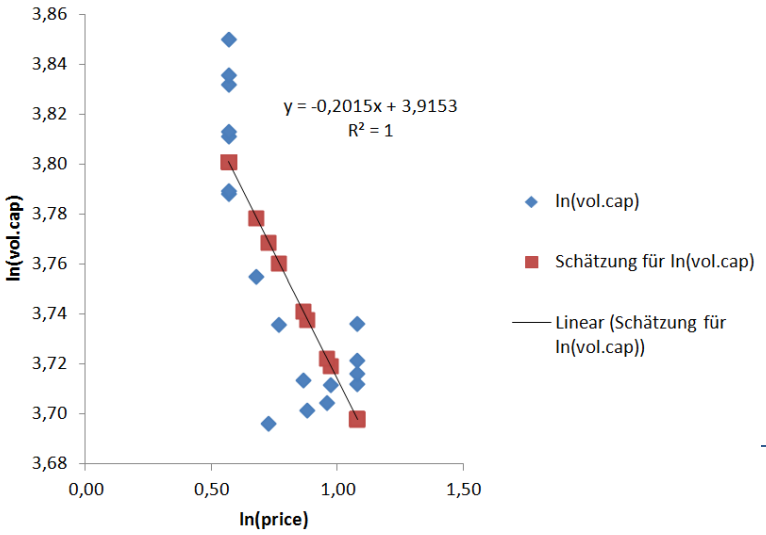
I **Model 1: Water consumption as a function of price**

Table 2: Regression results of model 1 - Dependent variable ln(vol.cap)

*** $p < 0,001$

Summary	
R2	0,65
Adj. R2	0,63
F-stat	30,3
N	18

	Coeff.	*Std.err*
Constant	3,915***	0,030
ln (price.120)	-0,202***	0,037



From the regression results in table 2 we can conclude that price is a significant determinant of water demand in Berlin. As we used a double-log regression, price elasticity is the coefficient estimated, i.e. -0.202. **This means that water consumption per capita is inelastic to price.**

Stuttgart – EnBW Energie Baden-Württenberg AG

Preliminary overview

Preliminary overview	
Region	City of Stuttgart, Stuttgart
Operator and type of authority	Operator: EnBW Energie Baden-Württemberg AG Authority: Lower water authority at the Environmental Agency of State Capital of Stuttgart (Untere Wasserbehörde beim Amt für Umweltschutz, Landeshauptstadt Stuttgart)
Geographical coverage	City of Stuttgart (EnBW Energie Baden-Württemberg AG operates only drinking water for Stuttgart)
Area (km²)	207.36 km² [35]
Sector	Domestic sector
No. Of municipalities	one municipality (total served area of the operator)
No. of customers	607,841 (Oct 2015) [36] (main residence: 601,045, secondary residence: 6,796) (total served area of the operator)
Type of data available	Water prices 1980-2015 (yearly) (drinking water + sanitation) Population 2004-2015 Income per household (1990, 2000, 2014) Income per capita (1991-2012) Average household size (1970, 1987, 2000, 2006, 2011, 2014) Residential buildings with one, two or more than three apartments (1987, 2005, 2011) Precipitation volume per month, number of rainy days per month (1995-2014), Precipitation volume per year, number of rainy days per year (1980-2014) Average temperature per year, Maxim temperature per year, number of days with more than 25°C per year, number of days with more than 30°C per year (1980-2014) Water consumption households and small businesses (1979-2013, not for all years) (total volume, daily volume per capita)
Proposed focus of the case study	assessment of elasticity on the whole study area
Source	local and regional statistics offices, National Climatic Data Center of the NOAA.

1. Water service description

1a	Name of the service: EnBW Energie Baden-Württemberg AG

[35] http://www.wasserqualität-trinkwasserqualität.de/wasser-qualitaet/staedte/stuttgart

[36] http://www.wasserqualität-trinkwasserqualität.de/wasser-qualitaet/staedte/stuttgart

1b	Location (MS, Region) Germany, Baden-Württemberg
1c	Type of authority (Municipality, Group of municipalities, Union, other): Municipality
1d	Management type (Public management, Leasing, Concession, other): Concession
1e	Water Competences (among Supply, Supply and Treatment, Supply, Treatment and Abstraction): Supply, Treatment and Abstraction
1f	Sanitation service (Yes, Distinct, Unknown): Stadtentwässerung Stuttgart
1g	Number of Municipalities under authority: 1

2. Contextual information

	Description of housings and population
2a	Population in the area of authority: 612,441[37] (2014) (data available for 1961-2014)
2b	Population density: 2,954 inhabitants/km^2 [38] (2014) (data available for 1961-2014)
2c	Household's income - in euros per capita (mean or distribution): 22.739 Euro/inhabitant (disposal income) (2012)[39] (data available for 2000-2012, before revision: 1991-1999)
2d	Share of individual houses: 35% for detached houses and 50% for detached + semi-detached houses (2014)[40]
2e	Share of permanent housings: 98%[41] (2015)

	Climatic information
2f	Number of days with rainfalls during spring and summer:

Year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Nb days	84	87	92	74	88	94	92	97	80	77	64	87	87

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Nb days	101	91	84	85	92	97	98	92	82	61	86	87	93

Year	2007	2008	2009	2010	2011	2012	2013	2014

[37] Statistisches Landesamt Baden Württemberg (2014): Gebiet, Bevölkerung und Bevölkerungsdichte, Stuttgart, Landeshauptstadt. https://www.statistik-bw.de/SRDB/Tabelle.asp?H=1&U=01&T=01515020&E=GE&K=111&R=GE111000, Accessed 26 November 2015.

[38] Statistisches Landesamt Baden Württemberg (2014): Gebiet, Bevölkerung und Bevölkerungsdichte, Stuttgart, Landeshauptstadt. https://www.statistik-bw.de/SRDB/Tabelle.asp?H=1&U=01&T=01515020&E=GE&K=111&R=GE111000, Accessed 26 November 2015.

[39] Statistisches Landesamt Baden Württemberg (2015): 6.5.1 Einkommen, Bruttoentgelte, Arbeitnehmerentgelte in Stuttgart seit 2000. http://statistik1.stuttgart.de/statistiken/tabellen/3272/jb3272.php, Accessed 26 November 2015.

[40] Statistisches Landesamt Baden Württemberg (2015): Wohngebäude und Wohnungen seit 1986 nach Gebäudetypen. https://www.statistik-bw.de/Wohnen/GebaeudeWohnungen/07055020.tab?R=GS111000

[41] Based on main and secondary presence presented in „Preliminary Overview", no further data available.

Nb days	84	105	88	92	79	80	90	82	

Data from National Climatic Data Center - Station of Stuttgart Schnarrenberg (http://www.ncdc.noaa.gov)

2g Number of days with a temperature above 28°C:

Year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Nb days	10	14	29	10	16	15	12	11	13	17	23	25	9

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Nb days	29	20	7	20	21	21	20	24	15	51	24	29	29

Year	2007	2008	2009	2010	2011	2012	2013	2014
Nb days	17	17	19	23	17	23	23	15

Data from National Climatic Data Center - Station of Stuttgart Schnarrenberg (http://www.ncdc.noaa.gov)

Other descriptors of housings and population - *To be discussed*

2h	Population age (mean or distribution): available for 2014 (Table „Einwohner 2014 nach Alter und Migrationshintergrund" of the document listed in the footnote)[42]
2i	Average household size: 2,0 (1987-2011)[43]
2j	Average house size: size per flat: 75.17 m^2 (2011: Wohnfläche je Wohnung), (only flats) [44] size per inhabitant: 36.1 m^2 (2011, Wohnfläche in Wohngebäuden je Einwohner) (all housings for main residence)[45]
2k	Share of houses with lawn: no data
2l	Share of houses with swimming pool: no data
2m	Share of houses with private well: no data
2n	Equipment rate for main water saving devices (rainwater tank, flow reducers, dual-flush toilets): no data
2o	Equipment rate for main water consuming devices (shower vs. tub, washing machine, dishwasher): no data

[42] Landeshauptstadt Stuttgart (2015): Stuttgarter Einwohnerdaten. Stuttgart.

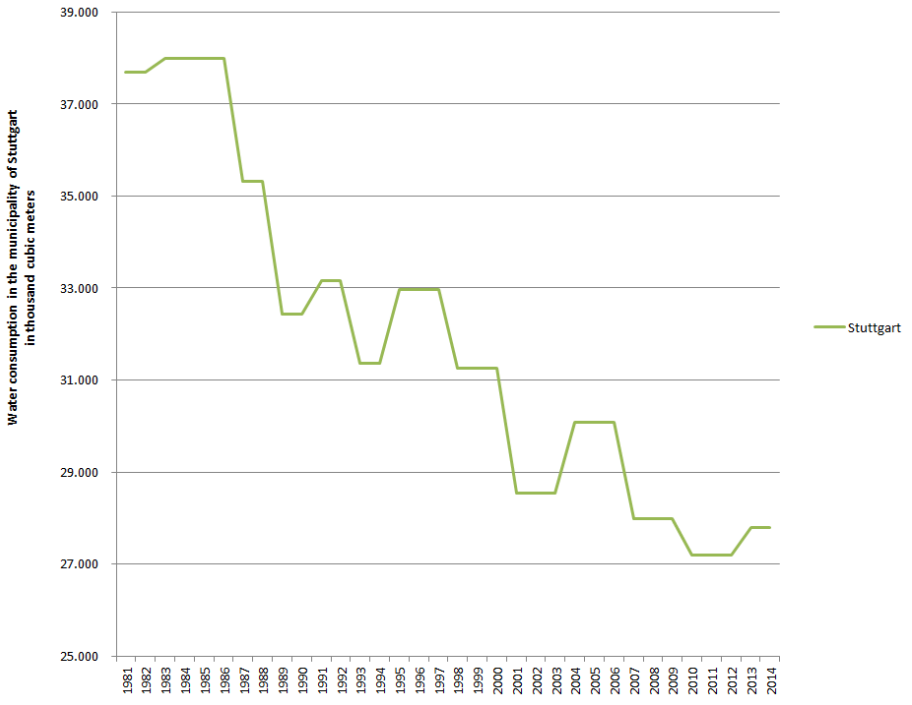
[43] Statistisches Landesamt Baden-Württemberg (2015): Haushalte sowie durchschnittliche Haushaltsgröße. Landeshauptstadt Stuttgart. https://www.statistik-bw.de/PrivHaushalte/EntwStruktur/99025080.tab?R=GS111000

[44] Landeshauptstadt Stuttgart (2012): Stuttgarter Wohnungsdaten. Stuttgart.

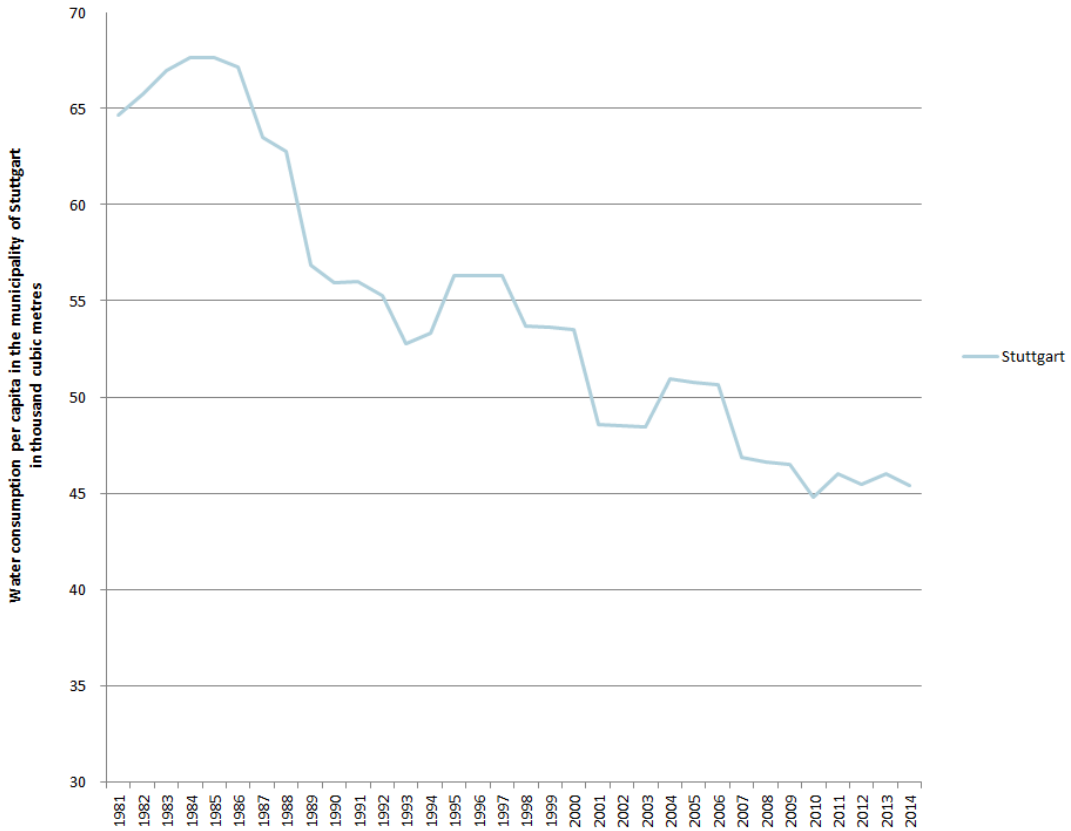
[45] Landeshauptstadt Stuttgart (2012): Stuttgarter Wohnungsdaten. Stuttgart.

3. Water consumption and price

	Water Consumption data
3a	Water consumption - volume charged: 1979-2013[46]



[46] Statistisches Landesamt Baden-Württemberg (2015): Trinkwasserversorgung in Stuttgart seit 1979. http://www.stuttgart.de/item/show/18442/1/publ/13802,Accessed 26 November 2015.

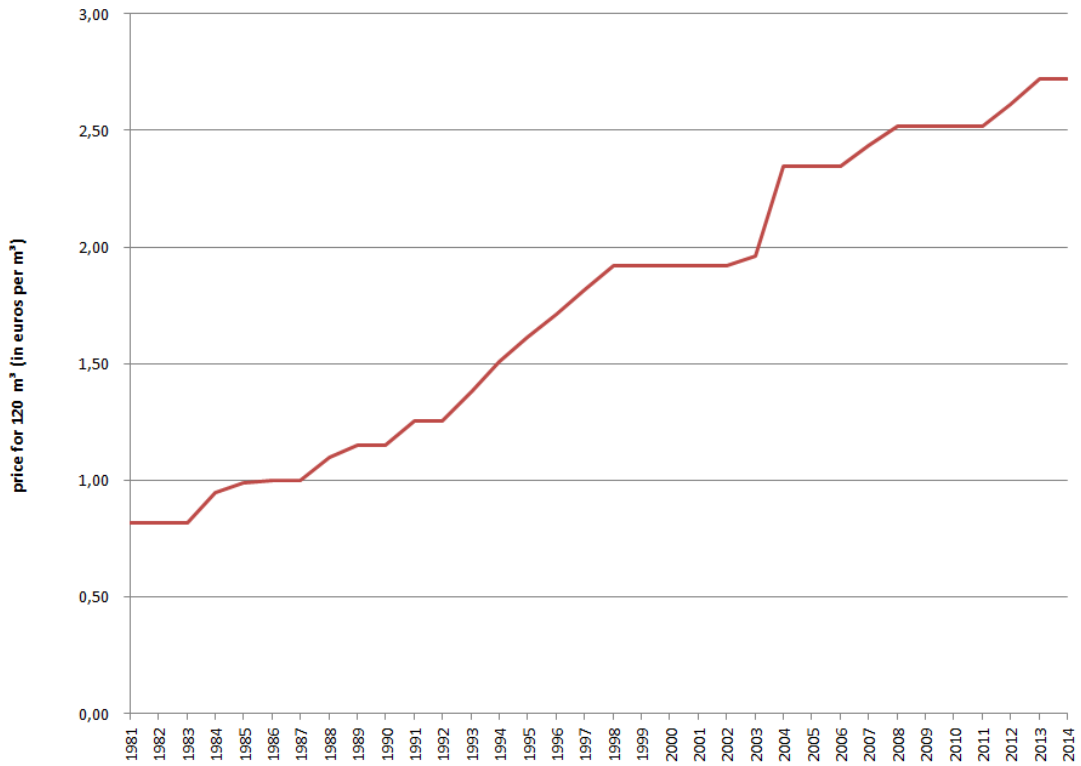


3b	Number of account holders: No data
3c	Population supplied: 607,841 (Oct 2015) [47]
3d	Rate of connection to sanitation network: 99.1 % (2007) (for region: Baden-Württemberg)[48]
3e	Individual meters (only for houses, for all housings, a mix, other): No data

	Water Price data
3f	Structure tariff (existence of a fixed part, per-unit volume charge, block prices, free allowance): Fixed part + per-unit volume charge

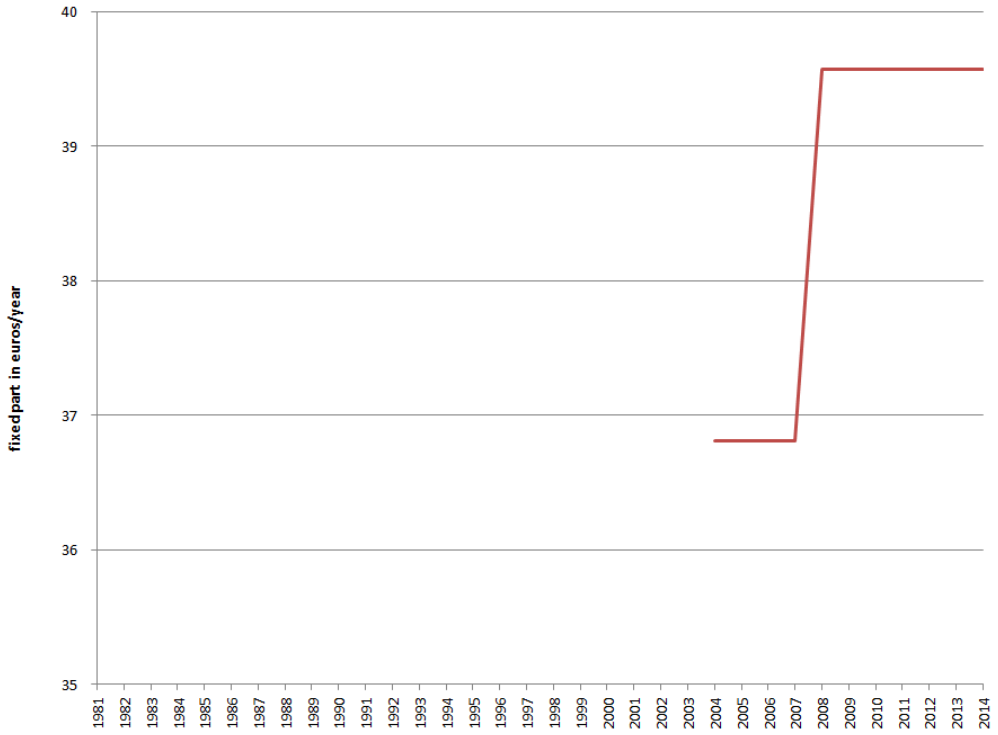
[47] http://www.wasserqualität-trinkwasserqualität.de/wasser-qualitaet/staedte/stuttgart

[48] Statistisches Landesamt Baden-Württemberg (2009): Fast flächendeckende öffentliche Wasserversorgung und zentrale Abwasserbehandlung In: Statistisches Monatsheft Baden-Württemberg 5/2009.



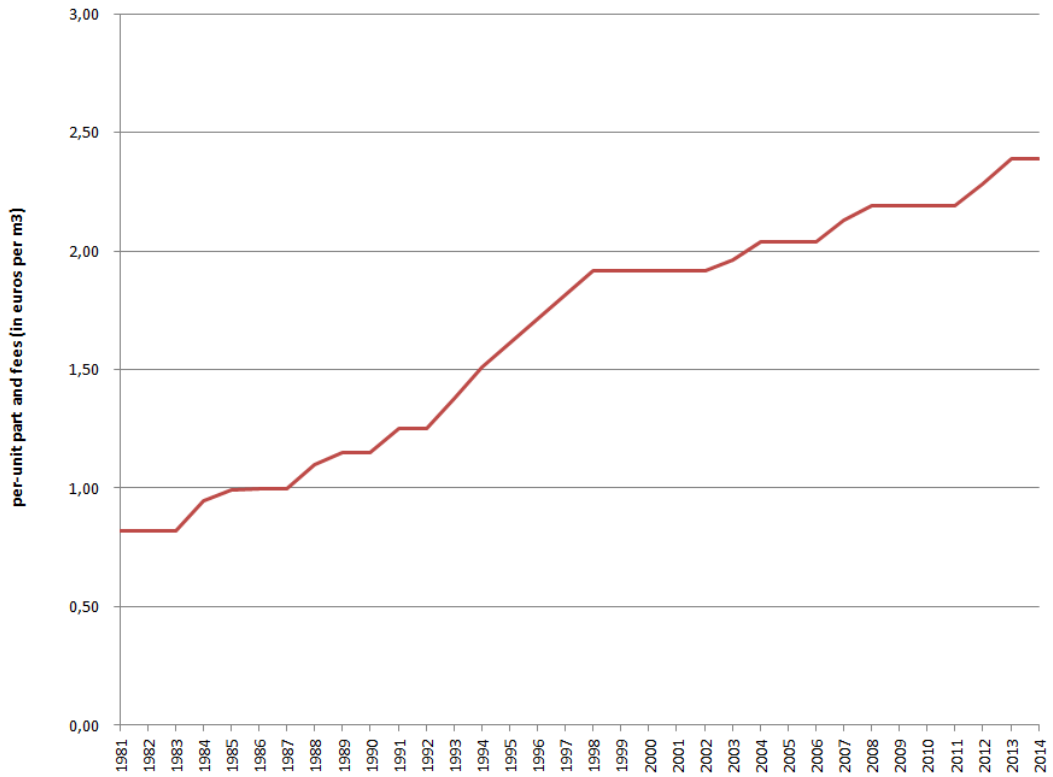
3g	Fixed part - Water (if variable with diameter, domestic meters are generally 15mm): Adopted in 2004, increased in 2007[49]

[49] EnBW Energie Baden-Württemberg AG (2015): Strom-, Erdgas- und Wasserpreise in Stuttgart seit 1980.



3h	Per-unit volume charge (or charges if block prices) – Water: 1980-2015[50]

[50] EnBW Energie Baden-Württemberg AG (2015): Strom-, Erdgas- und Wasserpreise in Stuttgart seit 1980.

	
3i	Fees – Water: No
3j	Taxes – Water: No
3k	Fixed part – Sanitation: No
3l	Per-unit volume charge – Sanitation : 1980-2015[51]
3 m	Fees – Sanitation: No
3n	Taxes – Sanitation: No
3o	Existence of other specific tariffs (lawn, other): No
3p	Existence of a social tariff - If yes, conditions and price: No

4. Other information

4a	Changes in the water service management or in the water price structure during the last years 1988: Water abstraction charge established in the Federal state of Baden-Württemberg. (Water abstraction charge is paid by the water supplier to the public authority.) 2002: 9% of stocks of EnBW AG are bought back by the company from the public company (Stuttgarter Verkehrs- und Versorgungsgesellschaft mbH)

[51] EnBW Energie Baden-Württemberg AG (2015): Strom-, Erdgas- und Wasserpreise in Stuttgart seit 1980.

	2004: Introduction of a fixed part of water price
4b	Motivations of changes
4c	Other comments The effect of water abstraction charges is differently discussed in literature. Neumüller (2000)[52] estimates that the introduction of the WAC lead to a reduction of specific water use between 1,8 and 3,6 liters per person and day. Other sources elaborate the effect on private water usage as being low, especially for very low charges. A higher consumption decline may occur for industry so a higher consumption decline my result already from lower charges (Gawel et al. 2011[53]). 2004 a fixed part of the water price was included. The annual price increase (per-unit price) is justified by the water suppliers by the decreased water demand. Through the reduction in water demand, the water infrastructure in many parts of Germany is dimensioned too large, which makes adjustments (e.g. reduction of pipe diameter) and flushing of pipelines necessary. Both types of measures increase the costs additionally.[54] Furthermore, price increases by long-distance water supplier (for Stuttgart, e.g. Bodensee-Wasserversorgung (BWV) which delivers water from the lake Bodensee to Stuttgart and further north). The BWV increased their prices in 2014 according to increased energy prices. (FOCUS Online 2013)[55] The general discussion on the reduced water abstraction in Germany - the water consumption per inhabitant per day decreased since 1990 by 17 %[56] (based on water consumption of households and small businesses) – describes the main reason for the water demand reduction in a behavioral change of water consumers and technical changes. Households use more modern equipment such as water efficient household appliances and water fittings. (BDEW 2015) The awareness for water saving in Germany is relatively high, it is integrated in school curricula and in for many years also in information by NGOs such as BUND.[57,58] In 2014, the Trade Commission (Kartellbehörde) of Baden-Württemberg decided that the water price for Stuttgart was inflated. They decided that the water price should be reduced by 30 % for the years back to 2007. ENBW went to court because they explained that the topography of Stuttgart (in a

[52] Neumüller, J. (2000): Wirksamkeit von Grundwasserabgaben für den Grundwasserschutz. Am Beispiel des Bundeslandes Hessen, Darmstadt.

[53] Gawel, E., Wolfgang Köck, Katharina Kern, Stefan Möckel, Marcel Fälsch, Thomas Völkner, Robert Holländer (2011) 'Weiterentwicklung von Abwasserabgabe und Wasserentnahmeentgelten zu einer umfassenden Wassernutzungsabgabe'. Umweltbundesamt, Dessau-Roßlau. URL http://www.uba.de/uba-info-medien/4189.html.

[54] E. Hamacher, M. Posch: Heftiges Gerangel um die Kosten des Wassers. In: Welt Online., 25 June 2010, http://www.welt.de/wirtschaft/article8166631/Heftiges-Gerangel-um-die-Kosten-des-Wassers.html, accessed 09. Feb 2016.

[55] FOCUS Online (2013): Preis für Bodensee-Trinkwasser steigt 2014. 13 Nov 2013, http://www.focus.de/regional/baden-wuerttemberg/wasser-preis-fuer-bodensee-trinkwasser-steigt-2014_aid_1157499.html, accessed 9 Feb 2016.

[56] BDEW (2015): Wasserfakten im Überblick. Mai 2015. https://www.bdew.de/internet.nsf/id/C125783000558C9FC125766C0003CBAF/$file/Wasserfakten%20-%20%C3%96ffentlicher%20Bereich%20Mai%202015.pdf, accessed: 19 November 2015.

[57] http://www.spiegel.de/spiegel/a-719873.html

[58] http://www.bund-bremen.net/themen_und_projekte/klima_umwelt/trinkwasser/wassersparen/wasserspartipps/, http://www.fnp.de/ratgeber/hausundgarten/Es-gibt-noch-Reserven-nbsp-Wasser-sparen-im-Haushalt;art337,1465804

	mountain basin) with its large altitude difference leads to high costs for water infrastructure and water supply (especially technical costs). (Schulz-Braunschmidt 2014)[59] In July 2015, both organizations reached a settlement with the result that the prices are kept at their levels for 2015, but for Aug 2012 to Dec 2014 the prices will be reduced by 20.5 percent retrospective. The consumers will get back money from ENBW. (Faltin 2015)[60]
4d	Other water demand management instruments & years when these have been established and implemented (e.g. example specific restrictions for a given year when there is drought)

5. Regression analysis

Analysis conducted and descriptive statistics

Two models were tested:

- One where the mean delivered volume per household is regressed on the average price a household will pay for a yearly consumption of 120m^3 of drinking water (the price includes both fixed and variable costs for drinking water).
- A second model, which in addition to price also includes all other variables we had: income per capita, share of individual houses (detached houses), the number of hot days and the number of rainy spring and summer days. The regression returned high p-values for the additional variables, suggesting the latter were not significant. For this reason, only the results of the first model are shown below.

All data are at the municipality level (1 municipality) and for the period 1981-2014. Both models are performed using an ordinary least squares (OLS) estimator. In both regressions, price and water consumption were log-transformed.

Values of water consumption and water price for the period 1981-2014 are given in the template, as well as climate variables and values at a municipality scale of median income and share of individual houses. In Tableau 8 the summary statistics of variables are presented.

Table 3: Descriptive statistics

Variable	Description	Mean	Median	Std.dev	Var	Min	Max	N
price.120	Average price per cubic meter for a 120 m3 consumption	1,75	1,87	0,640	0,410	0,82	2,72	34
vol.cap	Average delivered volume per capita	54,46	53,59	7,39	54,66	44,82	67,64	34
income.cap	Per capita income	18454	18421	2914	8496369	15276	22739	34
p.houses	Share of individual houses (detached houses)	0,30	0,29	0,023	0,00053	0,28	0,35	34
hot.days	Number of days with a temperature above 28°C	20	20	8	67	7	51	12371
rainy.days	Number of rainy days during spring and summer	87	87	9	85	61	105	6251

[59] Schulz-Braunschmidt, W. (2014): Kartellamt senkt Wasserpreis um 30 Prozent. In: Stuttgarter Zeitung, 5. September 2014, http://www.stuttgarter-zeitung.de/inhalt.trinkwasser-in-stuttgart-kartellamt-senkt-wasserpreis-um-30-prozent.c544f0ca-bd53-4b7e-b2c8-0c00532f68f9.html, accessed 9 Feb 2016.

[60] Faltin, T. (2015): EnBW zahlt 40 Millionen an Kunden. In: Stuttgarter Zeitung, 9. July 2015, http://www.stuttgarter-zeitung.de/inhalt.wasserpreis-in-stuttgart-enbw-zahlt-40-millionen-an-kunden.ba28d811-6adb-4d0e-aab5-988f57aa4d40.html, accessed 9 Feb 2016.

Model 1 - Results

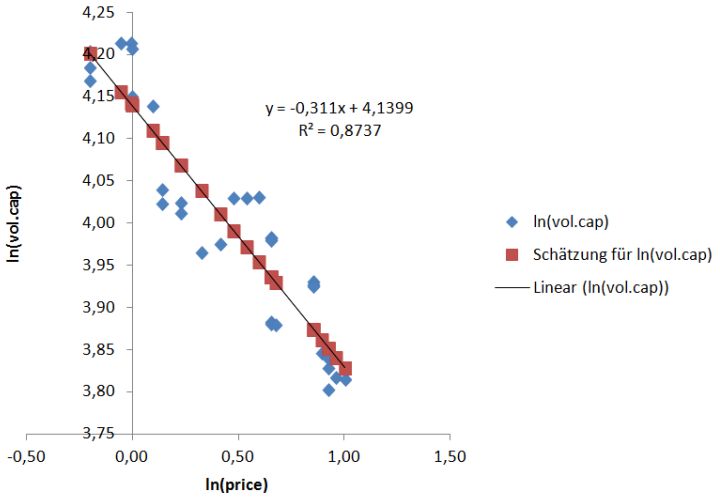
Model 1: Water consumption as a function of price

Table 4: Regression results of model 1 - Dependent variable ln(vol.cap)

*** $p < 0{,}001$

Summary	
R2	0,87
Adj. R2	0,87
F-stat	221,4
N	34

	Coeff.	*Std.err*
Constant	4,140***	0,013
ln (price.120)	-0,311***	0,021



From the regression results in table 2 we can conclude that price is a significant determinant of water demand in Stuttgart. As we used a double-log regression, price elasticity is the coefficient estimated, i.e. -0.311. **This means that water consumption per capita is inelastic to price.**

Model 2 - Results

In model two the water demand per household (lnvolperhh) is regressed on the same price variable used in model 1 (ln_totpriceeur) in addition to a range of geographic and socio-economic variables. The model is formulated as

$$lnvolperhh = \beta_0 + \beta_1 ln\_totpriceeur + \beta_2 share\_indhouse + \beta_3 share\_summerhouse + \beta_4 \ln\_pop + \beta_5 \ln\_dispincpercap + \beta_6 yeardummies + \beta_7 regionaldummies + \varepsilon \quad (2)$$

The full estimation results are presented in table 4 below. The estimated price parameter still has the expected negative sign, is significant and now also has a more reasonable point estimate of around -0.8, implying that water demand decreases less than proportionally with price increases. Intuitively -0.8 is perhaps still a little high given the "necessity" of water consumption, but then again one can argue that only a small fraction of our current water consumption is actually "necessary". That elasticity in fact differs over both price levels and consumption levels is a well-established fact (Dalhuisen et al., 2003).

The share of summerhouses is negative and significant. One should probably be careful in interpreting this as causation of the kind "more summer houses lead to lower per capita water demand". Rather, one can suspect that this variable is in fact picking up some other, unobserved by us, effect. What that underlying variable is will be hard to discern without access to much more detailed data. If one was to speculate it might be the case that some individuals will choose to be registered for tax in their summerhouse but only spend the summer months there, thus driving down per capita consumption of water. This would again demand more detailed data to analyze. The share of individual houses is not significant.

Population level and disposable income are not significant. This is somewhat surprising, but one should keep in mind that we control for other variables, such as region, which may very well pick up differences both with regards to income and population size.

There are no significant changes over time for this three-year period. This is not surprising given that water demand will tend to change slowly over time if no drastic policy tools are instated.

For the regional dummies the capital region (Copenhagen) constitutes the baseline case. Only one dummy is significant, the one for Southern Denmark. This could have many explanations, but one might be that information campaigns, the Green Capital award for Copenhagen and other initiatives have been very much focused on the Copenhagen region. There may of course also be more subtle differences in water use, which certainly deserve more attention.

The overall explanatory power of the model is 23,5% as measured by R^2. This is quite an improvement over model 1 but still relatively low given the explanatory variables included.

Table 4 Regression results model 2

Regression statistics	
R2	23.5%
Adj R2	19.7%
Std.err.	0.551
N	283

ANOVA

	df	***SqS***	***Ls***	***F***	***p-value***
Regression	13.000	25.269	1.944	7.571	0.000
Residual	271.000	82.226	0.303		
Total	284.000	107.496			

	Coeff.	***Std.err***	***t-value***	***p-value***	***Lower 95%***	***Upper 95%***
Constant	15.685***	4.337	3.617	0.000	7.147	24.223
ln_totpriceeur	-0.804***	0.217	-3.696	0.000	-1.232	-0.376
share_indhouse	-0.005	0.003	-1.627	0.105	-0.012	0.001
share_summerhouse	-0.013***	0.004	-3.630	0.000	-0.020	-0.006
ln_pop	-0.041	0.057	-0.714	0.476	-0.154	0.072
ln_dispincpercap	-0.416	0.314	-1.324	0.187	-1.035	0.203
2011	-0.072	0.084	-0.851	0.395	-0.238	0.094
2012	-0.042	0.081	-0.522	0.602	-0.203	0.118
2013	-	-	-	-	-	-
Hovedstaden	-	-	-	-	-	-
Midtjylland	-0.102	0.127	-0.802	-	-0.352	0.148
Nordjylland	-0.040	0.149	-0.270	0.787	-0.333	0.252
Sjælland	-0.194	0.120	-1.613	0.108	-0.430	0.043
Syddanmark	0.217*	0.126	1.732	0.084	-0.030	0.465

The dependent variable is the log of yearly household consumption of drinking water in m^3. *** denotes statistical significance at the 1% level, ** at the 5% level and * at the 10% level. *Hovedstaden* and *2013* are baseline alternatives in their respective dummy vectors.

Conclusions

Price has a clear relationship with water demand in Denmark. In isolation its explanatory power is quite low, but when one controls for socioeconomic and geographic factors the available data lead to a reasonable price elasticity estimate of around -0.8. This can be taken as an indication that the Danish water supply system indeed functions, at least partly, as a market. Especially when compared to Sweden, whose price elasticity in our estimations is not significantly different from zero. There are some indications that this is a relatively recent development given that the elasticity estimate reported in the meta-analysis of Dalhuisen et al. (2003) during the 1980's is around 0.0 to -0.10. This is also well in line with the major reforms, e.g. environmental taxes etc. that were instated in the early 1990's in Denmark.

Future efforts could for example focus on the effect of price ceilings or more long run estimates of elasticity. To study water demand at a finer geographical level is also a promising line for future research.

2. Denmark

Whole country

Preliminary overview

Preliminary overview	
Region	Nordic
Operator and type of authority	
Geographical coverage	All of Denmark, although certain smaller areas will not be included due to small water utilities not being included in statistics.
Area (km^2)	
Sector	Domestic
No. Of municipalities	There are currently 98 municipalities in Denmark. Up until 2007 there were 270.
No. of customers	Total population is 5,5 million, analysis done on municipal and utility level.
Type of data available	We have detailed data on delivered volume, price (ceiling), major costs and investments. We have these for the years 2010, 2011, 2012 and 2013 and for roughly 350 utilities (depending on what variables are ultimately chosen). In addition to this demographic, financial data etc. are collected at the municipal level. In all likelihood we will aggregate data from the utility level to municipal level given that more data is available on the municipal level.
Proposed focus of the case study	Assessment of elasticity with a special focus on the difference between urban and rural areas and the effects of a price ceiling. Given that a price ceiling is set by central authorities one will have to take this into account when estimating e.g. elasticity as this will typically assume a competitive market with a direct connection between price and demand.
Source	Data on water consumption provided by the Danish Competition and Consumer Authority. Environmental, financial and demographic data provided by Statistics Denmark.

1. Water service description

1a	All utilities extracting in excess of 200 000m^3 per year are included. Name of the service
1b	Location (MS, Region)
1c	Type of authority (Municipality, Group of municipalities, Union, other)
1d	Management type (Public management, Leasing, Concession, other)

1e	Water Competences (among Supply, Supply and Treatment, Supply, Treatment and Abstraction)
1f	Sanitation service (Yes, Distinct, Unknown)
1g	Number of Municipalities under authority

2. Contextual information

	Description of housings and population
2a	Total population is 5,5 million. The Copenhagen metropolitan area has almost 2 million inhabitants. Population data for all municipalities is available.
2b	Population density is 131 inhabitants per km^2
2c	GDP per household is 96168 Euro for entire country. Income per household on municipal level is also available. Disposable income per capita is 22900 Euro per year. Household's income - in euros per capita (mean or distribution)
2d	44 percent of the population reside in individual houses. Share of individual houses
2e	Approximately 99.35 % of houses in Denmark are permanent. There are roughly 18 000 summer houses, meaning less than 1 percent of the stock of houses.. Share of permanent housings

	Climatic information
2f	Total number of days with precipitation is 171 on average. Number of days with rainfalls during spring and summer
2g	Very few days with temperatures above 28°C. Average yearly temperature is 7.7°C. Number of days with a temperature above 28°C

3. Regression results

Analysis conducted and descriptive statistics
In the following the results of two regression models for water demand in Denmark are presented. The data were made available by the Danish Consumer and Competition Authority[61]. The data cover both drinking water and wastewater utilities and cover all utilities delivering in excess of 200 $000m^3$ per year. All information has been aggregated from the utility level to the municipality level in order to be able to retrieve additional socio-economic and geographic variables. All data are for the years 2011, 2012 and 2013.

[61] All data are freely available on the authorities web page http://en.kfst.dk/

Two separate models are estimated. The first simply regresses volume on price and the second includes a broader range of explanatory variables. See further discussion about these below. In table 1 below all included dependent and independent variables are presented with their descriptive statistics.

Table 1 Descriptive statistics

Variable	Description	Mean	Median	Std.dev	Min	Max	Sum	N
lnvolperhh	Log of yearly household water use in m^3	4.432	4.566	0.617	1.741	6.396	1254	283
ln_totpriceeur	Log of total price in euros for yearly consumption of $83m^3$	6.484	6.487	0.197	6.004	7.163	1835	283
share_indhouse	Share of individual houses (%)(share of total number of residential houses)	62.742	65.215	16.175	2.898	89.234	17756	283
share_summerhouse	Share of summerhouses (%)(share of total number of residential houses)	9.869	4.837	12.858	0.000	66.415	2793	283
ln_pop	Log of municipal population	10.687	10.700	0.723	7.548	13.235	3024	283
ln_dispincpercap	Log of yearly disposable income per capita in euros	12.230	12.197	0.132	12.017	12.804	3461	283
2011	Year dummy	0.336	0.000	0.473	0.000	1.000	95	283
2012	Year dummy	0.336	0.000	0.473	0.000	1.000	95	283
2013	Year dummy	0.329	0.000	0.471	0.000	1.000	93	283
Hovedstaden	Regional dummy (Copenhagen area)	0.307	0.000	0.462	0.000	1.000	87	283
Midtjylland	Regional dummy (Mid Jutland)	0.191	0.000	0.394	0.000	1.000	54	283
Nordjylland	Regional dummy (Northern Jutland)	0.113	0.000	0.317	0.000	1.000	32	283
Sjælland	Regional dummy (Zealand)	0.180	0.000	0.385	0.000	1.000	51	283
Syddanmark	Regional dummy (Southern Denmark)	0.208	0.000	0.407	0.000	1.000	59	283

All variables for the years 2011, 2012 and 2013 if not otherwise specified.

In table 2 below a correlation matrix is presented to give a preliminary view of the relationships between the dependent and independent variables. The dependent variable, *lnvolperhh*, has the expected negative correlation with the main independent variable, *ln_totpriceeur*. Other notable relationships with the dependent variable include the negative correlation with *share_summerhouse* and the negative correlation with regional dummy *Sjaelland*. In general there are no alarming linear relationships between the independent variables which could indicate problems of multicollinearity.

Table 2 Correlation matrix for included variables

	lnvolperhh	*ln_totpriceeur*	*share_indhouse*	*share_summerhouse*	*ln_pop*	*ln_dispincpercap*	*2011*	*2012*	*2013*	*Hovedstaden*	*Midtjylland*	*Nordjylland*
lnvolperhh	1,000											
ln_totpriceeur	-0,348	1,000										
share_indhouse	-0,152	0,392	1,000									
share_summerhouse	-0,304	0,311	-0,197	1,000								
ln_pop	0,134	-0,237	-0,238	-0,372	1,000							
ln_dispincpercap	0,041	-0,214	-0,133	-0,242	-0,006	1,000						
2011	0,008	-0,141	-0,007	0,018	-0,020	-0,138	1,000					
2012	-0,008	0,004	-0,007	0,018	-0,020	-0,002	-0,505	1,000				

2013	0,000	0,138	0,014	-0,037	0,040	0,141	-0,497	-0,497	1,000					
Hovedstaden	0,148	-0,256	-0,514	-0,143	-0,051	0,512	-0,003	-0,003	0,007	1,000				
Midtjylland	-0,063	-0,104	0,133	0,009	0,158	-0,097	-0,002	-0,002	0,005	-0,324	1,000			
Nordjylland	-0,049	0,009	0,145	0,122	-0,066	-0,225	0,006	0,006	-0,012	-0,238	-0,173	1,000		
Sjælland	-0,221	0,200	0,104	0,088	0,003	-0,063	-0,002	-0,002	0,005	-0,312	-0,228	-0,167	1,000	
Syddanmark	0,140	0,195	0,244	-0,025	-0,046	-0,253	0,004	0,004	-0,007	-0,342	-0,249	-0,183	-0,241	1,000

Model 1 - Results

In model 1 the consumed yearly volume per household (lnvolperhh) is regressed on the total price for a typical household consumption of 83m^3 per year (ln_totpriceeur). Both variables are logged meaning that the estimated price parameter represents price elasticity. The model can then be formulated as

$$lnvolperhh = \beta_0 + \beta_1 \ln\_totpriceeur + \varepsilon \qquad (1)$$

From the results in table 3 we can observe that the estimated price parameter is significant and larger than 1 (in absolute terms) which is intuitively surprising and suggests that Danish consumers consider water a luxury good. This would imply that demand would fall more than proportionately as an effect of a price increase. In all likelihood this is not in fact the case and the price variable could very well be picking up some other, unobserved, effect. In statistical terms this would be considered an under specified model and one should be very cautious in drawing inference on the results. The explained variance, as measured by R^2, is also quite low at around 12 % indicating that other factors explain a great deal of the variation in water demand over Danish municipalities. The full estimation results are presented in table 3 below.

Table 3 Regression results Model 1

Regression statistics	
R2	12.1%
Adj R2	11.8%
Std.err.	0.580
N	283

ANOVA

	df	*SqS*	*Ls*	*F*	*p-value*
Regression	1	13.013	13.013	38.703	0.000
Residual	281	94.482	0.336		
Totalt	282	107.496			

	Coeff.	*Std.err*	*t-value*	*p-value*	*Lower 95%*	*Upper 95%*
Constant	11.495***	1.136	10.120	0.000	9.259	13.731
ln_totpriceeur	-1.089***	0.175	-6.221	0.000	-1.434	-0.745

The dependent variable is the log of yearly household consumption of drinking water in m^3. *** denotes statistical significance at the 1% level, ** at the 5% level an * at the 10% level.

Model 2 - Results

In model two the water demand per household (lnvolperhh) is regressed on the same price variable used in model 1 (ln_totpriceeur) in addition to a range of geographic and socio-economic variables. The model is formulated as

$$lnvolperhh = \beta_0 + \beta_1 ln\_totpriceeur + \beta_2 share\_indhouse + \beta_3 share\_summerhouse + \beta_4 \ln\_pop + \beta_5 \ln\_dispincpercap + \beta_6 yeardummies + \beta_7 regionaldummies + \varepsilon \qquad (2)$$

The full estimation results are presented in table 4 below. The estimated price parameter still has the expected negative sign, is significant and now also has a more reasonable point estimate of around -0.8, implying that water demand decreases less than proportionally with price increases. Intuitively -0.8 is perhaps still a little

high given the "necessity" of water consumption, but then again one can argue that only a small fraction of our current water consumption is actually "necessary". That elasticity in fact differs over both price levels and consumption levels is a well-established fact (Dalhuisen et al., 2003).

The share of summerhouses is negative and significant. One should probably be careful in interpreting this as causation of the kind "more summer houses lead to lower per capita water demand". Rather, one can suspect that this variable is in fact picking up some other, unobserved by us, effect. What that underlying variable is will be hard to discern without access to much more detailed data. If one was to speculate it might be the case that some individuals will choose to be registered for tax in their summerhouse but only spend the summer months there, thus driving down per capita consumption of water. This would again demand more detailed data to analyze. The share of individual houses is not significant.

Population level and disposable income are not significant. This is somewhat surprising, but one should keep in mind that we control for other variables, such as region, which may very well pick up differences both with regards to income and population size.

There are no significant changes over time for this three-year period. This is not surprising given that water demand will tend to change slowly over time if no drastic policy tools are instated.

For the regional dummies the capital region (Copenhagen) constitutes the baseline case. Only one dummy is significant, the one for Southern Denmark. This could have many explanations, but one might be that information campaigns, the Green Capital award for Copenhagen and other initiatives have been very much focused on the Copenhagen region. There may of course also be more subtle differences in water use, which certainly deserve more attention.

The overall explanatory power of the model is 23,5% as measured by R^2. This is quite an improvement over model 1 but still relatively low given the explanatory variables included.

Table 4 Regression results model 2

Regression statistics	
R2	23.5%
Adj R2	19.7%
Std.err.	0.551
N	283

ANOVA

	df	***SqS***	***Ls***	***F***	***p-value***
Regression	13.000	25.269	1.944	7.571	0.000
Residual	271.000	82.226	0.303		
Total	284.000	107.496			

	Coeff.	***Std.err***	***t-value***	***p-value***	***Lower 95%***	***Upper 95%***
Constant	15.685***	4.337	3.617	0.000	7.147	24.223
ln_totpriceeur	-0.804***	0.217	-3.696	0.000	-1.232	-0.376
share_indhouse	-0.005	0.003	-1.627	0.105	-0.012	0.001
share_summerhouse	-0.013***	0.004	-3.630	0.000	-0.020	-0.006
ln_pop	-0.041	0.057	-0.714	0.476	-0.154	0.072
ln_dispincpercap	-0.416	0.314	-1.324	0.187	-1.035	0.203

2011	-0.072	0.084	-0.851	0.395	-0.238	0.094
2012	-0.042	0.081	-0.522	0.602	-0.203	0.118
2013	-	-	-	-	-	-
Hovedstaden	-	-	-	-	-	-
Midtjylland	-0.102	0.127	-0.802	-	-0.352	0.148
Nordjylland	-0.040	0.149	-0.270	0.787	-0.333	0.252
Sjælland	-0.194	0.120	-1.613	0.108	-0.430	0.043
Syddanmark	0.217*	0.126	1.732	0.084	-0.030	0.465

The dependent variable is the log of yearly household consumption of drinking water in m^3. *** denotes statistical significance at the 1% level, ** at the 5% level and * at the 10% level. *Hovedstaden* and *2013* are baseline alternatives in their respective dummy vectors.

Conclusions

Price has a clear relationship with water demand in Denmark. In isolation its explanatory power is quite low, but when one controls for socioeconomic and geographic factors the available data lead to a reasonable price elasticity estimate of around -0.8. This can be taken as an indication that the Danish water supply system indeed functions, at least partly, as a market. Especially when compared to Sweden, whose price elasticity in our estimations is not significantly different from zero. There are some indications that this is a relatively recent development given that the elasticity estimate reported in the meta-analysis of Dalhuisen et al. (2003) during the 1980's is around 0.0 to -0.10. This is also well in line with the major reforms, e.g. environmental taxes etc. that were instated in the early 1990's in Denmark.

Future efforts could for example focus on the effect of price ceilings or more long run estimates of elasticity. To study water demand at a finer geographical level is also a promising line for future research.

References

Dalhuisen, Jasper M.; Florax, Raymond J.G.M.; de Groot, Henri L.F.M.; Nijkamp, Peter (2001) *Price and Income Elasticities of Residential Water Demand: Why Empirical Estimates differ*, Tinbergen Institute Discussion Paper, No. 01-057/3

3. Spain

Aguas de Barcelona

Preliminary overview

Preliminary overview	
Region	Catalonia, metropolitan area of Barcelona
Operator and type of authority	Operator: Aigües de Barcelona (AGBAR); Authority: The Metropolitan Area of Barcelona (AMB) – *public administration*
Geographical coverage	Over two-thirds of the territory of the metropolitan area of Barcelona
Area (km^2)	425.4[62]
Sector	Domestic (*note: AGBAR also serves other sectors in the area, but this case study focuses on the domestic one*)
No. Of municipalities	23 municipalities managed by the operator
No. of customers	1,209,027 domestic customers in 2014[63]
Type of data available	Consumption data, population, population density, income per capita, rainfall, average temperatures, household size, water price.
Proposed focus of the case study	Assessment of elasticity for the 23 municipalities served by AGBAR with municipality scale data
Source	AGBAR, national, regional and local statistics offices (INE, Idescat, ACA, AMB), NOAA (US National Centers for Environmental Information)

1. Water service description

1a	Name of the service: Aigües de Barcelona (AGBAR)
1b	Location (MS, Region): Spain, Catalonia, 23 municipalities of the metropolitan area of Barcelona
1c	Type of authority : Public administration at the metropolitan area level (group of municipalities)
1d	Management type : Public-Private Partnership[64]
1e	Water Competences : Supply and Invoicing
1f	Sanitation service : Aigües de Barcelona (AGBAR)
1g	Number of Municipalities under authority: 36

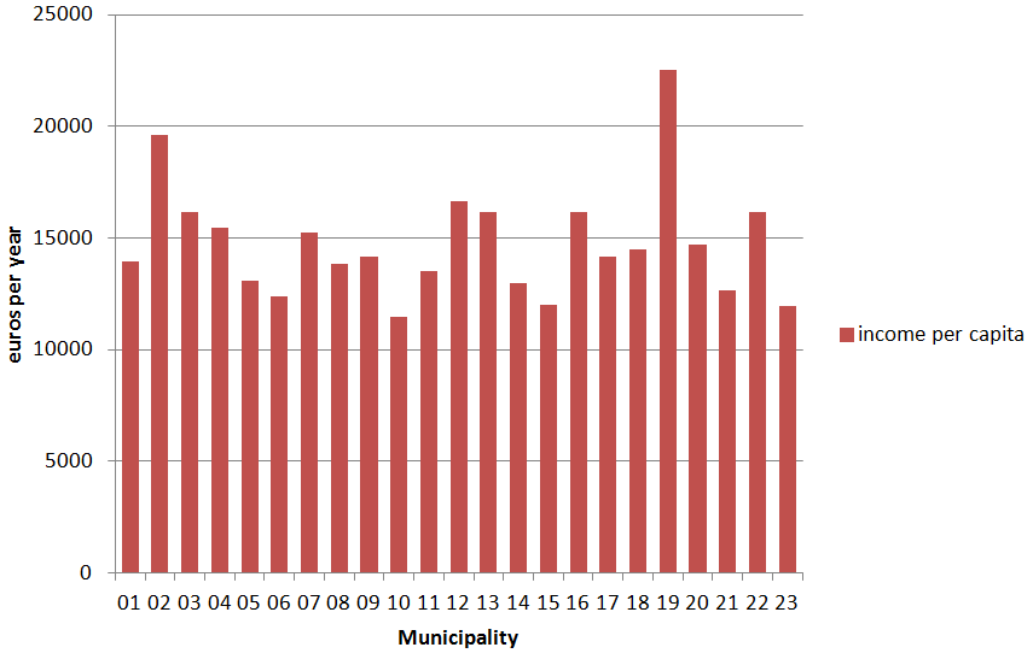
[62] AMB (n.d.) Municipis.Explorador de dades. Available on http://opendata.amb.cat/municipis/explorer#?rows=15. Last visited 14.11.2015.

[63] Aigües de Barcelona (2015) Informe 2015. Available on http://www.aiguesdebarcelona.cat/publicaciones. Last visited 14.11.2015.

[64] Ibid.

2. Contextual information

Information should be collected at the level of the area of authority. Detail by municipality, if the area is made of several municipalities, is not necessary unless it is easily available.

	Description of housings and population
2a	Population in the area of authority: 3,214,211 inhabitants (2014)[65] Population in the area served by AGBAR: 2,853,570 (2014) – same source
2b	Population density: 4,860 inhabitants/km² (2014) Density in the area served by AGBAR: 5,448 inhabitants/km2 (2014)
2c	Household's income - in Euros per capita per year: • Mean in 2010 was 16,200 €/yr (data for 3 municipalities is missing)[66] Income per capita in area served by AGBAR: 16,200 €/yr (mean 2010) – same source Data from 2 municipalities missing. 
2d	Share of individual houses: No data found.
2e	Share of permanent housings: 86% in 2011[67] Share of permanent housings in area served by AGBAR: 86% (2011) – same source

[65] AMB (2014) Evolució de la població, 1991-2014. Total. Available on http://www.amb.cat/es/web/area-metropolitana/dades-estadistiques/demografia/serie-historica. Last visited 14.11.2015.

[66] AMB (2015) Renda familiar disponible bruta per habitant. Available on http://www.amb.cat/es/web/area-metropolitana/dades-estadistiques/economia/produccio-i-renda. Last visited 16.11.2015.

[67] AMB (2014) Habitatges segons tipologia. Cens 2011. Available on http://www.amb.cat/es/web/area-metropolitana/dades-estadistiques/territori/edificis-i-habitatges. Last visited 16.11.2015.

	Climatic information
2f	Number of days with rainfalls during spring and summer (01.03. - 31.08.):

Year	2008	2009	2010	2011	2012	2013	2014
Nb days	39	33	43	44	32	45	37

Mean 2008-2014: 39 days

Data from National Climatic Data Center - Station of Barcelona Aeropuerto SP (http://www.ncdc.noaa.gov)

2g Number of days with a maximum temperature above 28°C:

Year	2008	2009	2010	2011	2012	2013	2014
No. days	59	64	63	67	57	56	41

Mean 2008-2014: 58 days

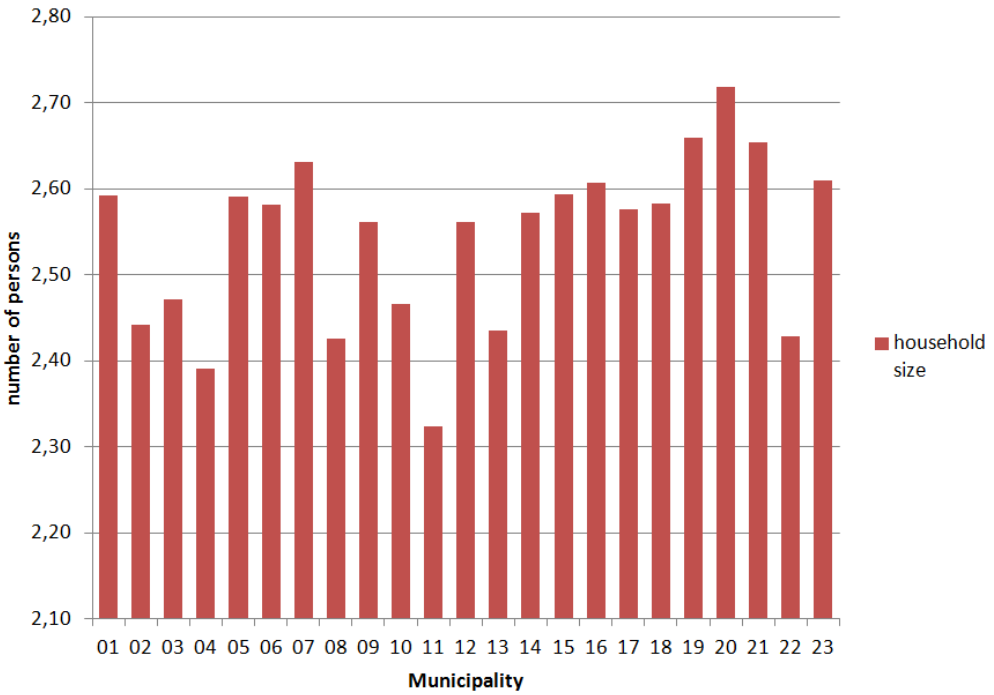
Data from National Climatic Data Center - Station of Barcelona Aeropuerto SP (http://www.ncdc.noaa.gov)

	Other descriptors of housings and population - *To be discussed*
2h	Population age (mean or distribution): in 2014[68]

Age	Percentage
0-4 years	5%
5-19 years	14%
20-39 years	28%
40-64 years	34%
65 or older	19%

2i Average household size: data available for 2008-2012, estimations calculated for 2013 and 2014 using simple linear regression.

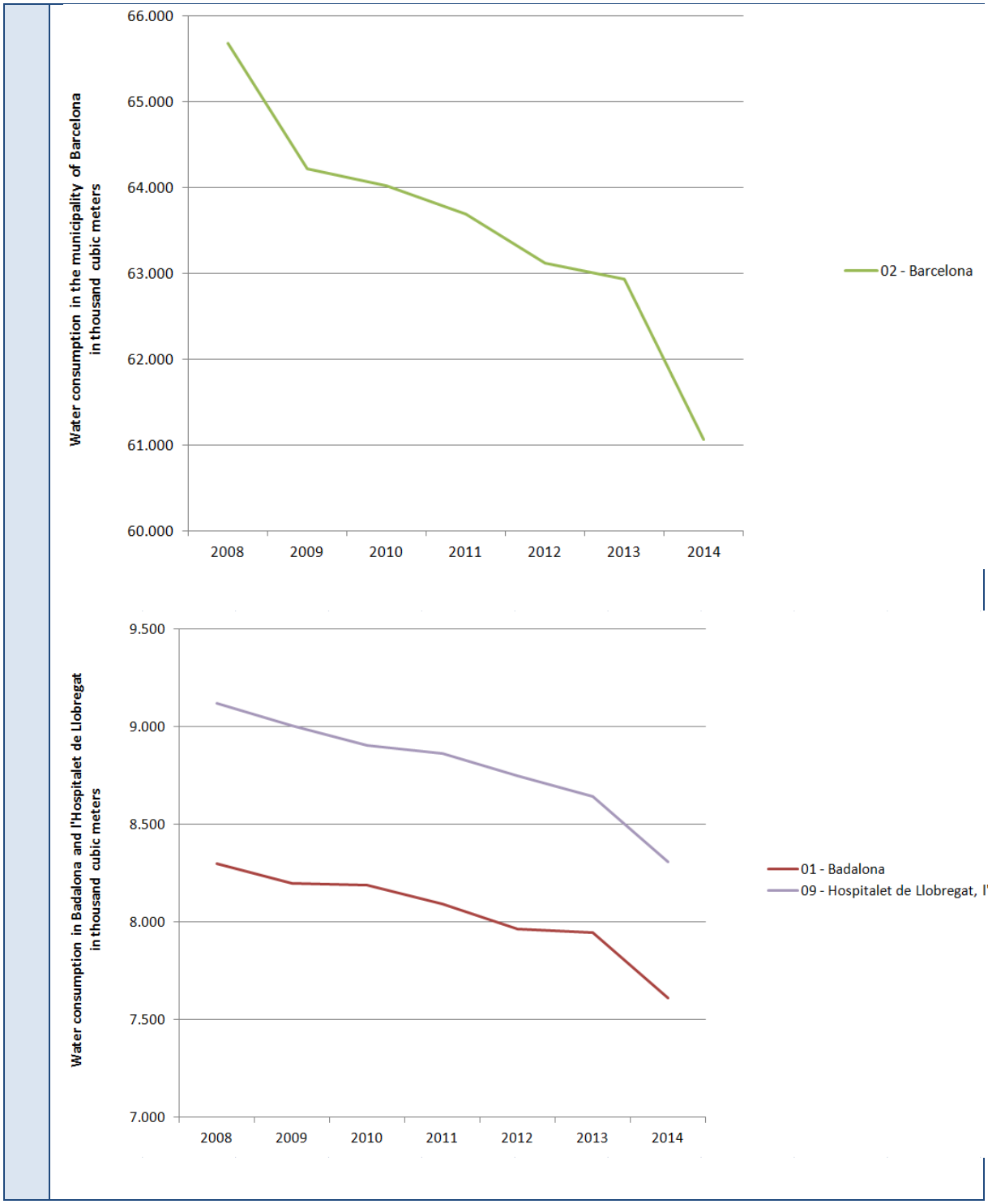
[68] AMB (2014) Població segons edat quinquennal, 2014. Data for 36 municipalities in the metropolitan area of Barcelona.

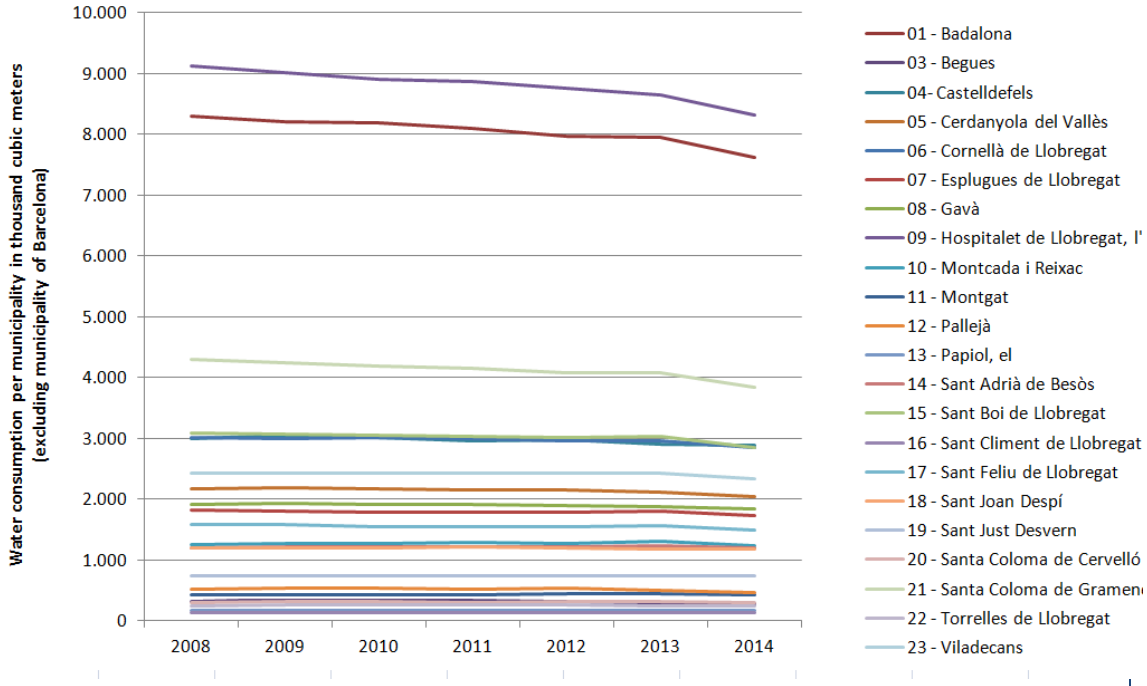
	
2j	Average housing size: data available for 2008-2012, estimations calculated for 2013 and 2014 using simple linear regression.
2k	Share of houses with lawn: no data found
2l	Share of houses with swimming pool: no data found
2m	Share of houses with private well: no data found
2n	Equipment rate for main water saving devices (rainwater tank, flow reducers, dual-flush toilets) : no data found
2o	Equipment rate for main water consuming devices (shower vs. tub, washing machine, dishwasher) : no data found

3. Water consumption and price

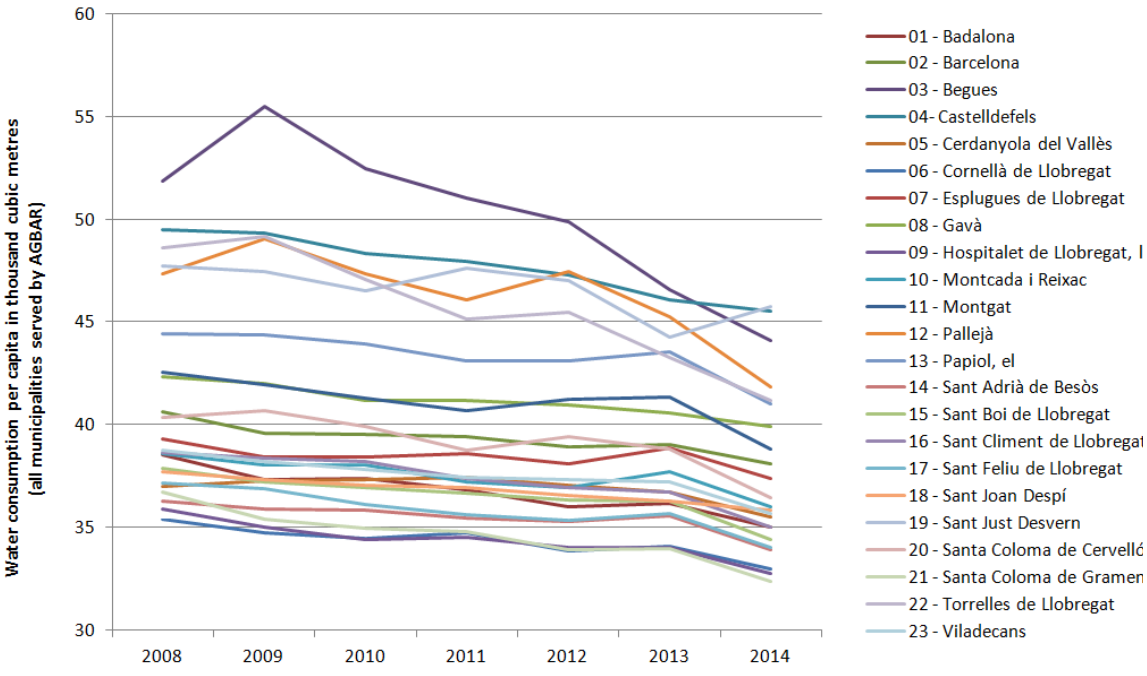
Information should be collected per year and per municipality (if detail available), and a minimum of 20 observations seems reasonable. Information should concern the domestic sector only.

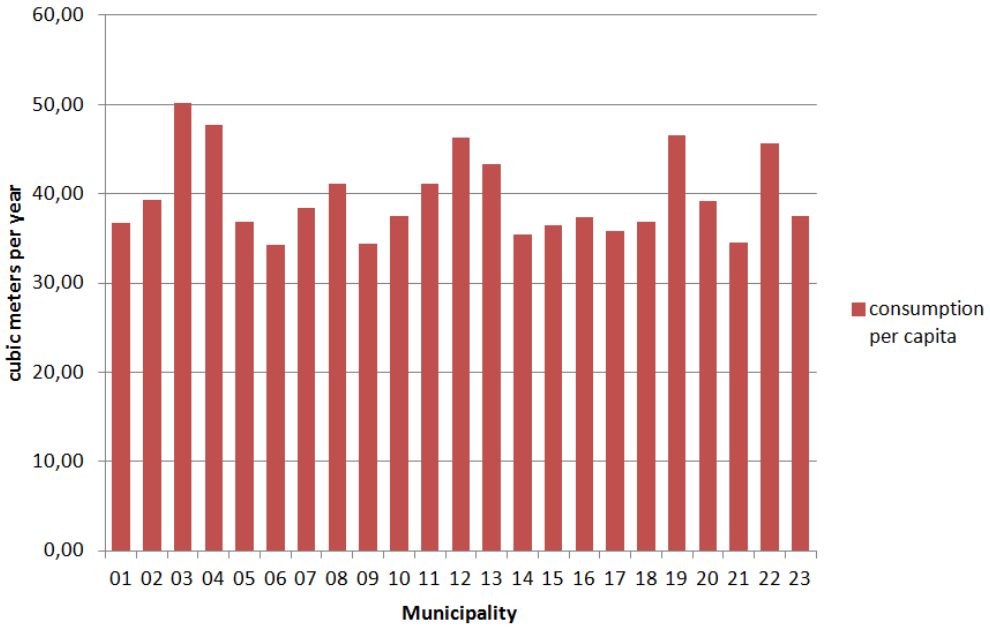
	Water Consumption data
3a	Water consumption - volume charged (domestic) Total consumption per municipality for the municipalities within the Metropolitan Area of Barcelona which are served by AGBAR


Water consumption in the municipality of Barcelona in thousand cubic meters
66.000
65.000
64.000
63.000
62.000
61.000
60.000
2008
2009
2010
2011
2012
2013
2014
02 - Barcelona
Water consumption in Badalona and l'Hospitalet de Llobregat in thousand cubic meters
9.500
9.000
8.500
8.000
7.500
7.000
2008
2009
2010
2011
2012
2013
2014
01 - Badalona
09 - Hospitalet de Llobregat, l'



Consumption per capita per municipality for the municipalities within the Metropolitan Area of Barcelona which are served by AGBAR

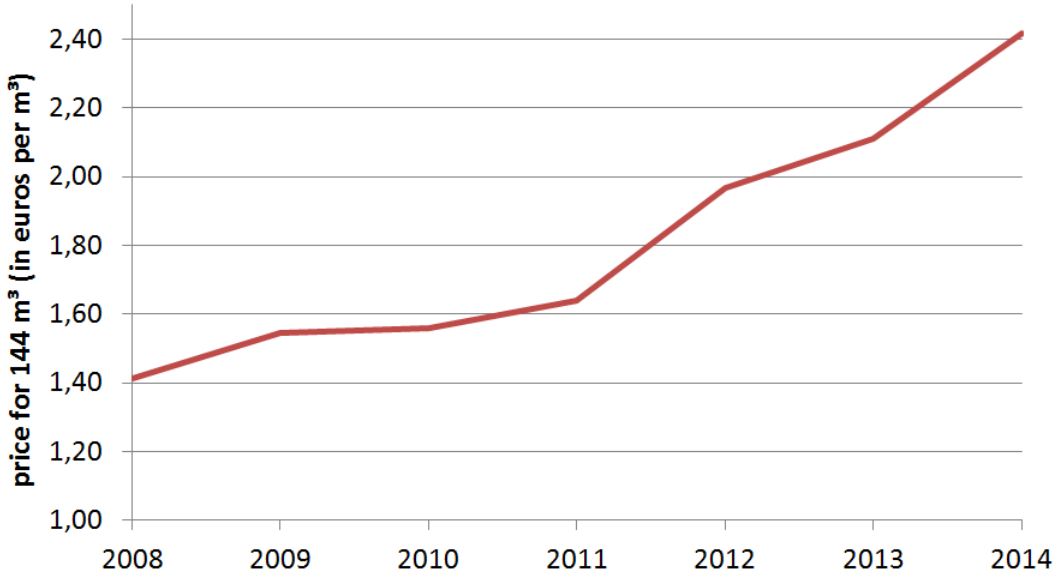


	Mean consumption per capita per municipality for the municipalities within the Metropolitan Area of Barcelona which are served by AGBAR 
3 b	Number of account holders: 1,209,027 domestic customers in 2014[69]
3c	Population supplied: The whole population in the 23 municipalities supplied within the metropolitan Area of Barcelona: 2,853,570 (2014) [70]
3 d	Rate of connection to sanitation network: no data found
3e	Individual meters (only for houses, for all housings, a mix, other): Metering is widespread in the domestic sector in Spain.

	Water Price data
3f	Structure tariff (existence of a fixed part, per-unit volume charge, block prices, free allowance) Fixed part + increasing block rates.

[69] Aigües de Barcelona (2015) Informe 2015. Available on http://www.aiguesdebarcelona.cat/publicaciones. Last visited 14.11.2015.

[70] AMB (2014) Evolució de la població, 1991-2014. Total. Available on http://www.amb.cat/es/web/area-metropolitana/dades-estadistiques/demografia/serie-historica. Last visited 14.11.2015.



3g

Fixed part - Water

This is called a *service fee* and it is variable on the basis of the household's nominal flow. The rates for 2015[71] are as follows (data for 2014 is also available):

Household type (nominal flow in m³/h)	Fixed monthly fee (€)
A (0.25)	2.66
B (0.33)	6.94
C (0.40)	7.86
D (0.50)	12.16
E (0.63)	13.11
F (1.00)	18.73
G (1.60)	30.37
H (2.50)	43.91
I (4.00)	66.46

Disaggregated data for the time range 2008-2013 were requested to AGBAR and the Catalan Water Agency (ACA), no response was received before the time of delivery of this report.

3h

Per-unit volume charge + Fees - Water & Sewerage

The rates for 2015[72] is as follows (data for 2014 is also available):

Block	Monthly consumption (m³)	Price (€/m³)

[71] AGBAR (2015) Tarifas para el servicio de suministro y el consumo de agua. Uso doméstico. Available on http://www.aiguesdebarcelona.cat/facturadelaigua/es/precios-tarifas/. Last visited 16.11.2015.

[72] Ibid.

	1	0-6	0.6341
	2	7-9	1.2682
	3	10-15	1.9023
	4	16-18	2.5363
	5	>18	3.1704

Disaggregated data for the time range 2008-2013 were requested to AGBAR and the Catalan Water Agency (ACA), no response was received before the time of delivery of this report.

3i Fees – Water: n/a

3j Taxes – Water: In 4 municipalities of the AMB (Barcelona, Montgat, Torrelles y Sant Climent de Llobregat) a sewer tax is charged which is intended to cover the cost of upkeep and maintenance of the sewerage network. The fees for 2014[73] were as follows:

Municipality	Block	Fee (€/m³)
Barcelona	1 (< 12m³/month)	0.1529
	2 (> 12m³/month)	0.2294
Montgat	Not applicable	0.111
Torrelles de Llobregat	Not applicable	0.3329
Sant Climent de Llobregat	Not applicable	0.2526

In all municipalities of the metropolitan area, the Water Levy is collected for the Catalan Water Agency (ACA). This is also based on increasing block rates. The rates for 2014[74] were as follows:

Block	Monthly consumption (m³)	Price (€/m³)
1	<9	0.4791
2	10-15	1.1036
3	16-18	2.7590
4	>18	4.4144

Disaggregated data for the time range 2008-2013 were requested to AGBAR and the Catalan Water Agency (ACA), no response was received before the time of delivery of this report.

Additionally, a Municipal Waste Treatment Tax (Tasa Metropolitana de Tratamiento y Deposición de Residuos Municipales) is collected for the AMB. The revenues are destined to the management and treatment of solid waste. The tax is calculated on the basis of the household type and water consumption levels. Charges for 2014[75] were as follows:

Consumption level (m³/month)	Household type (nominal flow in m³/h)	Yearly fee (€)
6	A (0.25), B (0.33), C (0.40)	23.39

[73] AGBAR (2015) La factura del agua para suministros domésticos año 2014. Available on http://www.aiguesdebarcelona.cat/facturadelaigua/pdfs/factura_domestica_2014_es.pdf. Last visited 16.11.2015.

[74] Ibid.

[75] Ibid.

		D (0.50), E (0.63)	61.41
		F (1.00), G (1.60), H (2.50), I (4.00)	65.26
	7-12	A (0.25), B (0.33), C (0.40)	56.42
		D (0.50), E (0.63)	99.71
		F (1.00), G (1.60), H (2.50), I (4.00)	106.06
	13-18	A (0.25), B (0.33), C (0.40)	93.07
		D (0.50), E (0.63)	149.66
		F (1.00), G (1.60), H (2.50), I (4.00)	198.75
	>18	A (0.25), B (0.33), C (0.40)	139.75
		D (0.50), E (0.63)	162.41
		F (1.00), G (1.60), H (2.50), I (4.00)	206.73

Disaggregated data for the time range 2008-2013 were requested to AGBAR and the Catalan Water Agency (ACA), no response was received before the time of delivery of this report.

Finally, VAT of 10% is applied on the total water consumption charge (fixed+variable tariffs) and also on the water levy charge.

3k Fixed part – Sanitation: n/a

3l Per-unit volume charge – Sanitation : n/a

3m Fees – Sanitation: n/a

3n Taxes – Sanitation: n/a

3o Existence of other specific tariffs (lawn, other): A special tariff is offered for households with more than 3 members. Here the block rates are extended as follows[76]:

Block	Extended range (m^3 per person per month)
1	2
2	3
3	5
4	6

3p Existence of a social tariff - If yes, conditions and price: Yes. The social tariff applies to the following:

- Individuals over 60 years and recipients of minimum pension for retirement; people with permanent disability; widows
- Individuals who are part of a family unit where all members are unemployed

The social tariff is applied as long as the invoiced consumption does not exceed the upper threshold of the second block.

[76] Ibid.

	Beneficiaries of the social tariff pay a reduced service fee (fixed part) which is 75% of the ordinary domestic service fee. Similarly, the price of the first block of the variable part is 75% of the ordinary rate. Consumption at the second block is charged at the ordinary rate.[77]

4. Other information

4a	Changes in the water service management or in the water price structure during the last years: 2007-2008
4b	Motivations of changes Severe drought event in Barcelona.[78]
4c	Other comments
4d	Other water demand management instruments & years when these have been established and implemented (e.g. example specific restrictions for a given year when there is drought)

Analysis conducted

Two models were tested:

- One where the mean delivered volume per household is regressed on the average price a household will pay for a yearly consumption of 144m^3 of drinking water. Since disaggregated data were not available for the full time range, estimations were calculated using information on the annual change in tariffs (fixed + variable) for water supply, including the water levy. The sewage tax charged in 4 of the 23 municipalities of the sample was not included in the calculation as disaggregated data for the time range were not available. The Municipal Waste Treatment Tax was also not considered for the same reasons as well as for not being directly related to water supply and sanitation services.
- A second model, which in addition to price also includes the median income per capita.

All data are at municipality level (23 municipalities) and for the period 2008-2014. Both models are performed using an ordinary least squares (OLS) estimator. In both regressions price and water consumption were log-transformed.

Values of water consumption and water price for the period 2008-2014 are given in the template, as well as climate variables and values at a municipal scale of median income per capita and household's size. In Tableau 8 the summary statistics of variables are presented. Below in Figure 2, water consumption per capita is plotted against the estimated prices.

Table 5: Descriptive statistics

Variable	Description	Mean	Median	Std.dev	Var	Min	Max	N

[77] Ibid.

[78] Martin-Ortega & Markandya (2009) The costs of drought: the exceptional 2007-2008 case of Barcelona.

Bernardo et al. (2015) Do droughts have long-term effects on water consumption? Evidence from the urban area of Barcelona.

price.144	Average price per cubic meter for a 144 m3 consumption	1,81	1,64	0,340	0,116	1,41	2,42	161
vol.cap	Average delivered volume per household	39,70	38,12	4,82	23,19	32,40	55,49	161
income.cap	Median household income	14758	14329	2520	9742111	4186	19807	161
hot.days	Number of days with a temperature above 28°C	58	59	8	63	41	67	2556
rainy.days	Number of rainy days during summer	39	39	5	24	32	45	1288

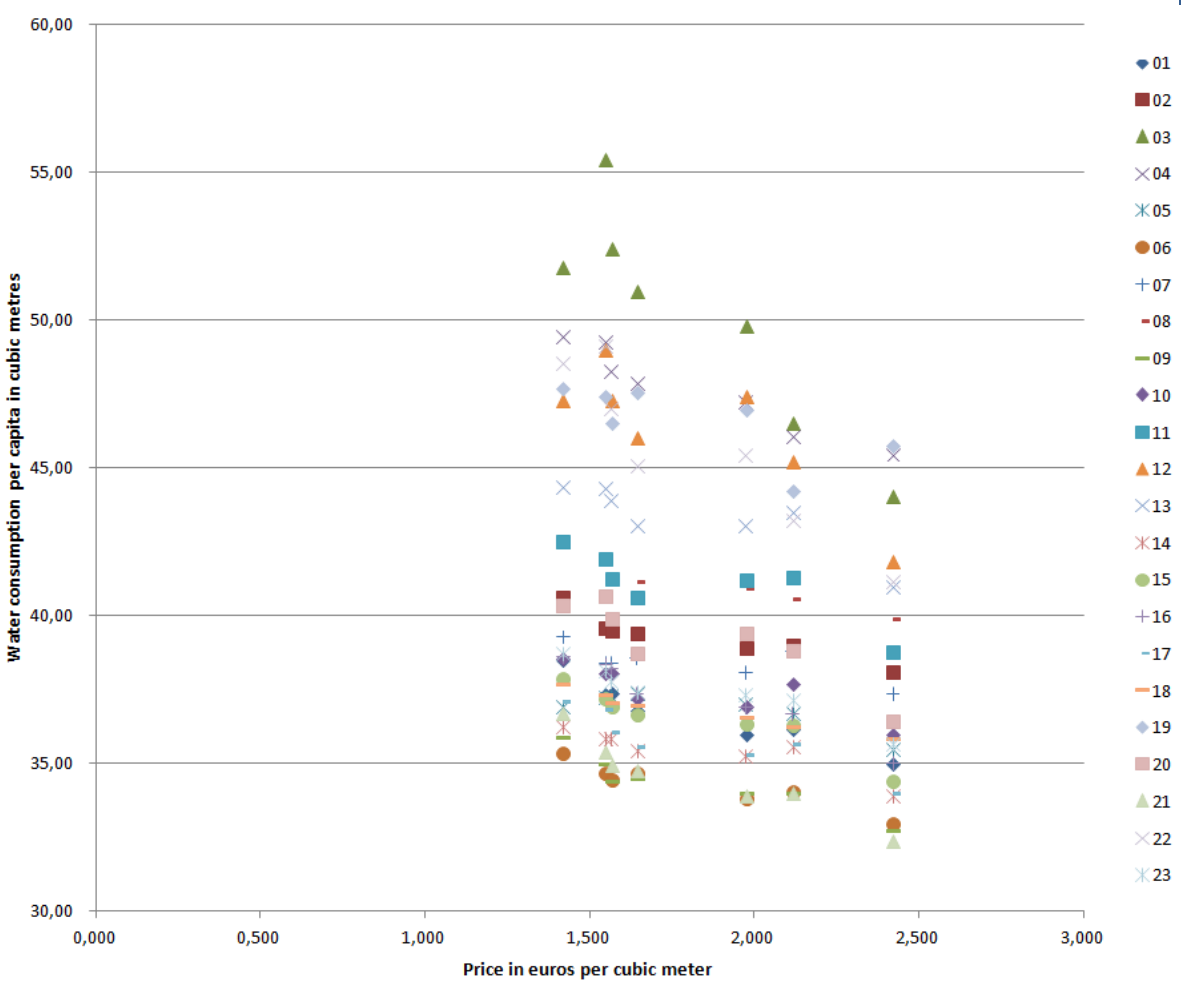


Figure 1: Water consumption and price

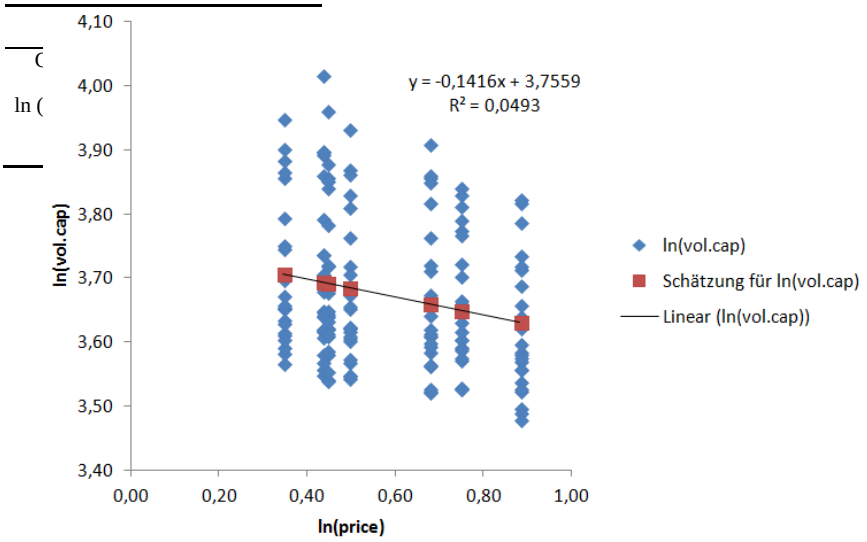
Model 1 - Results

Model 1: Water consumption as a function of price

Table 6: Regression results of model 1 - Dependent variable ln(vol.cap)

*** $p < 0,001$

Summary	
R2	0,05
Adj. R2	0,04
F-stat	8,24
N	161



As we used a double-log regression, price elasticity is the coefficient estimated, i.e. -0.142. **This means that water consumption per capita is inelastic to price.** However, from the regression results in table 2 we can conclude that while price could be a determinant of water demand in the Metropolitan Area of Barcelona, its R^2 value does not show a significantly strong correlation.

Model 2 - Results

Model 2: Water consumption as a function of price / income

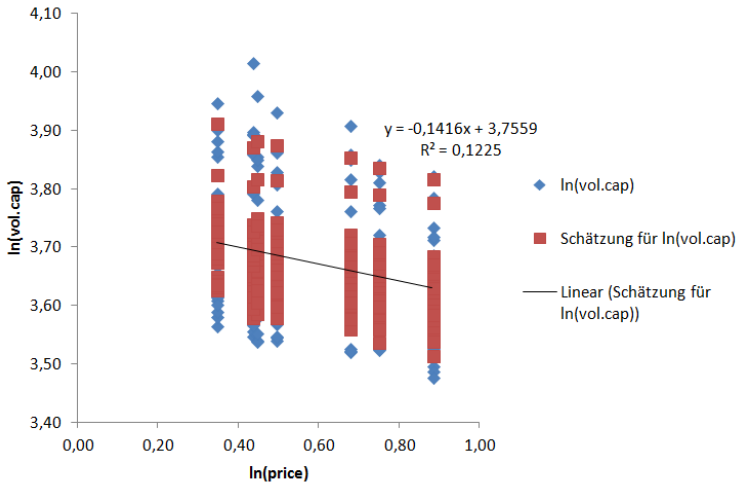
To test the role of other variables in influencing water demand, we ran a regression on a saturated model including all variables we had: water price, income per capita, number of hot days and number of rainy spring and summer days. The last two variables were not significant and so we kept only price and income in the second model.

Table 7: Regression results of model 2 - Dependent variable ln(vol.cap)

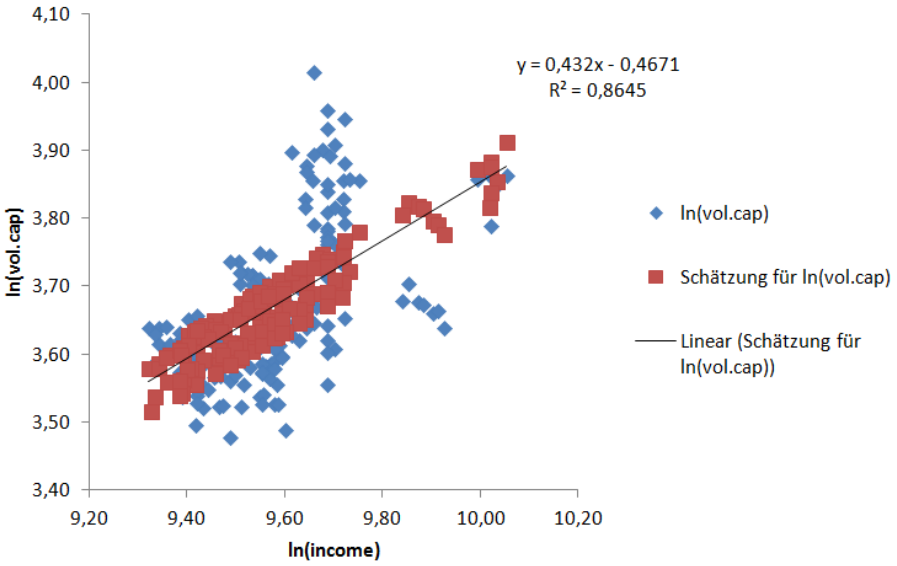
**** p < 0,001*

Summary	
R2	0,40
Adj. R2	0,39
F-stat	53,1
N	161

	Coeff.		*Std.err*
Constant	-0,413	*p*<0,35	0,432
ln (price)	-0,149	***	0,039



ln(income)	0,435	***	0,045



From the regression results in table 3 we can see that price together with income per capita explain 39% of the variations in water demand. This shows that the combined influence of these two variables is a better and more significant determinant of water demand in the Metropolitan Area of Barcelona.

As we used a double-log regression, price elasticity is the coefficient estimated, i.e. -0.15. The value is relevant with estimations found in literature. **It means that water consumption per household is elastic to price.** Moreover water consumption per household is also positively influenced by income but with variations lower than the increase of income (elasticity inferior to 1).

4. France

Eau de Grenoble

Preliminary overview

Preliminary overview	
Region	Rhône-Alpes Region, Department of Isère, City of Grenoble
Operator and type of authority	Operator: Eau de Grenoble Alpes (Public company) Authority: From 1/1/2015 Grenoble Alpes Métropole (49 municipalities) but on the period studied Ville de Grenoble (Municipality)
Geographical coverage	On the study period: the whole City of Grenoble
Area (km²)	18.13 km²
Sector	Domestic sector
No. Of municipalities	On the study period: 1 municipality managed by the operator, composed of 10 districts (not administrative districts but functional districts)
No. of customers	In 2014: 47 514 domestic customers[79] / 2 753 big consumers (includes domestic buildings) / 875 municipal infrastructures customers / 24 fire hydrant / 22 bulk customers
Type of data available	Data of price (water and sewerage), water consumption, number of customers for the 10 districts[80] for 2002-2014 + size of households, median income, share of individual houses for 2012 by IRIS[81] + climate data (rain and temperature) for 2002-2014
Proposed focus of the case study	Assessment of elasticity for the whole municipality with district scale data
Source	Eau de Grenoble, INSEE (French National Institute of Statistics and Economic Studies)

1. Water service description

1a	Name of the service: Eau de Grenoble Alpes
1b	Location (MS, Region): France, Rhône-Alpes

[79] Domestic customers are mainly households with individual metering (it ist he case for all detached houses and of more than half of the appartments buildings), but it also includes some small shops, restaurants or companies that consume only a little volume of water.

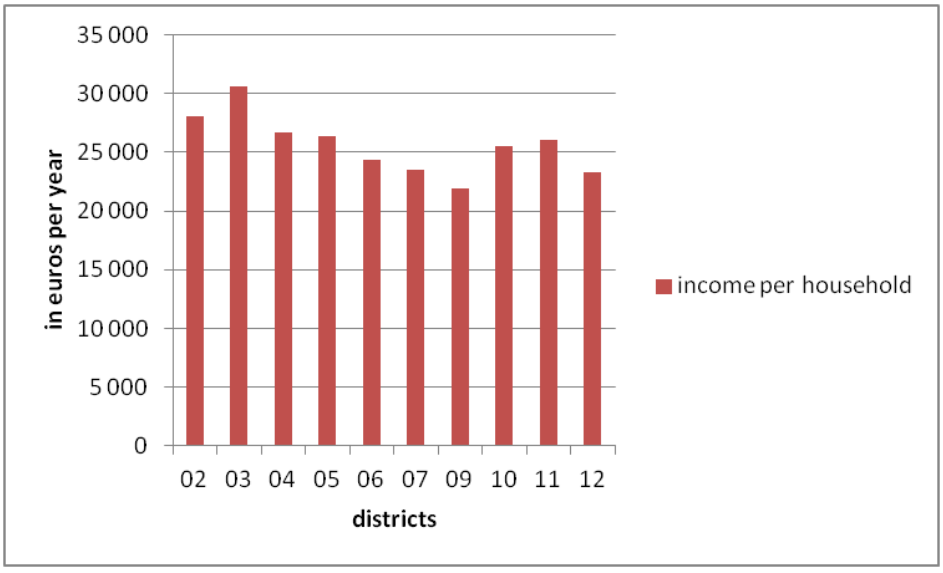
[80] Districts used for Eau de Grenoble's data were defined only by the list oft he streets composing each district, they were not geographically represented.

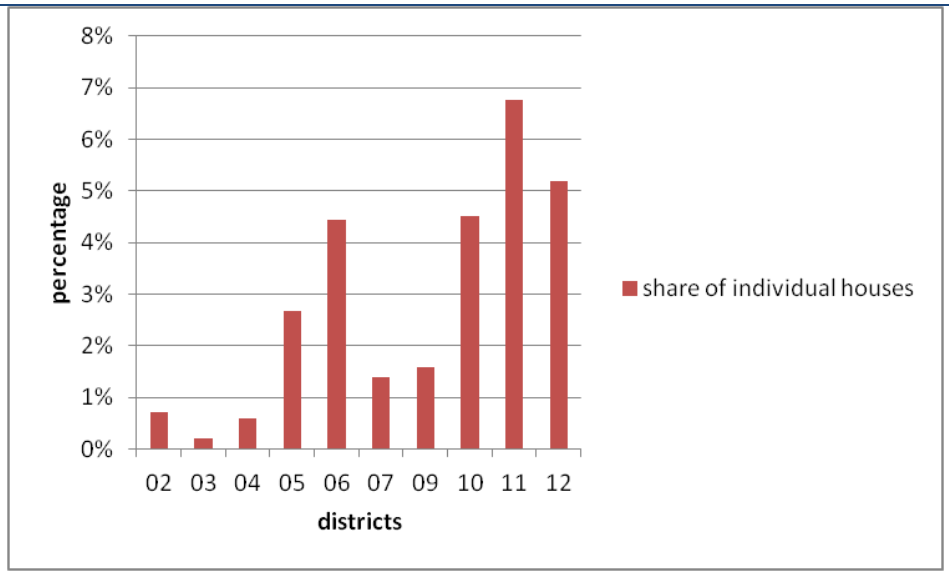
[81] IRIS is the fundamental unit for dissemination of infra-municipal data by INSEE. These units must respect geographic and demographic criteria and have borders which are clearly identifiable and stable in the long term. Correspondance between IRIS and districts was made visually on a GIS browser by representing the streets of each district on a map superposed with the IRIS map. So the IRIS (one or several) included in a district were identified, knowing that one IRIS could be affected to several districts. Then data at the IRIS scale were aggregated by mean at the district scale.

1c	Type of authority : Municipality during the study period
1d	Management type : Public management (since 1997)
1e	Water Competences : Treatment – Supply – Invoicing (management agreement) + Collection (management agreement)
1f	Sanitation service : Grenoble-Alpes Métropole (but Eau de Grenoble is in charge of invoicing)
1g	Number of Municipalities under authority: 1 during the study period

2. Contextual information

	Description of housings and population
2a	Population in the area of authority: 158 483 in 2014
2b	Population density: 8 734 inhabitants/km²
2c	Household's income - in euros per household: • Mean in 2011 is 31 944 €/year per household • Median 25 262 €/year per household - 1st quartile 15 437 - 3rd quartile 41 109
2d	Share of individual houses: 3.4% in 2012





2e	Share of permanent housings: 88% in 2012

Data from INSEE, Recensement de la population 2012 & INSEE-DGFiP Revenus fiscaux localisés des ménages 2011.

Climatic information

2f No information on the whole study period found. Precipitation during spring and summer (1.05 to 31.08) - Mean on 2008-2014: 305 mm

Year	2008	2009	2010	2011	2012	2013	2014
Nb days	81	60	62	51	74	73	62

Data transmitted by the operator - Station of Rochefort (water catchment area)

2g Mean temperature during the months of June/July/August (period 2002-2014): 20°C

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Nb days	20,0	24,5	20,7	20,0	19,8	19,0	19,6	21,1	20,0	19,2	20,5	19,8	19,0

Data transmitted by the operator - Station of Rochefort (water catchment area)

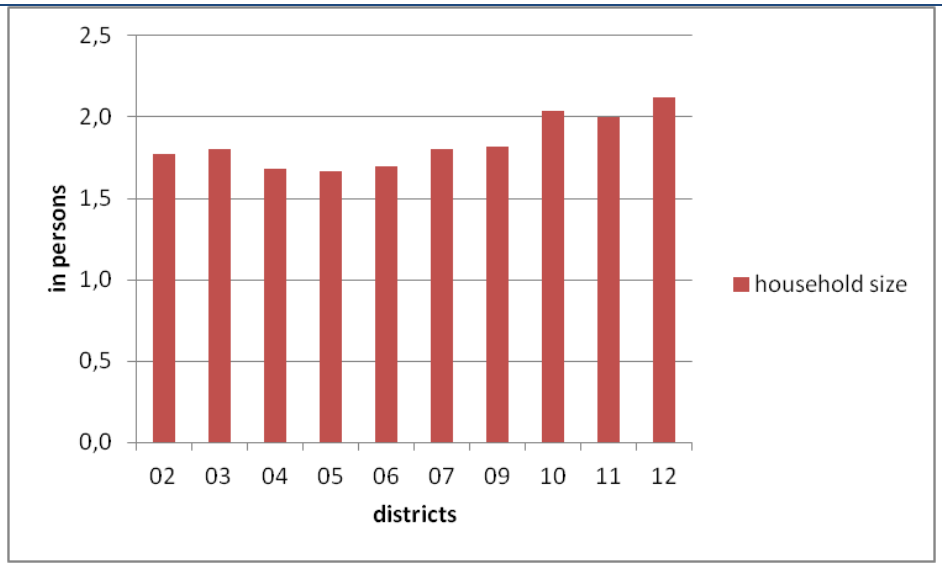
Other descriptors of housings and population - *To be discussed*

Data from INSEE, Recensement de la population 2012

2h Population age (mean or distribution): in 2012

Age	Percentage
Moins de 5 ans	7%
6 à 17 ans	10%
18 à 39 ans	43%
40 à 64 ans	24%
65 ans ou plus	16%

2i Average household size: in 2012 - 82 208 households in total
1,9 persons per household in 2012



	1 personne	2 personnes	3 personnes	4 personnes	5 personnes	6 personnes ou plus
Ensemble	50%	28%	11%	7%	3%	1%

2j Average housing size: in 2012 - 82 208 housings

	Moins de 40 m²	De 40 à moins de 100 m²	100 m² ou plus
Ensemble	23%	67%	10%

.

2k Share of houses with lawn: no data found

2l Share of houses with swimming pool: no data found

2m Share of houses with private well: no data found

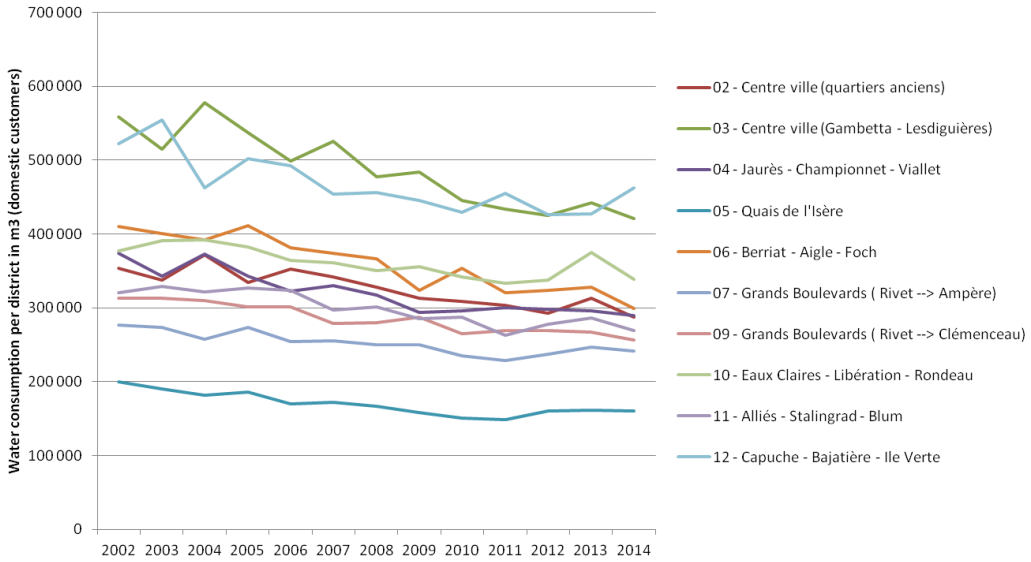
2n Equipment rate for main water saving devices (rainwater tank, flow reducers, dual-flush toilets) : no data found

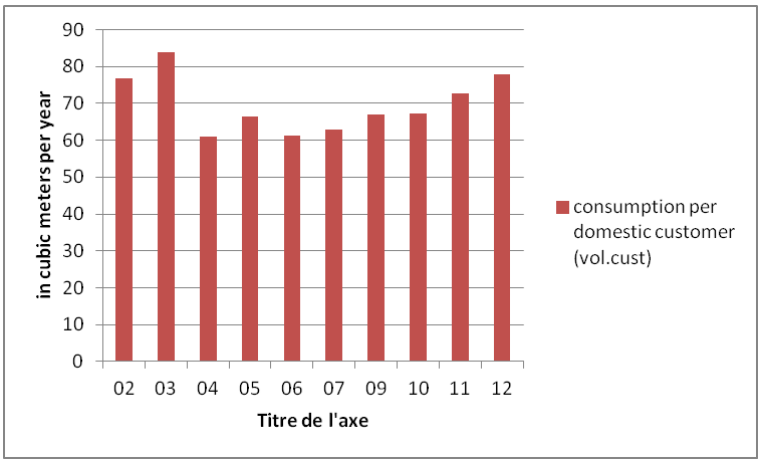
2o Equipment rate for main water consuming devices (shower vs. tub, washing machine, dishwasher) : no data found

3. Water consumption and price

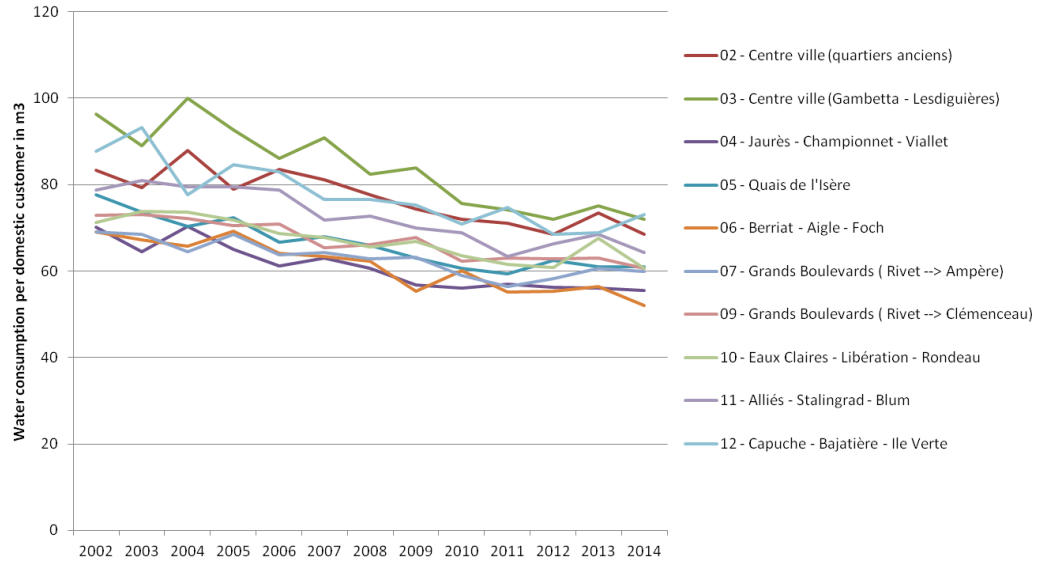
Information should be collected per year and per municipality (if detail available), and a minimum of 20 observations seems reasonable. Information should concern the domestic sector only.

	Water Consumption data
3a	Water consumption - volume charged (domestic) Total consumption per district- for the whole Grenoble 3 024 814 m3 by domestic customers in 2014



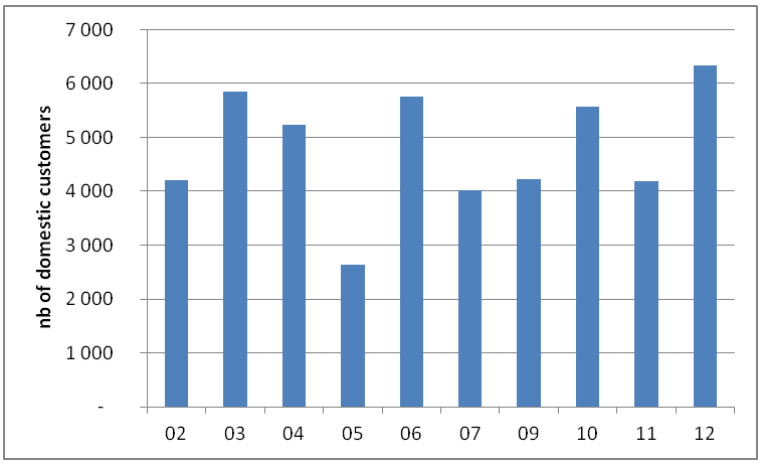


Mean consumption per domestic customer for Grenoble - mean of 70 m3/year per domestic customer



3b Number of domestic customers:

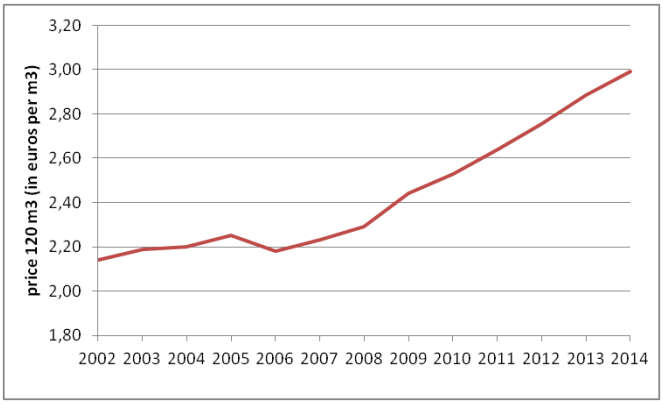
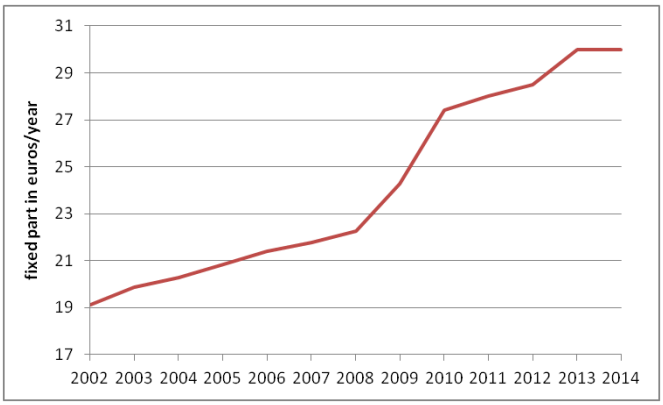
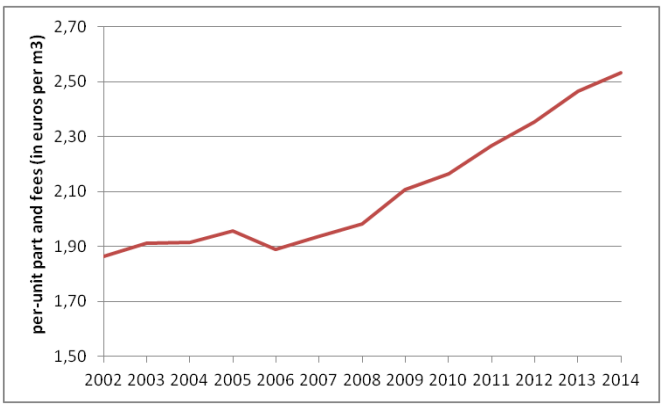
47 990 in 2014



3c Population supplied: The whole population of Grenoble - 158 483 in 2013, less homeless people and people living in encampments (ie 665 persons). But some inhabitant may live in buildings that are equipped with high volume meters and so not included in the "domestic customers".

3d Rate of connection to sanitation network: 99%

3e Individual meters (only for houses, for all housings, a mix, other): No data available for apartments buildings but Eau de Grenoble Alpes uses the ratio "number of domestic customers (47 990) / number of permanent housings (from national statistics, 82 200)" as a proxy. For 2013 = 58%

	Water Price data
3f	Structure tariff (existence of a fixed part, per-unit volume charge, block prices, free allowance) Water: Fixed part + Volumetric part + Fees and taxes Sewerage: Fixed part + Volumetric part + Fees and taxes Global price: 3.04 €/m3 in 2015 all taxes included for a 120 m3 consumption 
3g	Fixed part - Water 
3h	Per-unit volume charge + Fees - Water & Sewerage (detail water/sanitation and volumetric part/fees available) 
3o	Existence of other specific tariffs (lawn, other): No

3p	Existence of a social tariff - If yes, conditions and price: Students that receive the housing aid are not charged for the activation of their account. Grenoble will be one of the 40 French municipalities that will test social tariffs - experiment will begin in 2016.

4. Other information

4a Changes in the water service management or in the water price structure during the last years:

Year	Management type	Water competences
Avant 1996	Un service de l'eau de la Ville de Grenoble (qq personnes) avec DSP à la **COGESE** (Compagnie Générale des Eaux du Sud Est, filiale de la Lyonnaise des eaux)	Production – distribution – facturation (en DSP)
Fin 1996	« Affaire Carignon » Dénonciation des contrats et malversations	
1997	Création de la **Société des Eaux de Grenoble** (SEG) = *SEM*	Maîtrise d'ouvrage
	Et de la Société Grenobloise des Eaux et de l'Assainissement	Production – distribution – facturation (en sous-traitance)
1999	Fusion absorption de la SEG et de la SGEA => nouvelle SEG	Maîtrise d'ouvrage + Production – distribution – facturation
2000	Transfert de l'assainissement à la Métropole et création de la REG (1 personne)	Maîtrise d'ouvrage + Production – distribution – facturation
2001	Liquidation de la SEG Transfert de personnels de la SEG à la **Régie des Eaux de Grenoble** (REG) = *EPI, régie dotée de la personnalité juridique et de l'autonomie financière*	Maîtrise d'ouvrage + Production – distribution – facturation
2014	Création de la Régie de l'Eau Potable (REP) de Grenoble Et de la **SPL Eau de Grenoble**	Maîtrise d'ouvrage + Production – distribution – facturation (contrat de gestion)
Décembre 2014	Fusion absorption de la SPL Eau de Grenoble et de la SPL SERGADI	
2015	Régie de l'Eau de la Métropole SPL Eaux de Grenoble Alpes	Production – distribution – facturation (contrat de gestion) + recouvrement (contrat de gestion)

The decrease of water price in 1996 is explained by the transition to public management (the previous concession had been denounced due to suspicion of misappropriation of funds).

4b Motivations of changes

4c Other comments

4d Other water demand management instruments & years when these have been established and implemented (e.g. example specific restrictions for a given year when there is drought)

Communication or awareness campaigns:

- Distribution of low-flow device for taps and shower: around 1 200 per year
- 8 stands in 2015 (sport or gastronomic events) and 1 children festival of 1 week on water and water savings
- Distribution of carafes to Grenoble restaurants to incite to consume tap water: 55 restaurants use them
- Distribution of books on Eau de Grenoble to schools and libraries (260 books offered)
- Awareness campaigns to schools on demand with a visit oft he abstraction site.

3. Regression anaylsis

Analysis conducted

Two models were tested:

- One where the mean delivered volume per household is regressed on the average price a household will pay for a yearly consumption of 120m^3 of drinking water (the price includes both fixed and variable costs for drinking water and sewage as well as fees and taxes).
- A second model, which in addition to price also includes the median household's income and the mean household's size.

All data are at a district level (10 districts) and for the period 2002-2014. Both models are performed using an ordinary least squares (OLS) estimator. In all regression, price and water consumption were log-transformed.

Descriptive statistics

Values of water consumption and water price for the period 2002-2014 are given in the template, as well as climate variables and values at a district scale of median income, household's size and share of individual houses. In Tableau 8 the summary statistics of variables are presented. Below in Figure 2, water consumption per household is plotted against price.

Tableau 8: Descriptive statistics

Variable	Description	Mean	Median	Std.dev	Var	Min	Max	Nb of ob
price.120	Average price per cubic meter for a 120 m3 consumption	2,44	2,29	0,282	0,08	2,14	2,993	1
vol.cust	Average delivered volume per domestic customer	69,67	68,53	9,48	89,87	51,97	99,97	1
hh.size	Average household size	1,8	1,9	0,15	0,023	1,67	2,12	1
hh.income	Median household income	25623	25786	2420	5856616	21906	30626	1
p.houses	Share of individual houses	0,028	0,021	0,022	0,0005	0,002	0,0677	1
summer.temp	Average temperature during June/July/August	20	20	1	2	19	25	1

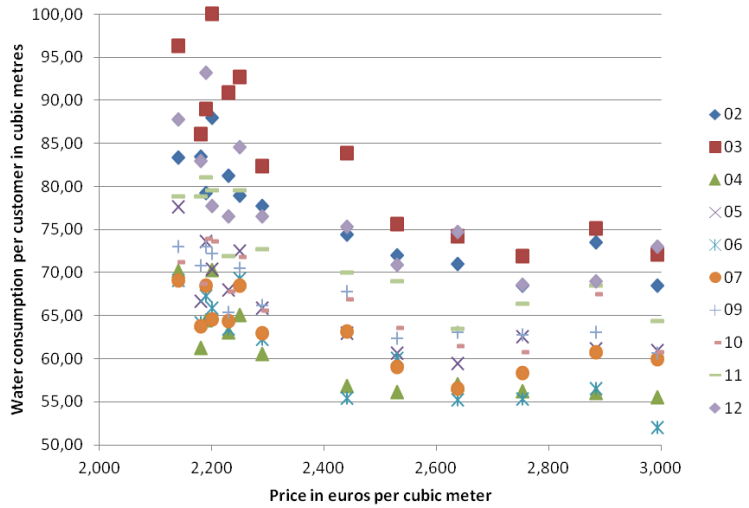


Figure 2: Water consumption and price

Model 1 - Results

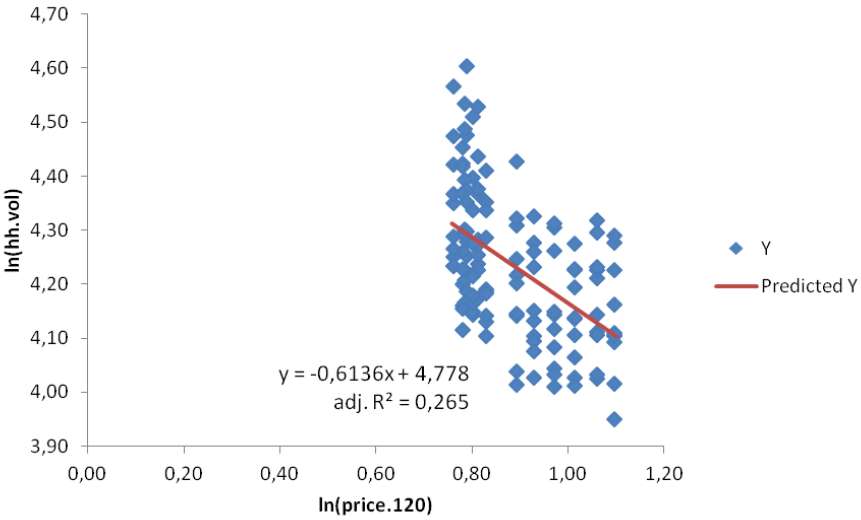
Model 1: Water consumption as a function of price

Tableau 9: Regression results of model 1 - Dependent variable ln(vol_hh)

*** $p < 0,001$

Summary	
R2	0,27
Adj. R2	0,26
F-stat	47,5
N	130

	Coeff.	*Std.err*
Constant	4,778***	0,079
ln (price.120)	-0,614***	0,089



From the regression results in table 2 we can conclude that price is significantly correlated to water demand in Grenoble.

If we make the assumption that the causal effect if from price on demand (see discussion for more details) and as we used a double-log regression, price elasticity would be the coefficient estimated, i.e. -0.26. The value is relevant with estimations found in literature. **It would mean that water consumption per household is inelastic to price.**

Model 2 - Results

Model 2: Water consumption as a function of price / households' size / income

To test the role of other variables in influencing water demand, we ran a regression on a saturated model including all variables we had: water price, household's size, household's income, share of individual houses in each district and the average temperature in summer. The two last ones were not significant and so we kept only price, household's size and income in the second model. Interaction between price and income was also tested but not significant.

Tableau 10: Regression results of model 2 - Dependent variable ln(vol.hh)

**** p < 0,001*

Summary	
R2	0,63
Adj. R2	0,62
F-stat	70,9
N	130

	Coeff.		***Std.err***
Constant	-2,776	***	0,823
ln (price.120)	-0,613	***	0,064
ln(hh.size)	0,787	***	0,092
ln(income)	0,697	***	0,079

From the regression results in table 3 we can conclude that price with household's size and household's income are good and significant determinants of water demand in Grenoble (the three variables explaining 62% of the variations of water demand). As we used a double-log regression, price elasticity is the coefficient estimated, i.e. -0.61. The value is relevant with estimations found in literature. **It means that water consumption per household is inelastic to price.** Moreover water consumption per household is also positively influenced by income but with variations lower than the increase of income (elasticity inferior to 1). Household's size also partly determines water demand, but the difference in water consumption between a one-person household and a couple is lower than a factor 2.

5. Italy

Viveracqua

Preliminary overview

Preliminary overview	
Region	Veneto
Operator and type of authority	Viveracqua – Consortium of 14 public water operators, covering the entire Veneto region
Geographical coverage	Available data cover 18 municipalities scattered across the Verona province in the Veneto region – mostly rural municipalities (the city of Verona is not included)
Area (km^2)	610,1 km^2
Sector	Domestic sector
No. Of municipalities	18 – Elasticity was assessed for 16 municipalities (unsufficient data for 2 municipalities) Affi, Bardolino, Brenzone, Caprino Veronese, Castelnuovo, Cavaion, Costermano, Dolcé, Ferrara, Garda, Lazise, Malcesine, Pastrengo, Peschiera, Rivoli, San Zeno, Sant'Ambrogio, Valeggio
No. of customers	Water supply: 61 449 (2014) Wastewater collection and treatment: 51 366 (2014)
Type of data available	Data on: No. of customers water supply, invoiced volumes water supply, No. of customers wastewater collection and treatment, invoiced volumes wastewater collection and treatment, % of population served by wastewater collection and treatment – Period: 2008-2014 Data on: for each municipality, water tariffs differentiated by consumption block + Fixed component + VTA – Period: 2008-2015
Proposed focus of the case study	
Source	Customers, invoiced volumes and tariffs: Viveraqua

1. Water service description

1a	Name of the service Viveracqua
1b	Location (MS, Region) Italy, Veneto region (entire region)
1c	Type of authority (Municipality, Group of municipalities, Union, other) Consortium of 14 public water operators, covering the entire Veneto region
1d	Management type (Public management, Leasing, Concession, other) Consortium of 14 public water operators, covering the entire Veneto region
1e	Water Competences (among Supply, Supply and Treatment, Supply, Treatment and Abstraction) Water supply, wastewater collection and treatment

1f	Sanitation service (Yes, Distinct, Unknown) YES
1g	Number of Municipalities under authority 582

2. Contextual information

	Description of housings and population
2a	Population in the area of authority[82] 103 831 inhabitants Least populated municipality: Ferrara di Monte Baldo – 231 inhabitants Most populated municipality: Valeggio – 14 923 inhabitants
2b	Population density[83] Average density: 232,2 inhabitants/km^2 Lowest density: Ferrara di Monte Baldo – 8,6 inhabitants/km^2 Highest density: Peschiera del Garda – 581 inhabitants/km^2
2c	Household's income - in euros per capita (mean or distribution) Average income per capita in the Verona province: 19 581 EUR/capita (ISTAT) Average income per capita, average household income per municipality: http://www.ilsole24ore.com/speciali/ricchezza_comuni/comuni_redditi_province_verona.shtml
2d	Share of individual houses Not available
2e	Share of permanent housings Not available

	Climatic information
2f	Number of days with rainfalls during spring and summer Available data Average yearly temperature: 13° Average maximum yearly temperature: 17° Average minimum yearly temperature: 8° Precipitation: 800 mm/year Driest months: December and February, 54 mm Wettest month: November, 87 mm[84]
2g	Number of days with a temperature above 28°C

[82] www.comuni-italiani.it

[83] Same as above

[84] http://www.centrometeo.com/articoli-reportage-approfondimenti/climatologia/5411-clima-veneto

	Other descriptors of housings and population - *To be discussed*

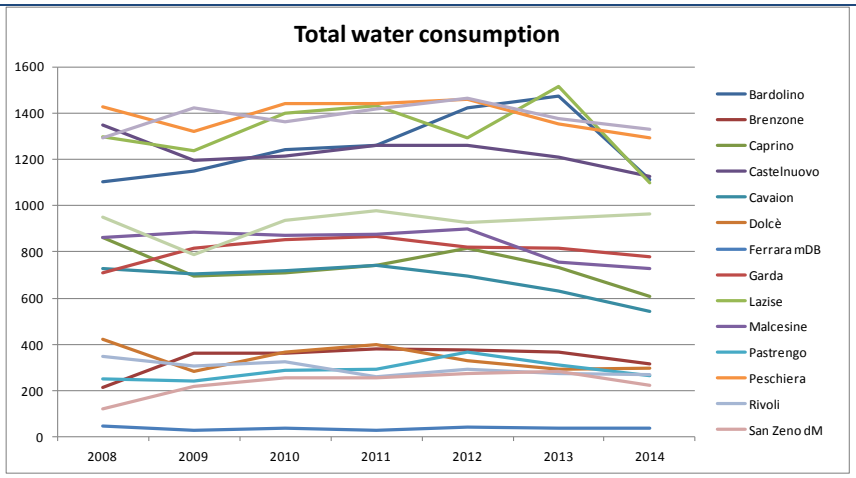
Information should be collected for the most recent year available.

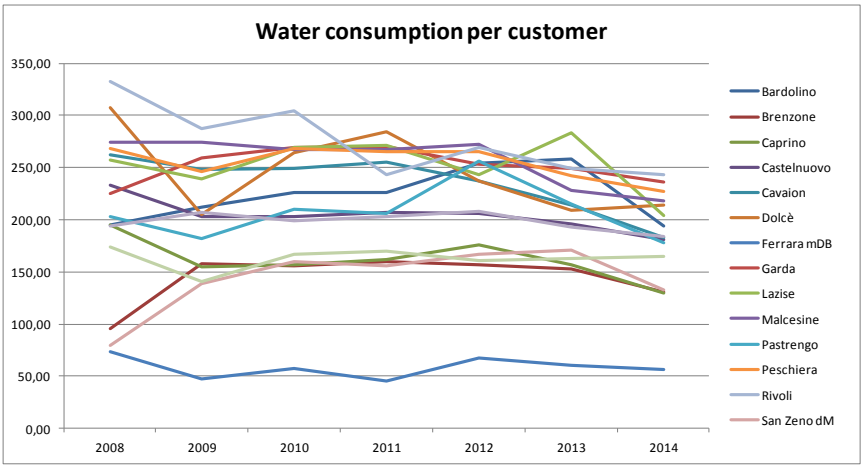
2h	Population age (mean or distribution) Average age: 43.9 0-14 years old: 14.4% 15-65 years old: 64.5% >65 years old: 21.1% (ISTAT – Data for 2015)
2i	Average household size 2,4 persons[85] Average household size per municipality: http://www.datiopen.it/it/opendata/Regione_Veneto_Numero_medio_componenti_per_famiglia_e_comune
2j	Average house size
2k	Share of houses with lawn
2l	Share of houses with swimming pool
2 m	Share of houses with private well
2n	Equipment rate for main water saving devices (rainwater tank, flow reducers, dual-flush toilets)
2o	Equipment rate for main water consuming devices (shower vs. tub, washing machine, dishwasher)

3. Water consumption and price

	Water Consumption data
3a	Water consumption - volume charged

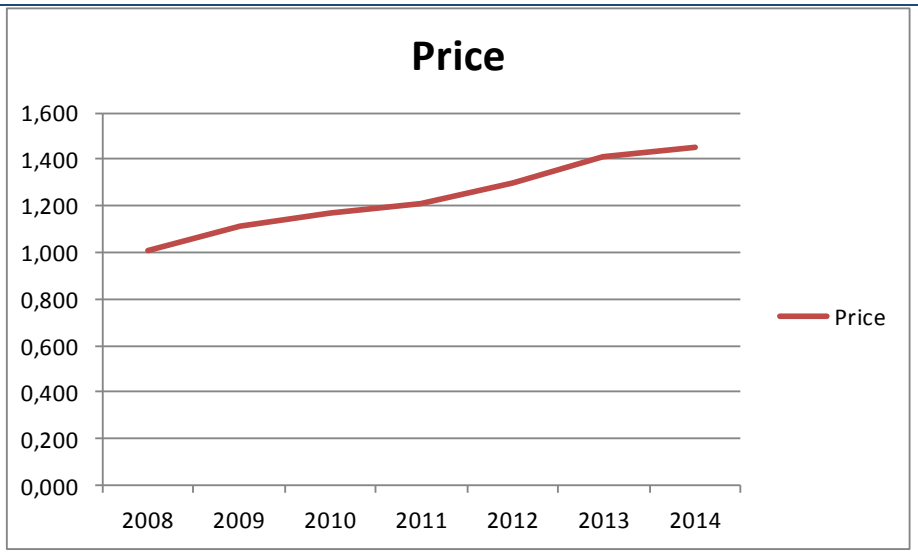
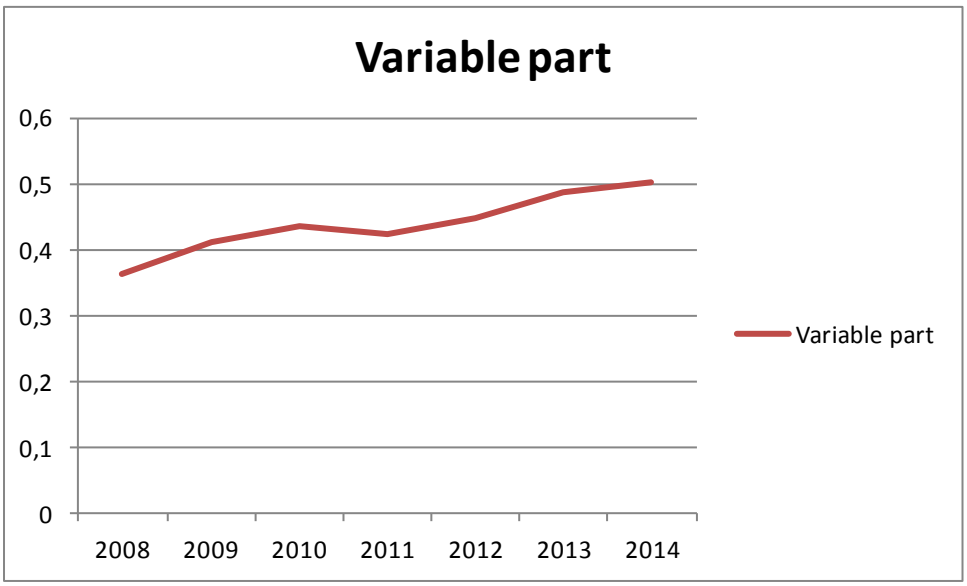
[85] http://www.urbistat.it/AdminStat/it/it/demografia/famiglie/veneto/5/2





3b	Number of account holders
3c	Population supplied 103 831 inhabitants
3d	Rate of connection to sanitation network
3e	Individual meters (only for houses, for all housings, a mix, other)

	Water Price data
3f	Structure tariff (existence of a fixed part, per-unit volume charge, block prices, free allowance) Mixed taridd: Volumetric component water + volumetric component wastewater collection + volumetric component wastewater treatment + fixed component Water supply: Since 2011, the same rate of the variable component has been applied in all municipalities Wastewater collection and treatment: the same rates have been applied in all municipalities over the whole period considered

	
3g	Fixed part - Water (if variable with diameter, domestic meters are generally 15mm) In the observed period, ranging from 18 and 22.2 EUR
3h	Per-unit volume charge (or charges if block prices) – Water 
3i	Fees – Water
3j	Taxes – Water
3k	Fixed part – Sanitation
3l	Per-unit volume charge – Sanitation
3m	Fees – Sanitation
3n	Taxes – Sanitation
3o	Existence of other specific tariffs (lawn, other)
3p	Existence of a social tariff - If yes, conditions and price

4. Regression analysis

Analysis conducted and descriptive statistics

Two models were tested:

- One where the mean delivered volume per household is regressed on the average price a household will pay for a yearly consumption of 120m^3 of drinking water (the price includes both fixed and variable costs for drinking water and sewage as well as fees and taxes).
- A second model, which in addition to price also includes the median household's income and the mean household's size.

All data are at a municipal level (10 districts) and for the period 2008-2014. Both models are performed using an ordinary least squares (OLS) estimator. In all regression, price and water consumption were log-transformed.

Values of water consumption and water price for the period 2002-2014 are given in the template, as well as climate variables and values at a municipal scale of median income, household's size and share of individual houses. In Tableau 8 the summary statistics of variables are presented[86].

Tableau 11: Descriptive statistics

Variable	Mean	Standard deviation	Median	Variance	Min	Max
Price.120	0,44	0,05	0,43	0,00	0,26	0,54
vol.hh	204,78	60,61	207,78	3673,00	45,69	332,05
hh.size	2,44	0,23	2,50	0,05	1,80	2,70
hh.income	28490,19	3259,60	28545,50	10625012,96	22688,00	34774,00

Model 1 - Results

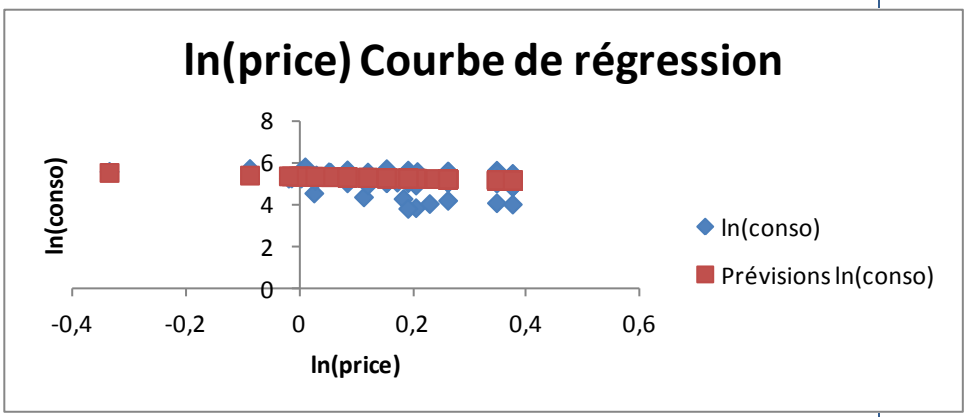
Model 1: Water consumption as a function of price

Tableau 12: Regression results of model 1 - Dependent variable ln(vol_hh)

*** $p < 0,001$

Summary	
R2	0,03
Adj. R2	0,03
F-stat	3,2
N	112

	Coeff.	*Std.err*
Constant	5,37	0,070
ln (price.120)	-0,51	0,287



[86] Available data included both data on volumes of supplied water and volumes of wastewater collected and treated. The two volumes were different. It was assumed that invoicing is based on supplied volumes, as measured by household metering devices, whereas the data on volumes of wastewater collected and treated are measured at the entrance of the treatment plant. Therefore, the regression analysis is based on supplied volumes.

From the regression results in table 2 we might conclude that price is inelastic to price, as the coefficient is -0.51. However, the critical F-value (Critical F-value > 0.05) reveals that the model is not significant or, in other word, that the **price is not a significant determinant of water demand**.

Model 2 - Results

Model 2: Water consumption as a function of price / households' size / income

To test the role of other variables in influencing water demand, we ran a regression on a saturated model including: water price, household's size, household's income.

Tableau 13: Regression results of model 2 - Dependent variable ln(vol.hh)
**** p < 0,001*

Summary	
R2	0,56
Adj. R2	0,54
F-stat	45,6
N	112

	Coeff.		*Std.err*
Constant	-11,08	***	2,453
ln (price.120)	-0,320	***	0,197
ln(hh.size)	1,649	***	0,292
ln(income)	1,458	***	0,250

This model is significant in explaining the determinants of water demand. Water price, however, is not a significant determinant of demand (coefficient= -0.320). In contrast, **household size and household income are significant determinant of water demand, and a positive correlation is observed** (household size, coefficient= 1,649; household income, coefficient= 1,458).

Conclusions

6. Romania

Regional Water Company Bacau (CRAB)

Preliminary overview

Preliminary overview	
Region	County of Bacau, Romania
Operator and type of authority	Regional Water Company Bacau (CRAB), organized as public company with 88 shareholders, the main shareholder being the municipality of Bacau. It has been founded and started operating at the end of 2010.
Geographical coverage	CRAB operates in the county Bacau, without covering the whole area of the county. A map displaying its coverage is available[87]
Area (km^2)	Information not available
Sector	Domestic sector
No. Of municipalities	According to the information displayed on its own website, CRAB currently services 20 localities, but there are works in progress which will soon connect other municipalities as well. 4 municipalities studied here
No. of customers	264371 inhabitants live in the area currently serviced by CRAB, while there are plans / works to expand the area to other municipalities which are shareholders of the company.
Type of data available	Data of price (water and sewerage), water consumption, number of customers and of inhabitants for the period 2011-2015 + size of households, mean income, share of individual houses and climate data for one year only and the county scale
Proposed focus of the case study	Assessment of elasticity for 4 municipalities with municipality scale data
Source	Data from the water company; Online resources http://www.apabacau.ro/ http://www.recensamantromania.ro/ http://www.insse.ro/cms/files/IDDT%202012/Date_IDDT/T6_1.Venitul%20total%20mediu%20lunar%20pe%20o%20gospodarie.htm http://adibacau.ro/fisiere/pagini_fisiere/act_constitutiv_ADIB_rescris.pdf

1. Water service description

[87] http://aport.ara.ro/images/Operatori/Companii/APA_BACAU/SC%20%20COMPANIA%20REGIONALA%20DE%20APA%20BACAU%20SA.png

1a	Name of the service: Regional Water Company Bacau (CRAB)
1b	Location (MS, Region): Romania, county Bacau
1c	Type of authority : Regional Water Company Bacau (CRAB), organized as public company with 88 shareholders, the main shareholder being the municipality of Bacau. It has been founded and started operating at the end of 2010.
1d	Management type : Concession contract between the Intercommunity Development Association Bacau (association of municipalities serviced by the water operator) and the CRAB.
1e	Water Competences : Supply, Treatment and Abstraction
1f	Sanitation service : Yes
1g	Number of Municipalities under authority: 87 (2014) - 4 studied here

2. Contextual information

	Description of housings and population
2a	Population in the area of authority: 264371 inhabitants live in the area currently serviced by CRAB, according to the last Census (2011). There are currently plans / works to expand the area to other municipalities which are shareholders of the company. Population in the study area: 157 951 in 2015 (4 municipalities)
2b	Population density: According to the last census (2011), population density in Bacau county is of 88,1 inhabitants / sq. kilometre.
2c	Household's income - in euros per household: In the North East region where the water operator provides its services, the mean household income in 2010 was of 455 EUR. There are significant differences however between the different municipalities serviced.
2d	Share of individual houses: In Bacau county, the share of individual houses is of 62,63% of the total number of buildings. (source: Census of buildings 2011)
2e	Share of permanent housings: In 2011, the share of permanent housings was of 83,71% in Bacau county. (source: Census of buildings 2011)

	Climatic information
2f	Number of days with rainfalls during spring and summer The monthly average precipitation during spring and summer in the city of Bacau for the years 1961 – 1990 are the following (mm):

April	May	June	July	August	September
51.6	72.1	77.4	77.8	59.4	47.8

The yearly quantities for July vary between 60 - 100 mm in the West to 20 - 30 mm in the East of the county.

Source: http://www.geaconsulting.ro/wp-content/uploads/downloads/2011/07/Bacau.pdf

National Meteorological Administration http://www.meteoromania.ro/anm/?page_id=2059

2g	Number of days with a temperature above 28°C Average monthly temperatures for Bacau municipality:

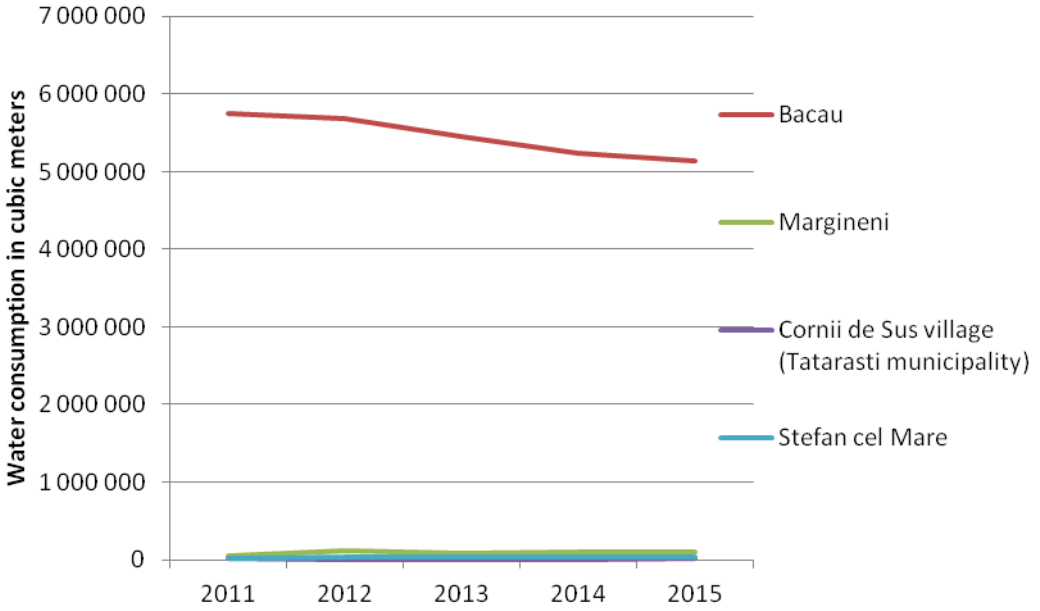
	Jan	Feb	March	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1901-2000	-3,6	-2,1	2,9	9,7	15,2	18,9	20,6	19,8	15,3	9,5	3,7	-0,9
2007	4,3	1,4	6,6	10,2	18,2	22,0	24,2	21,7	14,9	9,9	2,1	-2,0

Source: National Institute of Statistics

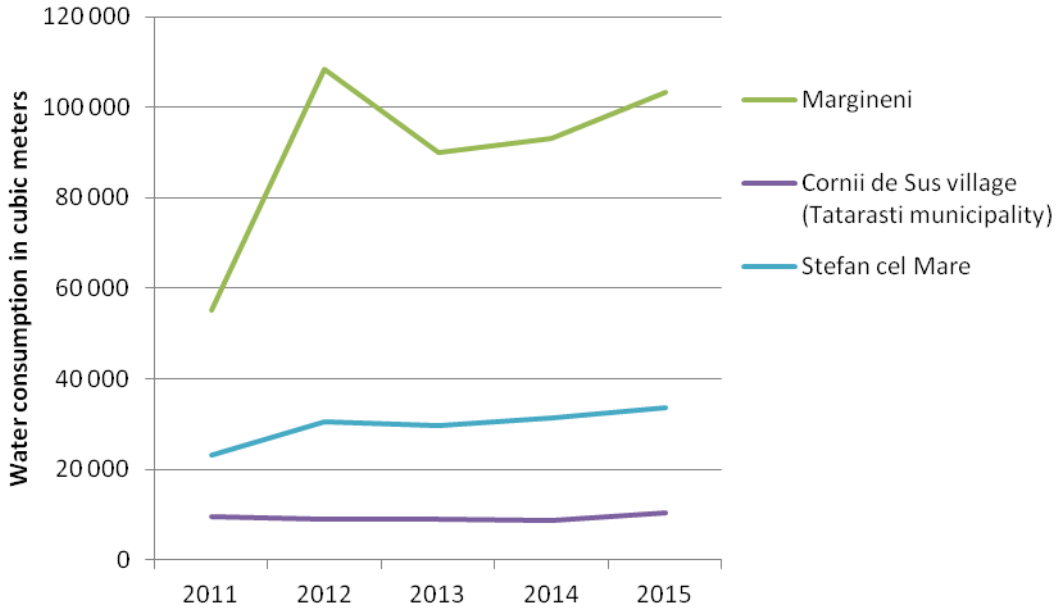
	Other descriptors of housings and population - *To be discussed*
2h	Population age (mean or distribution): Median population age in Romania is 40,6 years (Census 2011)
2i	Average household size: The average household size in Romania is 47,1 sq. meters (48,1 sq. meters in the urban areas and 45,9 sq. meters in the rural areas) (Source: Census of buildings in 2011)
2j	Average housing size: The average house size in Romania is 73 sq. meters (Source: BPIE, 2014)
2k	Share of houses with lawn: no data found
2l	Share of houses with swimming pool: no data found
2m	Share of houses with private well: no data found
2n	Equipment rate for main water saving devices (rainwater tank, flow reducers, dual-flush toilets) : no data found
2o	Equipment rate for main water consuming devices (shower vs. tub, washing machine, dishwasher) : no data found

3. Water consumption and price

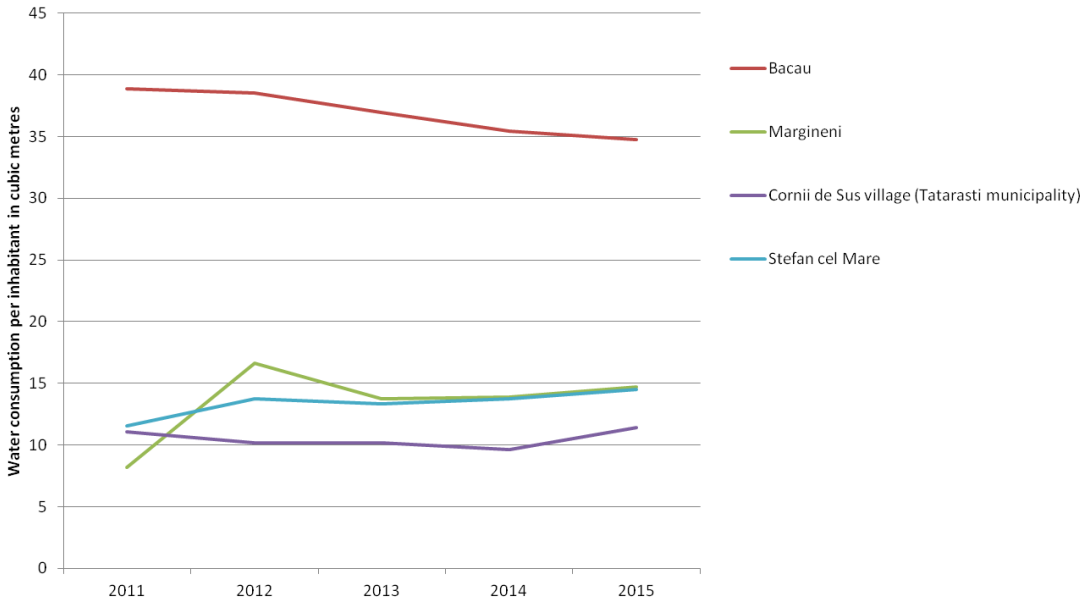
	Water Consumption data
3a	Water consumption - volume charged (domestic) See information in attached annex. 4 municipalities have been chosen for the purpose of this study: Bacau, Margineni, Cornii de Sus village (Tatarasti municipality) and Stefan cel Mare. The data refers to years 2011 – 2015. The same municipalities and periods have been analysed for points 3b – 3p. Total consumption per municipality: total for the 4 municipalities 5 280 845 m3 in 2015



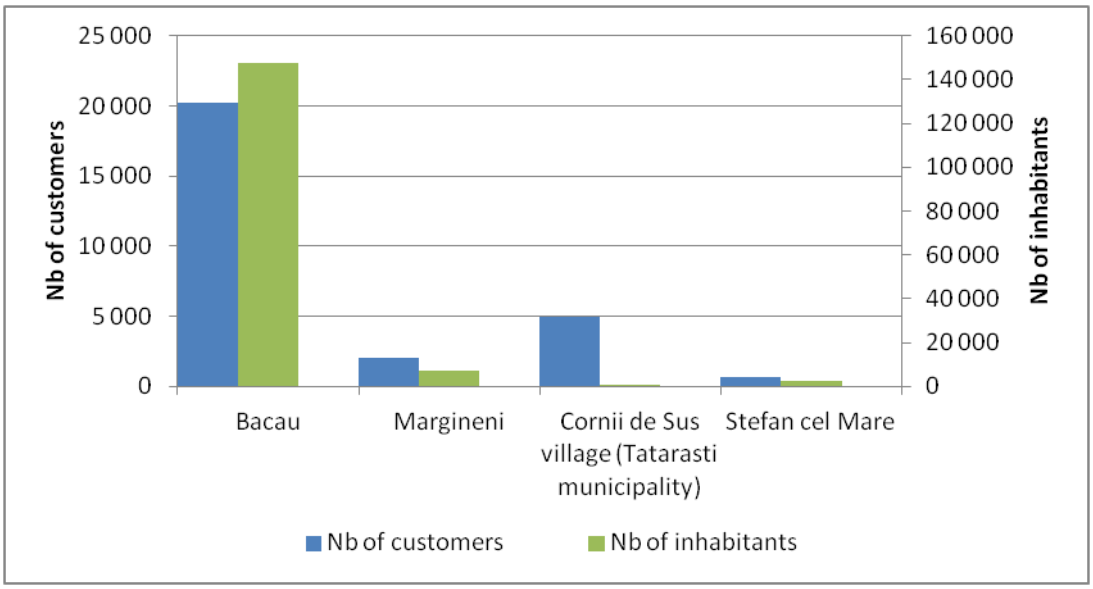
Zoom:



Mean consumption per inhabitant for the 4 municipalities in 2015 - mean of 33,4 m3/year per inhabitant



3 b Number of customers:27 912 in 2015



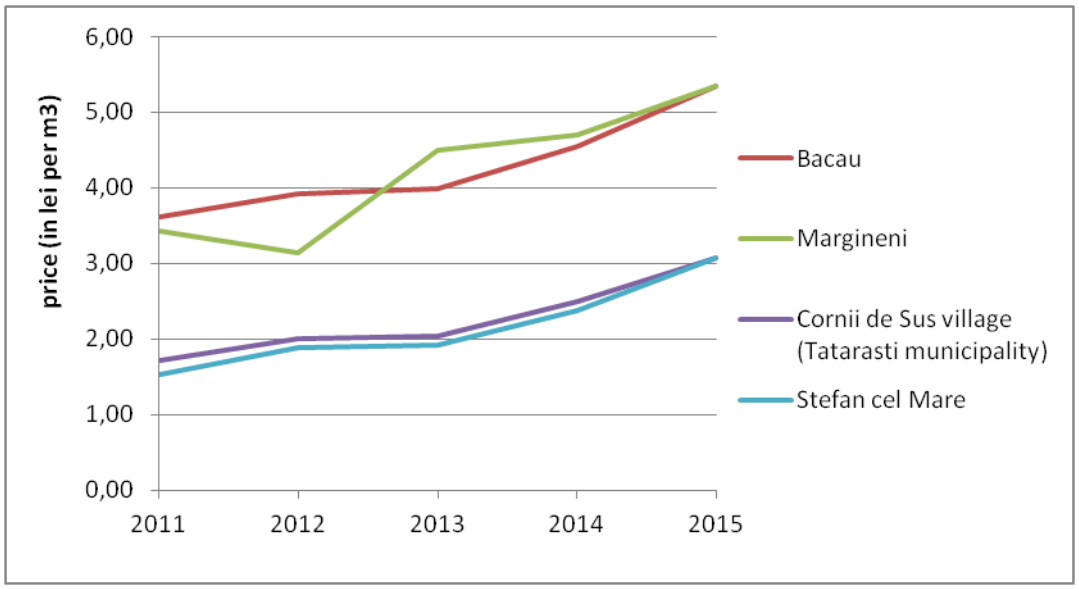
3c Population supplied: see above

3 d Rate of connection to sanitation network:

Municipality		Bacau	Margineni	Cornii de Sus village (Tatarasti municipality)	Stefan cel Mare
Year		2015	2015	2015	2015
Rate of connection to water supply and sanitation network	Water	86%	88%	38%	46%
	Sewage	84%	9%	0%	0%

	Metering rate	Water	98%	100%	100%	100%	
3e	Individual meters (only for houses, for all housings, a mix, other): see above						

	Water Price data
3f	Structure tariff (existence of a fixed part, per-unit volume charge, block prices, free allowance) Note: Tariffs do not contain VAT. Structure: no information Global price: Bacau 5,34 lei/m3 - Margineni 5,34 - Cornii de Sus village (Tatarasti municipality) 3,07 - Stefan cel Mare 3,07
3g	Fixed part - Water
3h	Per-unit volume charge + Fees - Water & Sewerage
3o	Existence of other specific tariffs (lawn, other): No
3p	Existence of a social tariff - If yes, conditions and price:



4. Other information

4a	Changes in the water service management or in the water price structure during the last years: No major changes occurred since the CRAB was established at the end of 2010. The Company was created as a merge between the two former companies: Bacau Water Company and Apaserv. The prices of water supply / sewage services were harmonised for all serviced municipalities, starting with January 2014.

4b	Motivations of changes: The harmonisation of water prices was necessary due to the fact that there were significant differences between tariffs of different municipalities which were recalculated and brought into a single tariff.
4c	Other comments
4d	Other water demand management instruments & years when these have been established and implemented (e.g. example specific restrictions for a given year when there is drought) Not used

5. Regression analysis

Analysis conducted and descriptive statistics

One model was tested where the mean delivered volume per inhabitant is regressed on the average price of drinking water.

All data are at a municipality level and for the period 2011-2015. The model is performed using an ordinary least squares (OLS) estimator. In the regression, price and water consumption were log-transformed.

Values of water consumption and water price for the period 2011-2015 are given in the template. In Tableau 8 the summary statistics of variables are presented. Below in Figure 2, water consumption per inhabitant is plotted against price.

Tableau 14: Descriptive statistics

Variable	Description	Mean	Median	Std.dev	Var	Min	Max	Nb of obs.
price	Average price per cubic meter	18,6	13,8	11,1	122,9	8,2	38,9	20
vol.inhab	Average delivered volume per inhabitant	3,231	3,105	1,226	1,502	1,530	5,340	20

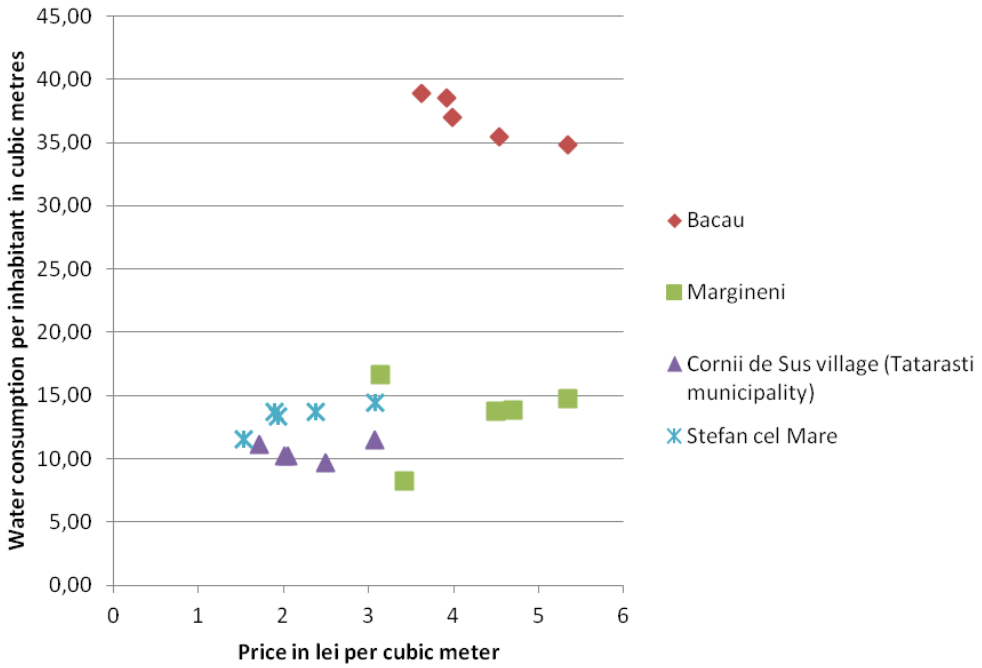


Figure 3: Water consumption and price

Model 1 - Results

Model 1: Water consumption as a function of price

Tableau 15: Regression results of model 1 - Dependent variable ln(vol_inhab)

Summary	
R2	0,32
Adj. R2	0,28
F-stat	8,4**
N	20

	Coeff.	*Std.err*
Constant	1,9675***	0,30
ln (price)	0,7376**	0,254

* p<0.05 ** p<0.01 *** p<0.001

From the regression results in table 2 we can conclude that price is significantly correlated to water demand in CRAB but due to the higher level of consumption in CRAB, this correlation cannot be interpreted to explain a potential causal effect of price on water demand (see the 5 red points on the graph above that explain the positive coefficient).

A regression without the municipality of Bacau was also tested but it was not significant.

Somes Water Company

Preliminary overview

Preliminary overview	
Region	Counties Cluj and Salaj
Operator and type of authority	Somes Water Company, organized as public company with the following shareholders: Cluj County Council, Salaj County Council, Dej Local Council, Gherla Local Council, Zalau Local Council, Huedin Local Council, Cehu Silvaniei Local Council, Simleul Silvaniei Local Council and Jibou Local Council. Since 2006, the company is a regional operator.
Geographical coverage	Somes Water Company operates in the counties Cluj and Salaj, but it does not completely cover the area of the two counties. A map displaying its coverage of the two counties is available here: http://aport.ara.ro/images/Operatori/Companii/CASOMES/COMPANIA%20DE%20APA%20SOMES.png
Area (km^2)	Information not available
Sector	Domestic sector
No. Of municipalities	Somes Water Company services 184 localities.
No. of customers	628268 inhabitants live in the area serviced by Somes Water company. The table attached shows the evolution of the connectivity to water supply and sewage systems in 4 municipalities of the area.
Type of data available	Data of price (water and sewerage), water consumption, number of customers and of inhabitants for the period 2009-2014 + size of households, mean income, share of individual houses and climate data for one year only and at the county scale
Proposed focus of the case study	Assessment of elasticity for 4 municipalities with municipality scale data
Source	1. Data from the water company; 2. Online resources http://www.casomes.ro/ http://www.recensamantromania.ro/

1. Water service description

1a	Name of the service: Somes Water Company
1b	Location (MS, Region): Romania, county Bacau
1c	Type of authority : Public company with the following shareholders: Cluj County Council, Salaj County Council, Dej Local Council, Gherla Local Council, Zalau Local Council, Huedin Local Council, Cehu Silvaniei Local Council, Simleul Silvaniei Local Council and Jibou Local Council. Since 2006, the company is a regional operator.
1d	Management type : Concession contract between the Regional Association for the Development of the Infrastructure in the Someş-Tisa River Basin (association of municipalities serviced by the water operator) and the Somes Water Company.
1e	Water Competences : Supply and Treatment
1f	Sanitation service : Yes

1g	Number of Municipalities under authority: 184 (December 2014) - 4 studied here

2. Contextual information

Information should be collected at the level of the area of authority. Detail by municipality, if the area is made of several municipalities, is not necessary unless it is easily available.

	Description of housings and population

Information should be collected for the most recent year available.

2a	Population in the area of authority: 628268 inhabitants live in the area serviced by Somes Water company, according to the last Census (2011). Population in the study area: 423 920 in 2014 (4 municipalities)
2b	Population density: According to the last census (2011), population density in Cluj county is of 98,8 inhabitants / sq. kilometre while in Salaj county the density is of 58,1 inhabitants / sq. kilometre.
2c	Household's income - in euros per household: In the North West region where the water operator provides its services, the mean household income in 2011 was of 589 EUR. There are significant differences however between the different municipalities serviced (source: Census 2011).
2d	Share of individual houses: In Cluj county, the share of individual houses is of 46,66% of the total number pf buildings, while in Salaj county the share is of 72,15% (source: Census of buildings 2011)
2e	Share of permanent housings: In 2001, the share of permanent housings was of 83% in Cluj county and of 79% in Salaj county (source: Census of buildings 2011)

	Climatic information

Information should be collected for the same period than water consumption and price data (see next section).

2f Number of days with rainfalls during spring and summer

The monthly average precipitation during spring and summer in Cluj Napoca and Zalau for the years 1961 – 1990 are the following (mm):

City	April	May	June	July	August	September
Cluj Napoca	43.3.	75.1	85.9	84.5	66.9	33
Zalau	52.4	77.3	99.1	72.2	74.8	39.7

Source: National Meteorological Administration

2g Number of days with a temperature above 28°C

Average monthly temperatures for Cluj Napoca:

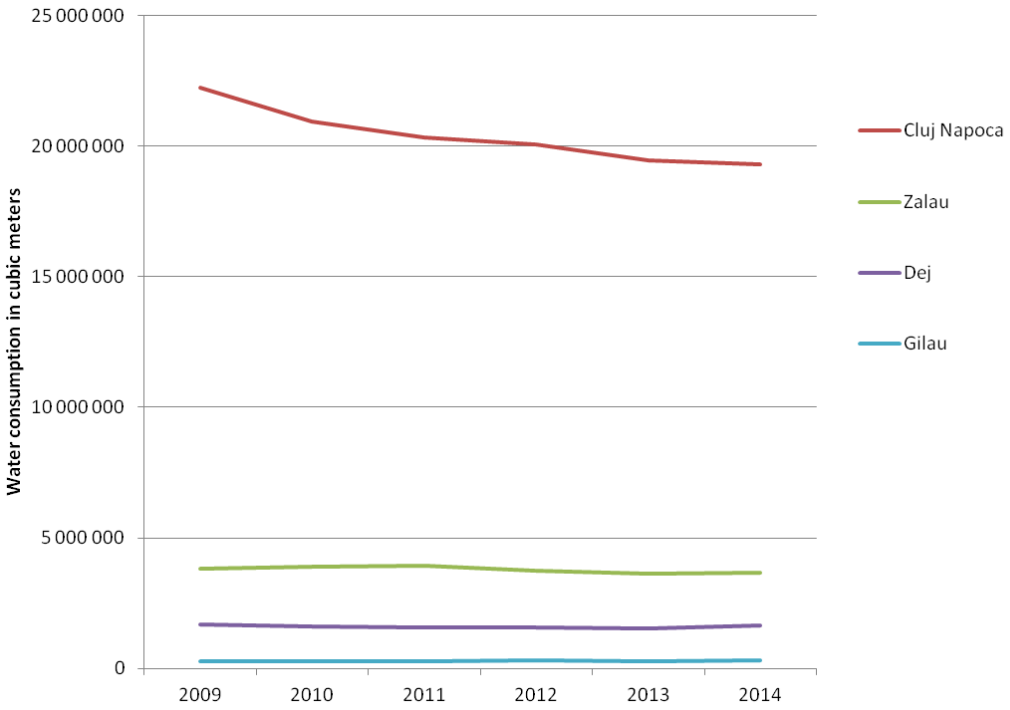
	Jan	Feb	March	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1901-2000	-4,2	-2,1	3,6	9,2	14,4	17,4	19,1	18,4	14,2	8,8	3,3	-1,4
2007	2,1	3,1	7,1	10,2	16,7	19,9	21,4	19,8	13,0	8,8	1,9	-2,6

Source: National Institute of Statistics

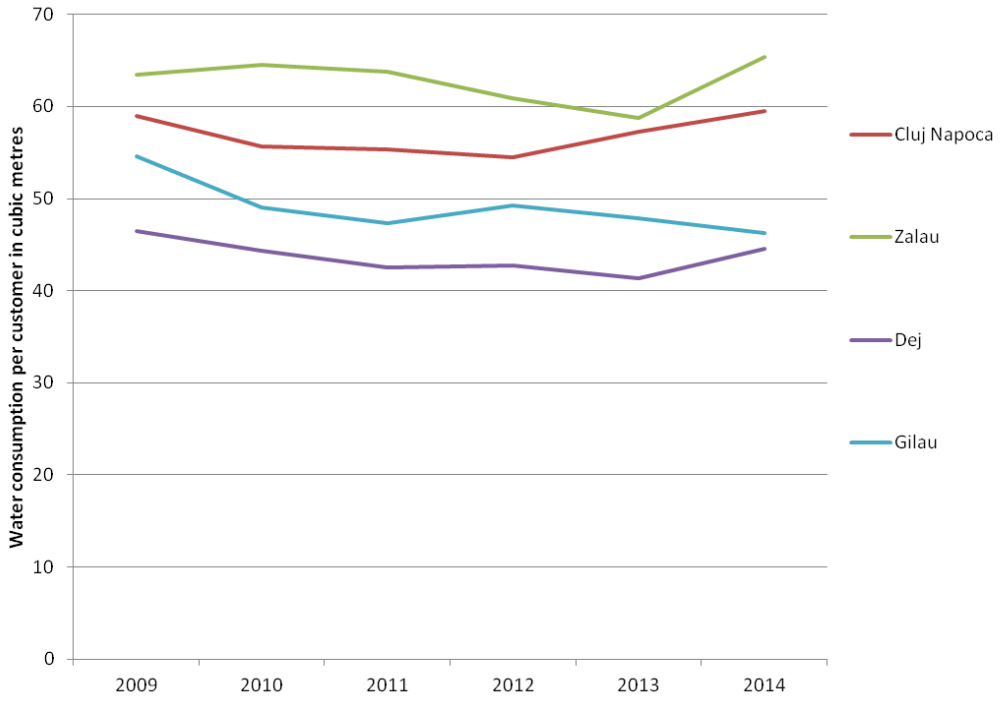
	Other descriptors of housings and population - *To be discussed*
2h	Population age (mean or distribution): Median population age in Romania is 40,6 years (Census 2011)
2i	Average household size: The average household size in Romania is 47,1 sq. meters (48,1 sq. meters in the urban areas and 45,9 sq. meters in the rural areas) (Source: Census of buildings in 2011)
2j	Average housing size: The average house size in Romania is 73 sq. meters (Source: BPIE, 2014)
2k	Share of houses with lawn: no data found
2l	Share of houses with swimming pool: no data found
2m	Share of houses with private well: no data found
2n	Equipment rate for main water saving devices (rainwater tank, flow reducers, dual-flush toilets) : no data found
2o	Equipment rate for main water consuming devices (shower vs. tub, washing machine, dishwasher) : no data found

3. Water consumption and price

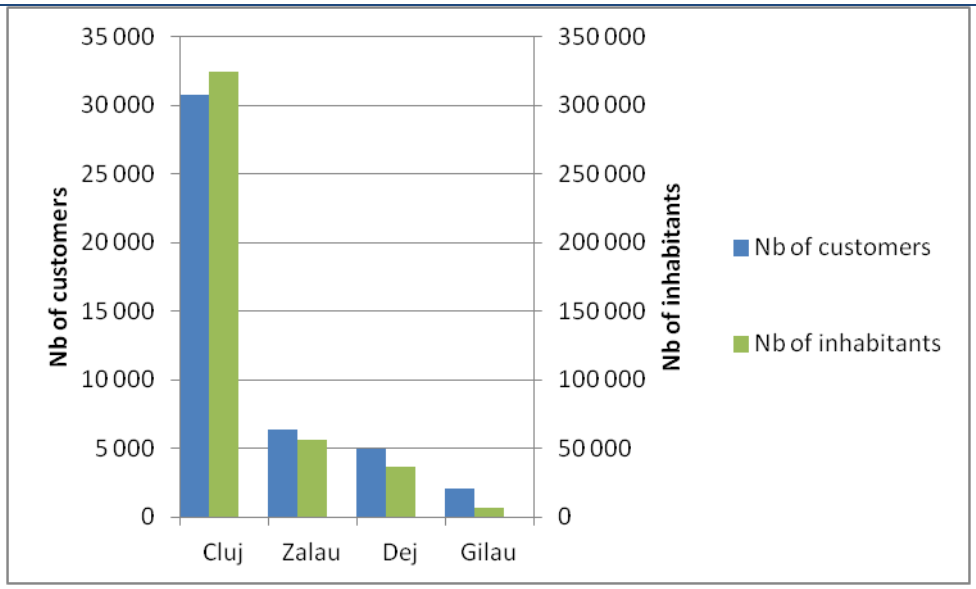
	Water Consumption data
3a	Water consumption - volume charged (domestic) See information in attached annex. 4 municipalities have been chosen for the purpose of this study: Cluj Napoca, Zalau, Dej and Gilau. The data refers to years 2009 – 2014. The same municipalities and periods have been analysed for points 3b – 3p Total consumption per municipality: total for the 4 municipalities 24 913 900 m3 in 2014



Mean consumption per inhabitant for the 4 municipalities in 2014 - mean of 59 m3/year per inhabitant



3b	Number of customers: 44 285 in 2014



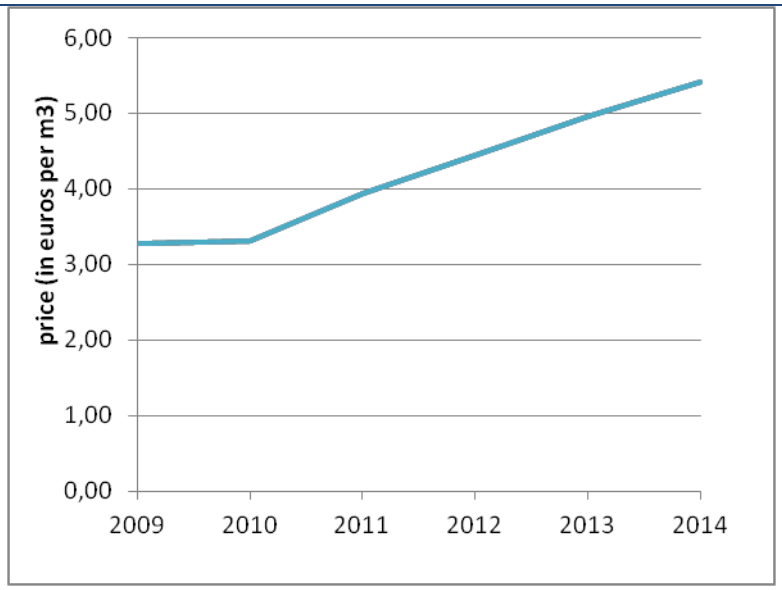
3c Population supplied: see above

3d Rate of connection to sanitation network:

Municipality		Cluj Napoca	Zalau	Dej	Gilau
Year		2014	2014	2014	2014
Rate of connection to water supply and sanitation network	Water	100%	99%	94%	77%
	Sewage	95%	98%	81%	41%
Metering rate	Water	100%	99%	100%	98%

3e Individual meters (only for houses, for all housings, a mix, other): see above

	Water Price data
3f	Structure tariff (existence of a fixed part, per-unit volume charge, block prices, free allowance) Structure: no detailed information. Since 2008, Somes water company introduced single prices for its whole area of activity. The prices and tariffs used by the water company are set by cubic meter of consumed and sewage water respectively. Global price: Bacau 5,42 lei/m3 in 2014 in the 4 municipalities

	
3g	Fixed part - Water
3h	Per-unit volume charge + Fees - Water & Sewerage
3o	Existence of other specific tariffs (lawn, other): 1) **Rainwater tariff**: rainwater that falls on the property of the users are drawn off in the public sewage system. Pricing of this service takes into consideration not just this fact, but also that rainwater needs to be treated before being released back into environment. The quantity of rainwater drawn off by the sewage system is determined by multiplying the specific quantity of rainwater, as communicated by the National Meteorological Administration for the month previous to invoicing, with the total surface of built and non-built premises, as declared by each user and with the discharge coefficient recommended by SR 1846-1:2006. 2) A **local special tax** might be established by the Local Council of the municipalities, on a determined period, additional to the water price. The Somes Water Company is just collecting the funds, the amounts being then transferred in an extra-budgetary account of the respective municipality, which decides (in consultation with the water company) on the destination of these funds. These funds can only be used for modernisation/extension works of the water supply / sewage networks in the respective municipality.
3p	Existence of a social tariff - If yes, conditions and price:

4. Other information

4a	Changes in the water service management or in the water price structure during the last years:

	The last major changes occurred during 2004 – 2006, when the company was transformed from being an autonomous public entity to a public stock company. The company started operating at a regional level and its shareholders structure reflect this situation. The prices of water supply / sewage services were consistently increased in the last years.
4b	Motivations of changes: The last major changes occurred during 2004 – 2006, when the company was transformed from being an autonomous public entity to a public stock company. The company started operating at a regional level and its shareholders structure reflect this situation. The prices of water supply / sewage services were consistently increased in the last years.
4c	Other comments
4d	Other water demand management instruments & years when these have been established and implemented (e.g. example specific restrictions for a given year when there is drought) Not used

5. Regression analysis

Analysis conducted and descriptive statistics

One model was tested where the mean delivered volume per inhabitant is regressed on the average price of drinking water.

All data are at a municipality level and for the period 2009-2014. The model is performed using an ordinary least squares (OLS) estimator. In the regression, price and water consumption were log-transformed.

Values of water consumption and water price for the period 2009-2014 are given in the template. In Tableau 8 the summary statistics of variables are presented. Below in Figure 2, water consumption per inhabitant is plotted against price.

Tableau 16: Descriptive statistics

Variable	Description	Mean	Median	Std.dev	Var	Min	Max	Nb of obs.
price	Average price per cubic meter	54,2	55,5	8,1	65,6	41,4	65,4	24
vol.inhab	Average delivered volume per inhabitant	4,129	3,935	0,827	0,685	3,268	5,420	24

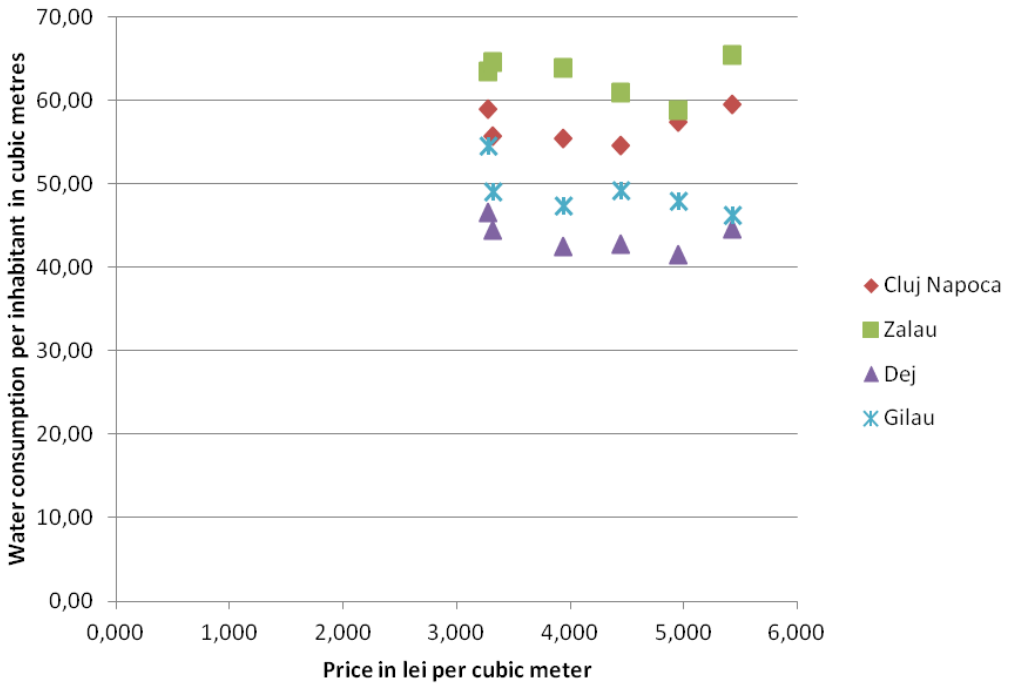


Figure 4: Water consumption and price

Model 1 - Results

Model 1: Water consumption as a function of price

Tableau 17: Regression results of model 1 - Dependent variable ln(vol_inhab)

Summary	
R2	0,01
Adj. R2	-0,03
F-stat	0,24
N	24

	Coeff.	*Std.err*
Constant	4,076***	0,23
ln (price)	-0,08	0,16

* p<0.05 ** p<0.01 *** p<0.001

From the regression results in table 2 we can conclude that the model is not significant (significance of F value > 0.05) - so that the variations of price cannot explain (even aprtly) the variations of water demand.

7. Sweden

Whole country

Preliminary overview

Preliminary overview	
Region	Nordic
Operator and type of authority	Municipal utilities
Geographical coverage	Entire Sweden, all municipalities.
Area (km^2)	
Sector	Domestic
No. Of municipalities	290 municipalities, all included in the data set. Due to some missing data we will in all likelihood use only around 190 of these.
No. of customers	To be determined No. of customers served in the study area – if the study area doesn't correspond to the whole area served by the operator (i.e. a subset is considered) please specify also the total area served by the operator
Type of data available	The data cover delivered volume and price for all 290 municipalities. In addition to this demographic, financial data etc. are readily available at the municipal level.
Proposed focus of the case study	Assessment of elasticity with a special focus on the difference between urban and rural areas.
Source	For data on supply and prices we rely on data from The Swedish Water & Wastewater Association, SWWA. For data on financial, environmental and demographic variables we rely on Statistics Sweden.

1. Water service description

1a	Name of the service
1b	Location (MS, Region)
1c	Type of authority (Municipality, Group of municipalities, Union, other)
1d	Management type (Public management, Leasing, Concession, other)
1e	Water Competences (among Supply, Supply and Treatment, Supply, Treatment and Abstraction)
1f	Sanitation service (Yes, Distinct, Unknown)
1g	Number of Municipalities under authority

2. Contextual information

	Description of housings and population

Information should be collected for the most recent year available.

2a	The population of Sweden is 9 828 000. The municipal population levels will be included in the analysis. Population in the area of authority
2b	Population density is 23,9 inhabitants per km2. Population density
2c	Household disposable income per capita is 21764 Euro. Municipal level data is available for the analysis. Household's income - in euros per capita (mean or distribution)
2d	38% of households live in individual houses. Share of individual houses
2e	There are roughly 680 000 non-permanent houses in Sweden, meaning summer and vacation houses. Share of permanent housings

	Climatic information

Information should be collected for the same period than water consumption and price data (see next section).

2f	To be determined. Number of days with rainfalls during spring and summer
2g	Very few days with temepratures above 28°C. Number of days with a temperature above 28°C

	Other descriptors of housings and population - *To be discussed*

Information should be collected for the most recent year available.

2h	Available at municipal level, and to be included in analysis. Population age (mean or distribution)
2i	Available at municipal level, and to be included in analysis. Average household size
2j	Available at municipal level, and to be included in analysis. Average house size
2k	Available at municipal level, and to be included in analysis. Share of houses with lawn
2l	Very few, i.e. too few to be included in analysis. Share of houses with swimming pool
2m	To be determined.

	Share of houses with private well
2n	Not available. Equipment rate for main water saving devices (rainwater tank, flow reducers, dual-flush toilets)
2o	Not available. Equipment rate for main water consuming devices (shower vs. tub, washing machine, dishwasher)

3. Water consumption and price

	Water Consumption data
3a	Due to some lacking data around 190 municipalities are included in the data set. The total delivered and charged volume is 417 859 597m^3. Water consumption - volume charged
3b	To be determined. Number of account holders
3c	To be determined. Population supplied
3d	To be determined. Rate of connection to sanitation network
3e	Some households are metered, some are not. Those who are not metered are charged according to their type and the typical consumption of a representative household. Individual meters (only for houses, for all housings, a mix, other)

	Water Price data
3f	The tariff usually consists of a fixed part and a volumetric part. The volumetric parts is not however metered in all cases but rather based on typical consumption of a representative household. The law on water services stipulates that charges may only cover the costs of providing the service. The municipalities have some degree of freedom in the specific design of the tariff as long as they adhere to the laws and regulations governing the supply of water. In Gothenburg, the second largest city in Sweden a house owner will pay a fixed yearly fee of 351 Euros and a volumetric charge of 1,73 Euros for drinking water and sewage services. Structure tariff (existence of a fixed part, per-unit volume charge, block prices, free allowance)
3g	Varies over municipalities, not available in data set. Fixed part - Water (if variable with diameter, domestic meters are generally 15mm)
3h	The average volumetric charge is 33 Euros per m^3. This however includes the fixed portion of those municipalities who chose to charge one. It also includes the sewage disposal charge. Per-unit volume charge (or charges if block prices) - Water
3i	Fees – Water
3j	Value added tax (25 %) is charged to consumers. Taxes – Water
3k	Fixed part – Sanitation
3l	Varies, see 3h.

	Per-unit volume charge – Sanitation
3m	Fees – Sanitation
3n	Taxes – Sanitation
3o	Existence of other specific tariffs (lawn, other)
3p	Existence of a social tariff - If yes, conditions and price

4. Regression analysis

Analysis conducted and descriptive statistics

In the following the results of two regression models for water demand in Sweden are presented. The data on water consumption were made available by the Swedish Water and Wastewater Association (SWWA). The data cover all utilities during 2014, i.e. drinking water and wastewater utilities. The Swedish system implies that each municipality is served by one utility. This further implies that explanatory variables have been collected at the municipality level, primarily from Statistics Sweden (SCB)[88].

Three separate models are estimated. The first simply regresses volume on price. The second model includes a broader range of explanatory variables, primarily socio-economic and geographic. For comparison reasons a third model is also estimated, where the yearly expenditure is used as the dependent variable and regressed on a range of independent variables. See further discussion about these below. In table 1 below all included dependent and independent variables are presented with their descriptive statistics.

Table 1 Descriptive statistics

Variable	Description	Mean	Median	Std.dev	Min	Max	Sum	N
share_indhouse	*Share of individual houses*	0,577	0,595	0,155	0,015	0,897	108	187
ln_totpriceeur	*Log of total expenditure for a yearly consumption of 120m^{3}in euros*	6,151	6,194	0,264	5,300	6,662	1 150	187
lnvolperhh	*Log of yearly water demand per household in m^3*	4,703	4,734	0,278	3,401	5,698	879	187
ln_incpercap_eur	*Log of before tax income per capita in euros*	10,206	10,175	0,122	10,025	10,829	1 909	187
urban	*Dummy, 1 if urban municipality*	0,417	0	0,494	0	1	78	187
rural	*Dummy, 1 if rural municipality*	0,080	0	0,272	0	1	15	187
other	*Dummy, 1 if other municipality*	0,503	1	0,501	0	1	94	187

[88] Data on consumption is available upon request from the SWWA. All data is for 2014 if not otherwise noted. Statistics Sweden provides all data free of charge via the web based database.

coastal	*Dummy, 1 if coastal municipality*	0,321	0	0,468	0	1	60	187

In table 2 below a correlation matrix between the included variables is presented. One can clearly observe that the dependent variable, water consumption per household and year (lnvolperhh), does not show any clear relationship with the other included variables. Some of the independent variables do show correlation with each other, which could suggest a problem of multicollinearity. This would not however affect the overall explanatory power of the model, only increase the risk of generating faulty parameter estimates. Given that an F-test of the complete model 2 below cannot reject the hypothesis that all coefficients are simultaneously equal to zero, this is a minor problem.

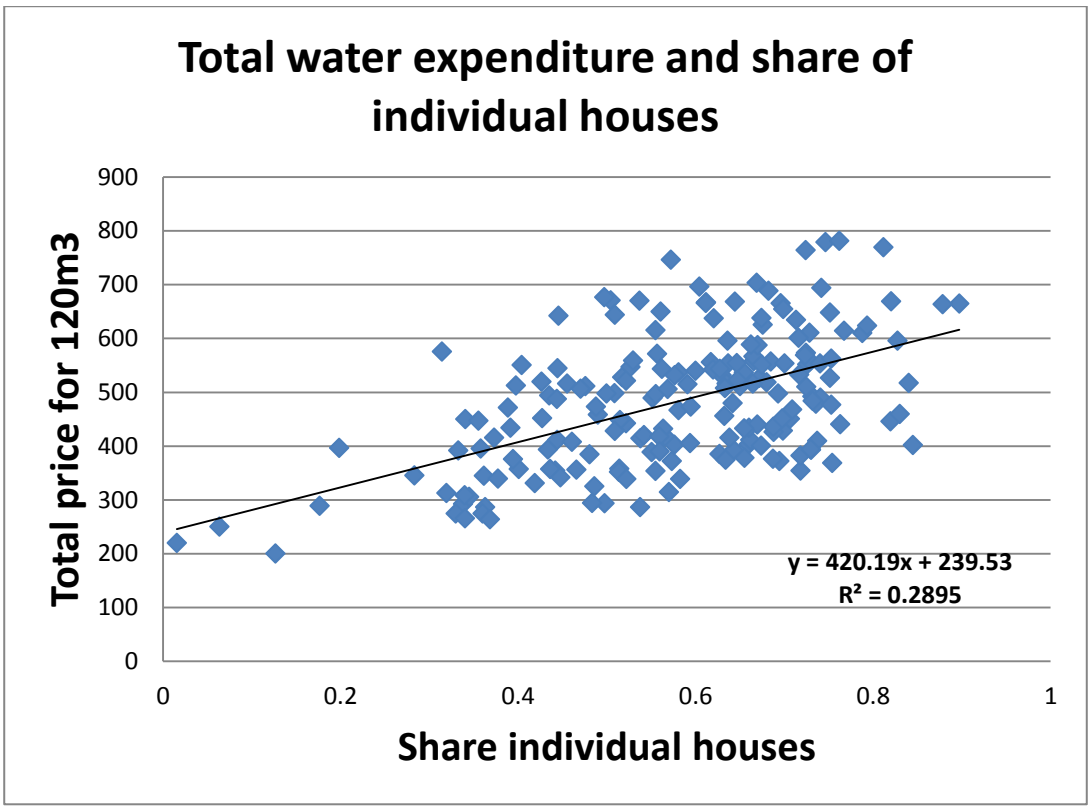
One of the more prominent relationships in the simple correlations is that between yearly household water expenditure (ln_totpriceeur) and the share of individual houses[89] (share_indhouse) (see Figure 1). We can also observe that the same relationship does not seem to hold between water consumption measured in volume (Involperhh) and the share of individual houses (share_indhouse). Based on these relationships one can suspect that water tends to be more expensive in rural and/or remote locations with higher shares of individual houses.

Table 2 Correlation matrix for included variables

	share_indhouse	***ln_totpriceeur***	***lnvolperhh***	***ln_incpercap_eur***	***urban***	***rural***	***other***	***coastal***
share_indhouse	1							
ln_totpriceeur	0,591	1						
lnvolperhh	-0,093	0,035	1					
ln_incpercap_eur	-0,220	-0,342	-0,026	1				
urban	-0,383	-0,350	0,002	0,550	1			
rural	0,089	0,188	0,058	-0,182	-0,250	1		
other	0,329	0,244	-0,033	-0,444	-0,850	-0,297	1	
coastal	-0,241	-0,107	0,030	0,285	0,255	0,050	-0,279	1

Figure 1 Total water expenditure and share of individual houses

[89] Share of individual houses is defined as the number of findividual houses divided by all other types of residences, primarily different types of apartments.



Model 1 - Results

In model 1 the log of water consumption per household is regressed on the log of the total price for a typical consumption of 120m^3 water and sewage services. The model can then be formulated as:

$$lnvolperhh = \beta_0 + \beta_1 \ln\_totpriceeur + \varepsilon \qquad (1)$$

That no significant relationship exists between the two variables is confirmed by a very low R^2, an insignificant f-test and an insignificant parameter estimate. The conclusion from this must be that price is a very poor determinant of Swedish water consumption. The results are discussed further below.

Table 3 Regression results model 1

Regression statistics	
R2	0,001
Adj R2	-0,004
Std.err.	0,278
N	187

ANOVA

	df	*SqS*	*Ls*	*F*	*p-value*
Regression	1	0,018	0,018	0,231	0,631
Residual	185	14,315	0,077		
Total	186	14,333			

	Coeff.	*Std.err*	*t-value*	*p-value*	*Lower 95%*	*Upper 95%*

Constant	4,474***	0,475	9,419	0,000	3,537	5,412
ln_totpriceeur	0,037	0,077	0,481	0,631	-0,115	0,189

The dependent variable is the log of yearly household consumption of drinking water in m^3. *** denotes statistical significance at the 1% level, ** at the 5% level an * at the 10% level.

Model 2 - Results

The second, more developed model, includes a wider range of explanatory variables whereas the dependent variable is still the log of yearly household water consumption; lnvolperhh. The model is formulated as:

$$lnvolperhh = \beta_0 + \beta_1 share\_indhouse + \beta_2 ln\_totpriceeur + \beta_3 ln\_incpercap\_eur + \beta_4 regional\ dummies + \beta_5 coastal + \varepsilon \quad (2)$$

For the vector of regional dummy variables *rural* is the baseline case and its coefficient estimate is hence not included in table 4 below. *Coastal* is a singular dummy variable, where 1 implies the municipality has a coastline, and hence not mutually exclusive with the regional dummy variables.

Table 4 Regression results model 2

Regression statistics	
R2	0,024
Adj R2	-0,014
Std.err.	0,279
N	187

ANOVA

	df	*SqS*	*Ls*	*F*	*p-value*
Regression	7	0,342	0,049	0,733	0,644
Residual	180	13,991	0,078		
Total	187	14,333			

	Coeff.	*Std.err*	*t-value*	*p-value*	*Lower 95%*	*Upper 95%*
Constant	4,397*	2,320	1,895	0,060	-0,182	8,976
share_indhouse	-0,312*	0,172	-1,810	0,072	-0,652	0,028
ln_totpriceeur	0,131	0,101	1,297	0,196	-0,068	0,330
ln_incpercap_eur	-0,027	0,209	-0,129	0,898	-0,440	0,386
urban	-0,050	0,087	-0,576	0,565	-0,221	0,121
rural						
other	-0,048	0,079	-0,606		-0,203	0,108
coastal	0,002	0,047	0,043	0,966	-0,091	0,095

The dependent variable is the log of yearly household consumption of drinking water in m^3. *** denotes statistical significance at the 1% level, ** at the 5% level an * at the 10% level.

As we can observe this development of the model does improve the explanatory power, but only marginally so. The f-test cannot reject the hypothesis that all estimated parameters are simultaneously equal to zero. The share

of individual houses (share_indhouse) is significant, but only at the ten percent level suggesting caution in interpretation.

It is interesting, and quite surprising, that a model that controls for living conditions, price level, income level and geographical location should have this low explanatory power. One possible explanation is that the variability in the explanatory variable is quite low with a standard deviation of 0.278 which can be compared to that in Denmark which is 0.617. The results further emphasize that the Swedish "market" for water in no way functions as a regular market, where price has an influence on demand. Again, this is stipulated in Swedish law, granting cost coverage as the only permissible basis for price setting for water utilities. What one may find slightly surprising is that even in the light of this, prices do still vary, as does demand and consumers should in theory be at least partly affected by price. That this does not seem to be the case could be taken as an indication of that Sweden a country historically has had an abundant supply of clean and cheap drinking water and that consumers in many senses do not treat it as a *traded good*. This could then be seen as a major obstacle if one is to implement a more incentive based pricing and consumption policy. A natural first step could be to legislate on compulsive water metering.

Model 3

We conclude from the estimations of model 1 and 2 that we can say very little about how Swedish water demand is shaped using the available data. An interesting exercise might be to instead try to explain how prices, or expenditure, are set as we already know that these are not determined by market demand. Such a model could then be formulated as

$$ln\_totpriceeur = \beta_0 + \beta_1 share\_indhouse + \beta_2 ln\_incpercap\_eur + \varepsilon \qquad (3)$$

The estimation results of (3) are given in table 5 below.

Table 5 Regression results model 3

Regression statistics	
R2	0,396
Adj R2	0,390
Std.err.	0,207
N	187

ANOVA

	df	*SqS*	*Ls*	*F*	*p-value*
Regression	2	5,150	2,575	60,390	0,000
Residual	184	7,846	0,043		
Totalt	186	12,997			

	Coeff.	*Std.err*	*t-value*	*p-value*	*Lower 95%*	*Upper 95%*
Constant	10,517***	1,308	8,041	0,000	7,937	13,098
Share_indhouse	0,922***	0,100	9,232	0,000	0,725	1,119
ln_incpercap_eur	-0,480***	0,127	-3,786	0,000	-0,730	-0,230

The dependent variable is the log of yearly household expenditure in euros for 120m^3 of water. *** denotes statistical significance at the 1% level, ** at the 5% level an * at the 10% level.

Interestingly, this is a quite well fitting model with a R^2 of around 39 % using only two explanatory variables; the share of individual houses and the log of income per capita. A more saturated model was also ran with all explanatory variables used in models 1 and 2, but ultimately these two variables were the only ones yielding significant parameter estimates. Again, this implies that household water demand has no influence on price. A model with price per m3 as the explanatory variable was also run with very similar results to the ones presented above.

The share of individual houses is positive and significant implying that in municipalities that have a larger share of individual houses, water expenditure tends to be higher. This is likely partly explained by the fact that more remote and rural communities will tend to have more individual houses and distribution of water will be more expensive in these, hence drive price upwards.

Income per capita is negative and significant, implying that in municipalities with a higher average income the price of water services will tend to be lower. This may seem counterintuitive, but is again partly related to the fact that income will tend to be lower in more rural communities and the cost of providing water services will simultaneously tend to be higher.

Conclusions

We conclude that demand for water in Sweden is not directly influenced by its price. We believe that this is both effect of legislation that stipulates cost coverage as the only permissible basis for pricing but also an effect of Swedish consumers viewing water as an abundant resource rather than a traded scarce good. This is possibly exasperated by the fact that relatively few households are directly metered for their water service charge. Neither income nor geographical location appear to be important determinants of water demand. This is slightly more surprising given that pricing is at least partly based on geographical location and the associated cost of providing water services. The results are well in line with Dalhuisen et al. (2003) whose meta-analysis report two estimates from Sweden where both are reported as ranges that cover zero. Höglund (1999) estimates long run price elasticity for Sweden and finds a marginal price elasticity of -0.10 and an average price elasticity of -0.2. Her data cover twelve years and one can speculate that the data we have may lead to estimates whose standard errors do not make it possible to separate them from zero.

There is a positive relationship between the share of individual houses and water demand. This relationship will need to be examined further at a finer geographical scale, and possibly over time, to discern the exact mechanism behind it. Another possible route is to study demand and price changes over a longer period of time to possibly estimate long run elasticities. The data to do so was not available at the time of this study.

References

Dalhuisen, Jasper M.; Florax, Raymond J.G.M.; de Groot, Henri L.F.M.; Nijkamp, Peter (2001) *Price and Income Elasticities of Residential Water Demand: Why Empirical Estimates differ*, Tinbergen Institute Discussion Paper, No. 01-057/3

Höglund, Lena (1999) *Household demand for water in Sweden with implications of a potential tax on water use.* Water Resources Research, Vol. 35, No. 12, Pp. 3853-3863,

8. United Kingdom

England – Essex and Suffolk Water

Preliminary overview

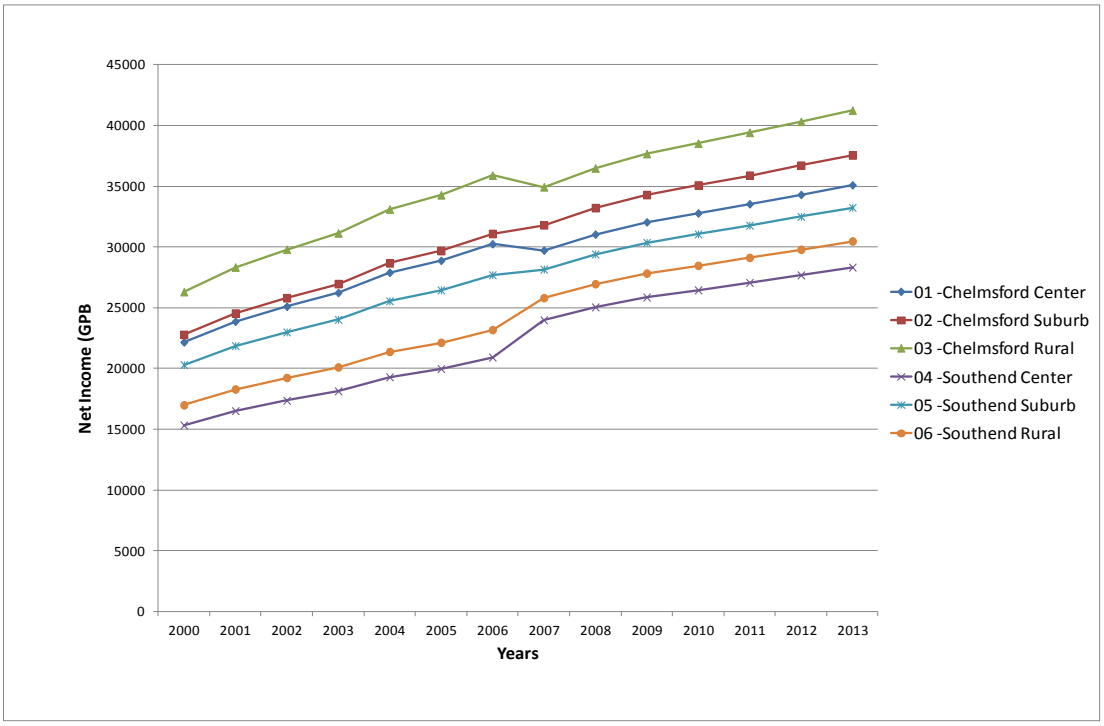
Preliminary overview	
Region	Essex, England
Operator and type of authority	Operator: Essex & Suffolk Water (private company) Authority: OFWAT (National water regulator)
Geographical coverage	Center, Suburbs and near rural areas of the towns of Chelmsford and Southend
Area (km^2)	Chelmsford = 144km2; Southend = 72km2
Sector	Domestic sector
No. Of municipalities	2 municipalities with same operator
No. of customers	
Type of data available	Data of price (water and sewerage), water consumption, number of customers for 6 areas (see above) for 2000-2013 + median income + climate data (rain and temperature) for 2000-2013
Proposed focus of the case study	Assessment of elasticity for the whole municipality with district scale data
Source	Eau de Grenoble, INSEE (French National Institute of Statistics and Economic Studies), NOAA (US National Centers for Environmental Information)

1. Water service description

1a	Name of the service: Essex and Suffolk Water
1b	Location (MS, Region): Essex, England
1c	Type of authority : Water company
1d	Management type : Private management
1e	Water Competences : Water supply only. Carries out Invoicing.
1f	Sanitation service : Wastewater treatment carried out by other company (Thames or Anglian water) – data on sewerage price from these companies
1g	Number of Municipalities under authority: Several -2 were selected for this study

2. Contextual information

	Description of housings and population
2a	Population in the area of authority: Chelmsford area: 157,072 (2001); 168,310 (2011) Southend area: 160,257 (2001), 173,658 (2011)
2b	Population density: Chelmsford area: 500 inhabitants/km²; Southend area: 41600 (2011)
2c	Household's income - in GBP per household:
2d	Share of individual houses: Chelmsford: Whole house or bungalow (detached): 30% (2001) and 30% (2011); whole house or bungalow (semi-detached): 32% (2001) and 31% (2011); whole house or bungalow (terraced): 21% (2001) and 21% (2011) Southend: Whole house or bungalow (detached): 16% (2001) and 16% (2011); whole house or bungalow (semi-detached): 32% (2001) and 31% (2011); whole house or bungalow (terraced): 19% (2001) and 18% (2011)
2e	Share of permanent housings: Chelmsford: 97,1% in 2011; Southend: 98% (2008)



Data from Neibourhood statistics : http://www.neighbourhood.statistics.gov.uk

	Climatic information

2f Number of days with rainfalls during spring and summer (1.05 to 31.08): Mean on 2000-2013: 60 days

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
74	73	65	46	58	50	61	65	68	51	52	53	82	42

2g Number of days with a maximum temperature above 28°C: Mean on 2000-2013: 6 days

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
1	7	6	12	4	9	18	1	1	2	6	3	6	11

Other descriptors of housings and population - *To be discussed*

Data from Neibourhood statistics : http://www.neighbourhood.statistics.gov.uk

2h Population age (mean or distribution): in 2011

Age	%
Less than 5	6
5-17	15
18-44	36
45-64	25
Over 65	18

2i Average household size:

Chelmsford: 64,563 households, 2,43 average size (2001). 69,667 households; 2,42 average household size (2011)

Southend: 70,978 households; 2,26 (2001). 74,678 household; 2,33 average household size (2011)

Chelmsford

Nb of occupants	1	2	3	4	5	6
% of households	27	36	16	15	5	1

Southend on sea

Nb of occupants	1	2	3	4	5	6
% of households	33	33	15	13	4	1

2j Average housing size: no data found

2k Share of houses with lawn: no data found

2l Share of houses with swimming pool: no data found

2m Share of houses with private well: no data found

2n Equipment rate for main water saving devices (rainwater tank, flow reducers, dual-flush toilets) : no data found

2o Equipment rate for main water consuming devices (shower vs. tub, washing machine, dishwasher) : no data found

3. Water consumption and price

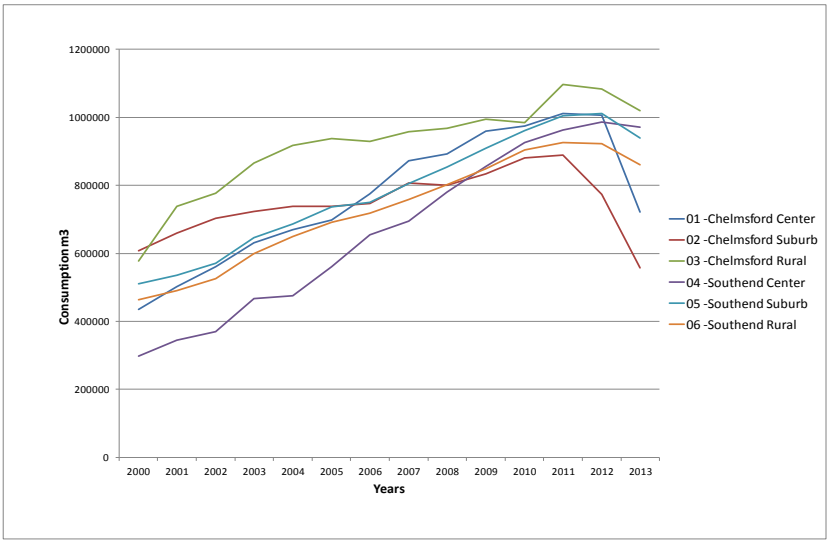
	Water Consumption data
3a	Water consumption - volume charged (domestic)

Total consumption (only on sample):

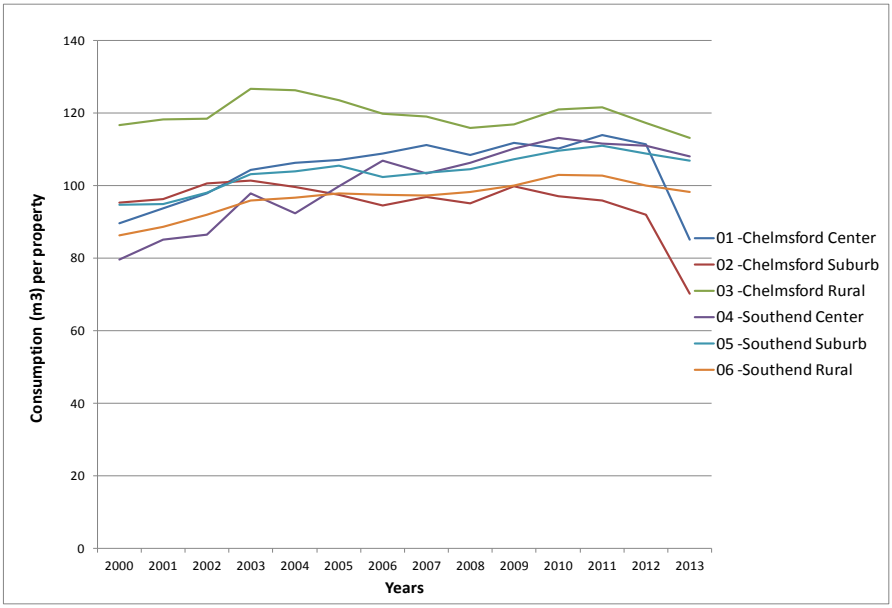
Chelmsford area: 2,300,256m^3 (2013)

Southend area : 2.770.812 m^3 (2013)

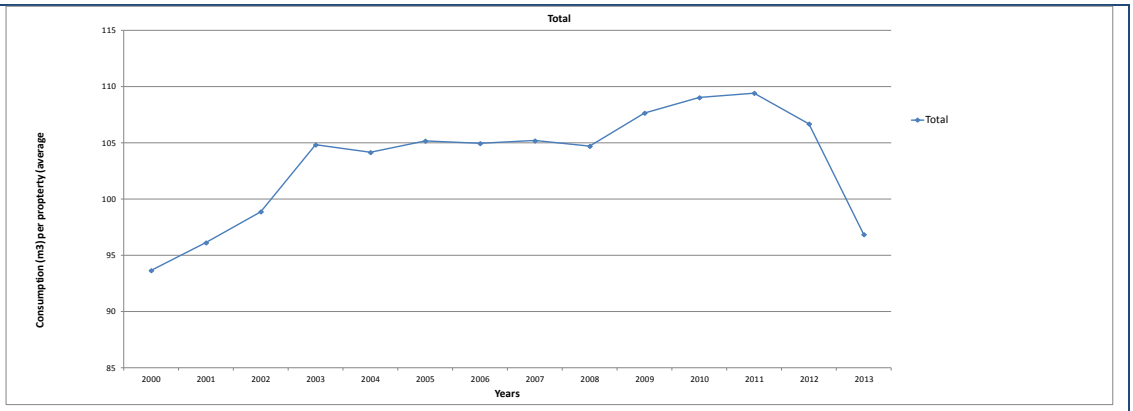
Total consumption



Consumption per property



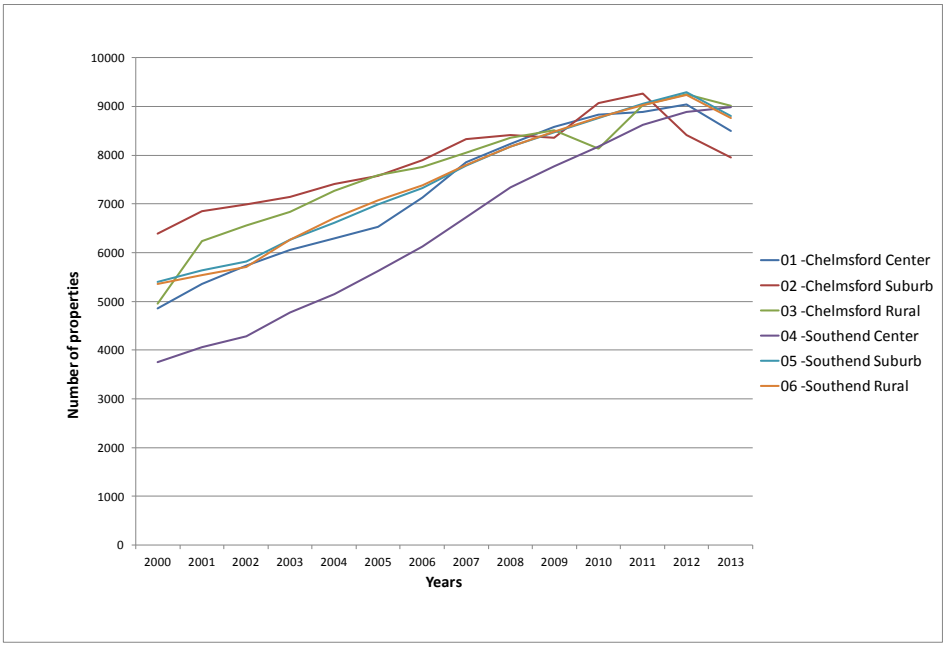
Consumption per property (average)



3b Number of account holders: only sample numbers

- Chelmsford area: 25.474 properties (2013)
- Southend area: 26.559 properties (2013)

Number of properties

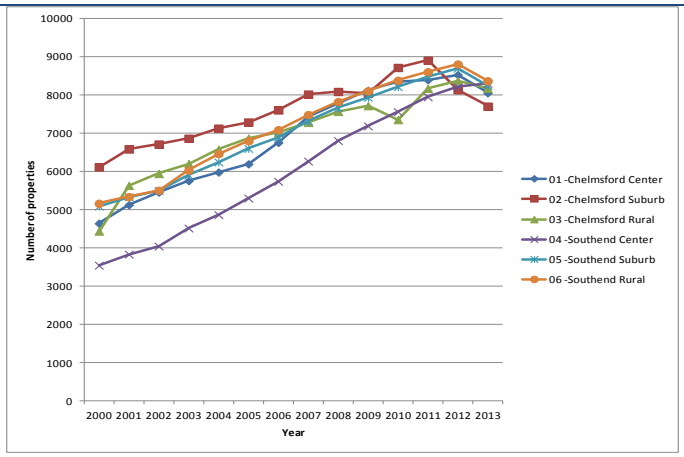


3c Population supplied:

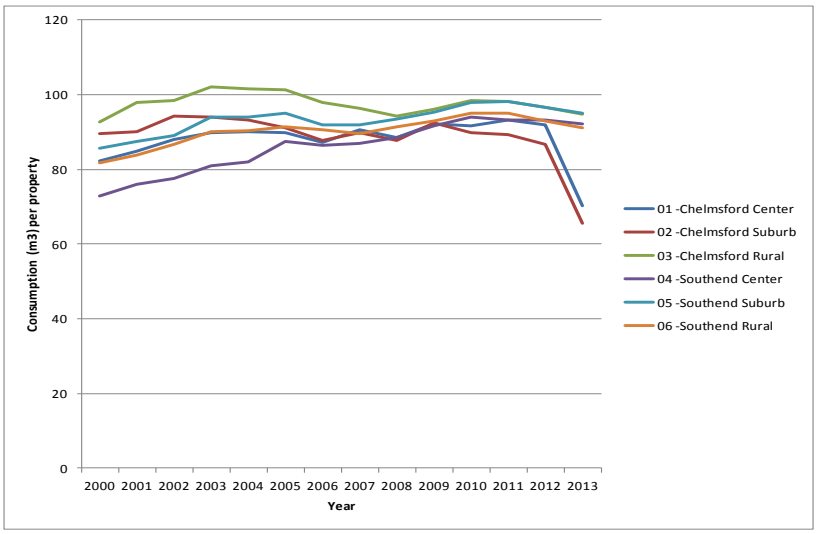
Samples for both Chelmsford and Southend areas (2013):

- Number of "low consumption" (<200m3/year) properties: 49.598 properties, ~117,795 inhabitants (assuming household size of 2,33)
- Number of large to medium consumption (>200m3) properties: 1.790

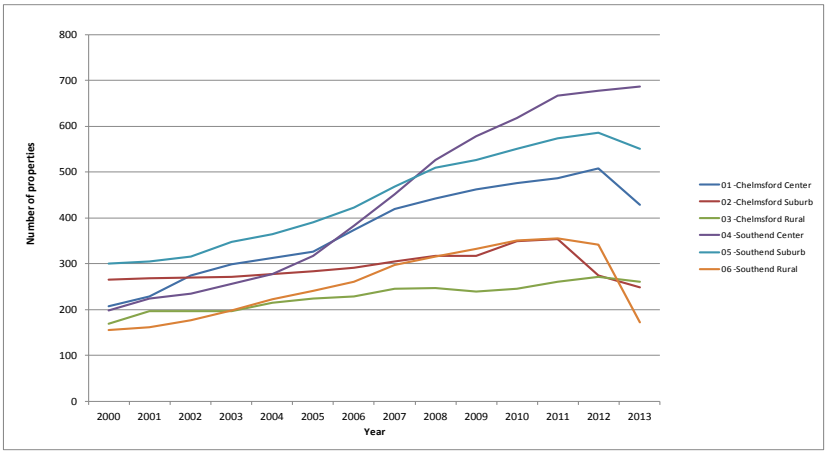
Number of "low consumption" (<200m3/year on average between 00-13) properties



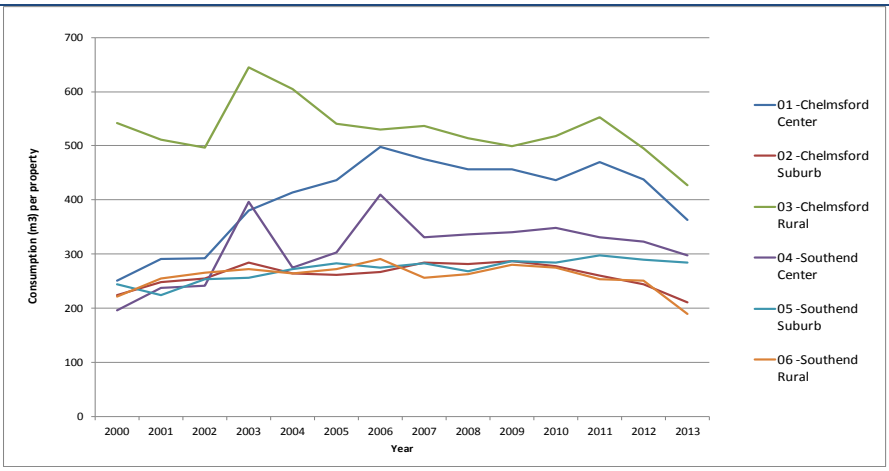
Consumption per "low consumption" (<200m3/year on average between 00-13) properties

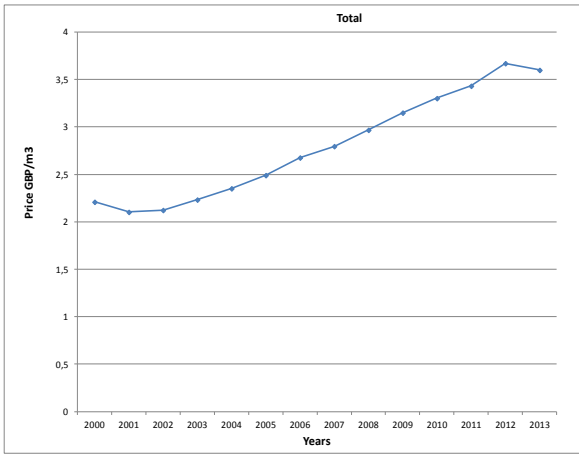


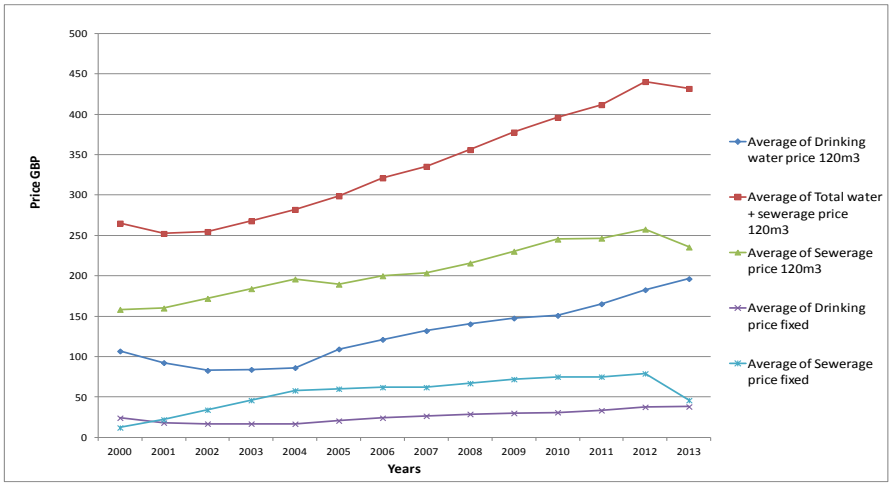
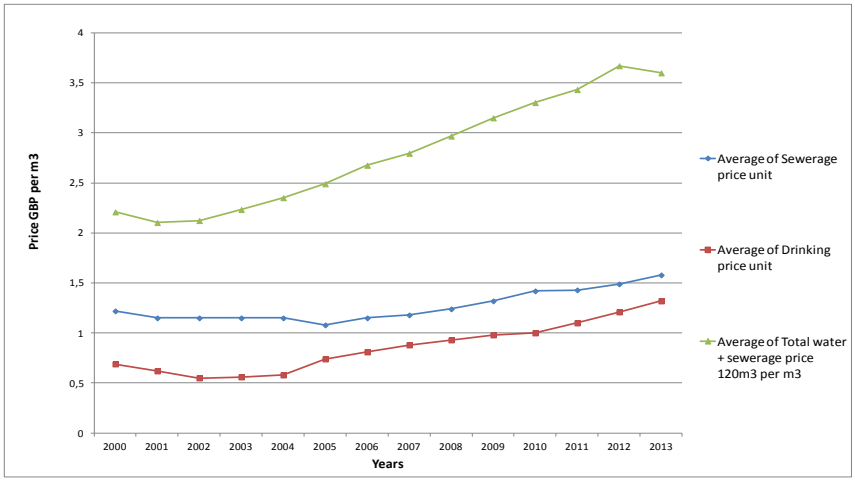
Number of large to medium consumption (>200m3/year on average between 00-13) properties



Consumption (m3) per large to medium consumption (>200m3/year on average between 00-13) properties

	
3d	Rate of connection to sanitation network: -
3e	Individual meters (only for houses, for all housings, a mix, other): Meter per property

	Water Price data
3f	Structure tariff (existence of a fixed part, per-unit volume charge, block prices, free allowance) Water: Fixed part + Volumetric part Sewerage: Fixed part + Volumetric part Global price: 3.60 GBP/m3 in 2013 for a 120 m3 consumption 
3g	Fixed part – Water

	Total price (based on 120m3) and fixed price for drinking and sewerage water 
3h	Per-unit volume charge + Fees - Water & Sewerage 
3o	Existence of other specific tariffs (lawn, other): No
3p	Existence of a social tariff - If yes, conditions and price: no .

4. Other information

4a	Changes in the water service management or in the water price structure during the last years: -
4b	Motivations of changes
4c	Other comments
4d	Other water demand management instruments & years when these have been established and implemented (e.g. example specific restrictions for a given year when there is drought) Essex and Suffolk Water carried out since 2007 the H2eco project to promote, educate and deliver water efficiency to customers. The project involves free water efficiency appointments within customer's home in a selected town or area. The visit involves a trained plumber assessing the property

and installing a range of free water saving devices wherever possible. This retrofit programme is based on financial incentives to encourage participation. It is accompanied by a wider awareness-campaign (e.g. every drop counts) with the following activities: bus shelter adverts, advan, local radio, ITV player, project vans, customary introductory mailing, pre-mailer card, invitation mailing, and reminder card. Various ways were offered to customers to respond: mail, telephone, web-site, text message, and e-mail.

Figure 10 Bus Shelter Advert

5. Regression analysis

Analysis conducted and descriptive statistics

Two models were tested:

- One where the mean delivered volume per household is regressed on the average price a household will pay for a yearly consumption of 120m^3 of drinking water (the price includes both fixed and variable costs for drinking water and sewage).
- A second model, which in addition to price also includes household's net income and the mean household's size.

All data are based on 6 samples from the region of Essex in England: 3 samples were taken from the town of Chimsford (town center, suburb and neighbouring rural areas) and 3 samples were taken from the town of Southend-on-sea (town center, suburb and neighbouring rural areas) for the period 2000-2013.

Both models are performed using an ordinary least squares (OLS) estimator. In all regression, price and water consumption were log-transformed.

Values of water consumption and water price for the period 2000-2013 are given in the template, as well as climate variables and values at sample scale of net income and household's size. In Tableau 8 the summary statistics of variables are presented. Below in Figure 2, water consumption per household is plotted against price.

Tableau 18: Descriptive statistics

year	mean	median	std.dev	variance	min	max

Total water + sewerage price 120m3 per m3	2,79	2,74	0,55	0,30	2,10	3,67
Consumption per property	103,38	103,07	10,75	115,62	70,16	126,66
income (net)	28.233	28.326	6.018	36.214.228	15.329	41.250
Household size	2,34	2,33	0,09	0,01	2,22	2,51
hot days	6	6	5	23	1	18
rainy summer days	60	60	11	129	42	82

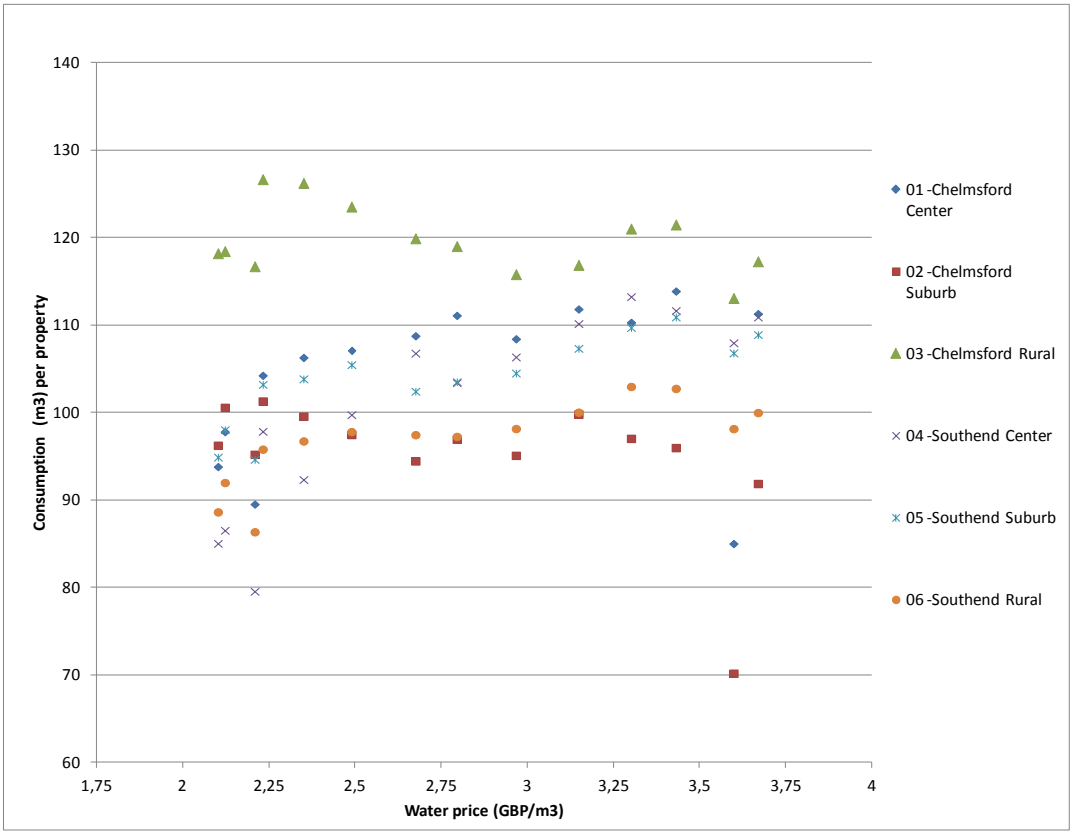


Figure 5: Water consumption and price

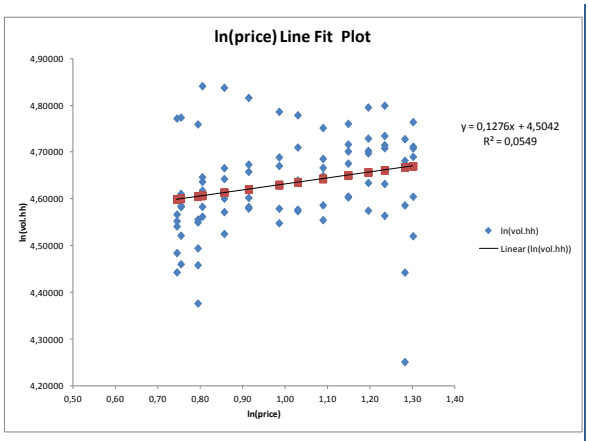
Model 1 - Results

Model 1: Water consumption as a function of price

Tableau 19: Sample 2000-2013

Summary	
R2	0,05
Adj. R2	0,04
F-stat	4,8
N	84

	Coeff.	*Std.err*	*P value*
Constant	4,504	0,06	<0,001
ln (price.120)	0,128	0,058	0,03



From the regression results in table 2 we can conclude that price is not a significant determinant of water demand in Essex. Moreover, the coefficient is positive which is inconsistent with the literature.

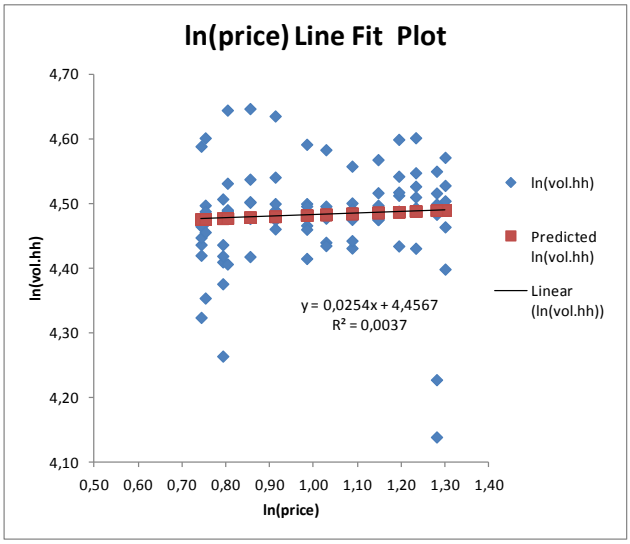
Many reasons may explain these results.

First, price elasticity was calculated on a changing sample base over time: as meters were installed across the 2000s and 2010s, additional properties with potentially different consumption patterns were considered in the analysis. To test this, a regression was performed on a sub-sample for which meter readings were available for the period 2000-2013. This focused on small consumers (=households, <200m3 per year on average between 2000-2013). Results presented below suggest that price is not a significant determinant amongst the low consumers sub-sample.

Tableau 3: Sample 2000-2013 for low cons

Summary	
R2	0,04
Adj. R2	-0,008
F-stat	0,31
N	84

	Coeff.	*Std.err*	*P value*
Constant	4,46	0,05	<0,001
ln (price.120)	0,025	0,05	0,58

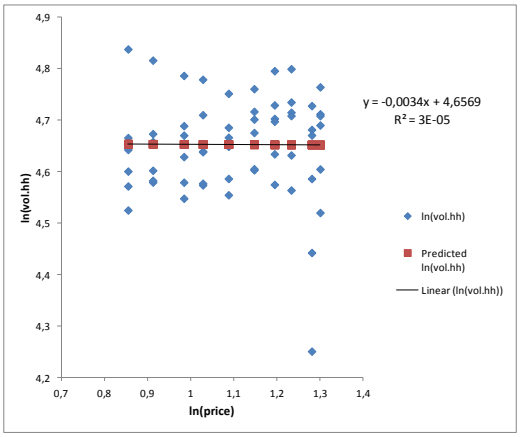


Second, as presented earlier, consumption per property has increased in the early 2000s and stabilized in the early 2010s (and reduced in some cases). Over this period, the water bill for 120m3 consumption has increased from 250 to 450 GBP. Thus, household does not seem to have responded to price changes in the 2000s. Reduction in the early 2010s may be linked to price and/or awareness-raising campaigns performed by Essex (see response to 4d). To test whether price becomes a better determinant to water demand later in the 2000s and 2010s, a regression was performed on the data between 2004 and 2013. Results below suggest that price is still not a significant determinant.

Table 4: Sample 2004-2013

Summary	
R2	2,7E-05
Adj. R2	-0,0172
F-stat	0,0016
N	60

	Coeff.	*Std.err*	*P value*
Constant	4,657	0,096	<0,001
ln (price.120)	-0,0034	0,086	0,968



Model 2 - Results

Model 2: Water consumption as a function of price / households' size / income

To test the role of other variables in influencing water demand, we ran a regression on a saturated model including all variables we had: water price, household's size, household's income, the number of hot days and the number of rainy summer days. Results suggest that none of the variables are significant determinants of water demand.

Tableau 20: Regression results of model 2 - Dependent variable ln(vol.hh)

Summary	
R2	0,33
Adj. R2	0,29
F-stat	7,65
N	84

	Coeff.	*Std.err*	*P value*
Constant	1,69	0,618	0,008
ln (price.120)	-0,08	0,08	0,332
In(income net)	0,25	0,08	0,002
Household size	0,19	0,14	0,166

Conclusions

Although water pricing appears inelastic, more recent years (2011-2013) have seen a significant reduction in the consumption per property. Three reasons are suggested: 1) meteorological reasons, 2) impact of the retrofit programme, and 3) impact of pricing following awareness-raising programme.