Czech University of Life Sciences Prague

Faculty of Economics and Management

Department of Economics

Bachelor Thesis

Evaluation of drinking water consumption by households in the CR

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CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Faculty of Economics and Management

BACHELOR THESIS ASSIGNMENT

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Economics and Management

Thesis title

Evaluation of drinking water consumption by households in the CR

Objectives of thesis

The aim of this thesis is to investigate and identify the most important determinants influencing drinking water consumption. This thesis is focused on households in the Czech Republic and their consumption and evaluates their consumption patterns.

Methodology

The methodology that will be applied to this thesis is divided into two approaches. In the theoretical part will be applied in-depth analysis that will provide deduction into the second practical part of the thesis. The second part will use methods of quantitative and qualitative research such as numerical, graphical and basic statistical methods.

The proposed extent of the thesis

35+

Keywords

water consumption, drinking water, externalities, households, Czech Republic

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Recommended information sources

Cary, J. (2008). Influencing attitudes and changing consumers' household water consumption behaviour. Water Science & Technology: Water Supply, 8(3), p.325.

Green households?: domestic consumers, environment, and sustainability. 1st pub. Editor Klaas Jan Noorman, Ton Schoot Uiterkamp. London: Earthscan Publications, 1998, xv, 267 s. ISBN 1853834815.

Salman, A., Al-Karablieh, E. and Haddadin, M. (2008). Limits of pricing policy in curtailing household water consumption under scarcity conditions. Water Policy, 10(3), p.295.

Wolters, E. (2014). Attitude–behavior consistency in household water consumption. The Social Science Journal, 51(3), pp.455-463.

Expected date of thesis defence

2015/16 SS – FEM

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Declaration

I declare that I have worked on my bachelor thesis titled "Evaluation of drinking water consumption by households in the CR" by myself and I have used only the sources mentioned at the end of the thesis. As the author of the bachelor thesis, I declare that the thesis does not break copyrights of any their person.

In Prague ……..

_____

Aleš Hojsák

Acknowledgement

I would like to thank Ing. Petr Procházka, MSc, Ph.D. for his supervision and co-operation with my bachelor thesis. Also I would like to thank all respondents that gave me a feedback and their data. Last but not least I would like to thank my family and relatives for their support over the studied years.

Vyhodnocení spotřeby pitné vody v domácnostech v České republice

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Evaluation of drinking water consumption by households in the CR

Souhrn

Tato bakalářská práce je zaměřena na vyhodnocení a popsání dosavadní spotřeby pitné vody se zaměřením na domácnosti v České republice. Cílem této práce je najít nejvíce ovlivňující determinanty v domácnostech České republiky zaměřující se na spotřebu stejně jako dokázat, že naše spotřeba vody může být nižší než doposud je.

Práce je rozdělena na dvě části. První, teoretická část týkající otázky ohledně vody se zabývá seznámením základních pojmů spotřeby vody a jejími typy. Následně je vysvětlena ekonomika spotřeby vody jako je poptávka, nabídka, elasticita a cenová stabilita. Práce také rozebírá téma vodního hospodářství, využití vody a požadavky na její kvalitu. V této části práce bude využita podrobná analýza, která pomůže lépe pochopit druhou, praktickou část.

Analytická část vyhodnocuje data na základě kvantitativního výzkumu a na základě mé vlastní případové studie týkající se spotřeby pitné vody v českých domácnostech. Následuje výzkum případové studie spotřeby vody dle jednotlivce.

Klíčová slova: spotřeba vody, pitná voda, externality, domácnosti, Česká republika, ekonomie, vodní hospodářství

Summary

The bachelor thesis focuses on the evaluation and description of current drinking water consumption with a focus on households in the Czech Republic. The goal of this work is to find the most influencing determiner in our households measured by consumption, as well as prove that our drinking water consumption can be lower than it already is.

The thesis is divided into two parts. The first theoretical part for water issue defines and introduces basic terms about water consumption and their types. Water economy, such as demand, supply, inelasticity and price stability. It also discusses the water industry, usage of water and water quality requirements. In-depth analysis will be used which will provide understating for the second part.

The second, analytical part, evaluates results based on quantitative research in my own case study on water treatment in Czech households and their evaluation. This is followed by research of my own consumption of drinking water.

Key words: water consumption, drinking water, externalities, households, Czech republic, economics, water industry

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List of Abbreviations

CZK – Czech crown

OECD – Organization for economic co-operation and development

PDF - Portable Document Format

PVK, a.s. – Pražské vodovody a kanalizace/Prague's water mains and sewerage

Sb. – sbírka zákonů/Collection of Laws

VÚME – Vybrané údaje majetkové evidence/ Selected data of property register

VÚPE - Vybrané údaje provozní evidence/ Selected operating records

WHO – World Health Organization

1. Introduction

Dealing with water issues in today's world is one of the most important topics to discuss. Society's dependence on water and economical aspects in an environmental view is more than clear in this area. There is plenty of water in the world, but this statement is not true for drinking water, which can be consumed by people. Due to the increasing price of water and the increasing number of people living on this planet it is time to think about water usage and water saving behavior.

I have been interested in water scarcity for a long time, therefore I chose this topic as the theme for my bachelor thesis.
This bachelor thesis focuses on drinking water consumption in households in the Czech Republic and proving that our drinking water consumption can be lower than it is.

The work is divided into two parts. The theoretical part, where basic terms and terminology are explained as well as the economical properties of water, which includes supply, demand, price stability or inelasticity. It also deals with the water industry in the Czech Republic and issues connected with water pipelines and water quality requirements.

In the analytical part of this thesis the author will be focused on a case study concerning the drinking water consumption in a neighborhood, in his family and research on his own consumption of drinking water. The author will be using quantitative methods in primary and secondary data research.

The first part of the case study will process and evaluate data from a building, where six families are living and the data can be proved to be very solid and relative.

The second part will be focused on the author's family's drinking water consumption and the price for each water activity.

The last part of the analytical section will consist of the author's self-research of drinking water consumption done on himself.

2. Thesis objectives and methodology

2.1. Objectives

The aim of this thesis is to give a general overview of water consumption in the Czech Republic. The theoretical part consists of base terminology, types of water consumption, the water industry, the quality of drinking water, water laws and decrees.
The analytical part is focused on the evaluation of water consumption and proving that our consumption can be lower than it is nowadays. Used data will be collected with the help of primary data research.

2.2. Methodology

The basis of the theoretical part is based on professional books found, which deal with the water industry in the Czech Republic and refer to water laws and acts. Materials for this topic are hard to find as there are little available. Especially when the work requires actuality. In this case the theoretical part is completed with the help of web presentations and books in PDF format. Trustworthy web pages such as Ministry of Agriculture, Ministry of the Environment, statistical office or OECD have been used.

In the first topic of the analytical part, water consumption during the last 10 years is evaluated. Linear trend lines are used in the analysis. Data obtained by primary data research and their evaluation with graphs and correlation analysis are used for the next topics. This type of obtaining data was chosen because of their fitness to the research and high level of control while the data is collected.

3. Theoretical part for water issue

3.1. Terminology

Water rates; payments for delivering water from public pipelines and its distribution. It's obligatory to pay for water when water from public pipelines reach the water meter connected to your household pipeline. The owner or operator of water pipelines have the right for water charges.[1]

Sewer rates; payments for the outflow of public sewage via a sewerage system and sewage treatment. Obligation of the consumer is valid when sewage reaches the sewerage system. The owner or operator of the sewerage system has the right for the sewer charges. The price of sewage usually creates half of total price of water. [2]

Drinking water; also known as potable water or tap water, is water safe enough for drinking and food preparation. Drinking water must have physico-chemical properties, which aren't harmful for health. Drinking water must not contain microorganisms, parasites or any other sort in the number of concentration that could endanger public health and which quality responds to regulation no. 252/2004 Sb., in valid reading. [3, 4]

Rainwater; water fallen as rain that has not collected soluble matter from the soil and is therefore soft [5]

Water pipeline; operationally separate file of buildings and equipment including water mains and water supply objects, ie. especially buildings for the collection and sampling of surface water or groundwater, its modification and accumulation. [6]

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[1] Vodárna. Vodárna Plzeň, a.s. [online]. [cit. 2016-01-25]. Available on: http://www.vodarna.cz/zakaznici/fakturace-a-ceny/vodne-a-stocne/

[2] Vodárna. Vodárna Plzeň, a.s. [online]. [cit. 2016-01-25]. Available on: http://www.vodarna.cz/zakaznici/fakturace-a-ceny/vodne-a-stocne/

[3] PROJECT ISA S.R.O. Technické standardy pro vodárenská zařízení ve správě TS Hostivice [online]. Hostivice: Ministerstvo Zemědělství, 2010, 34 [cit. 2016-01-20]. Available on: http://www.ts.hostivice.cz/wp-content/uploads/VODOVOD_textova_cast.pdf

[4] Vyhláška č. 252/2004 Sb. kterou se stanoví hygienické požadavky na pitnou a teplou vodu a četnost a rozsah kontroly pitné vody. In: . 2004, 252/2004.

[5] Zákon č. 254/2001 Sb. o vodách a o změně některých zákonů (vodní zákon). In: . 2001, 254/2001.

Surface water; water naturally occurring on the Earth's surface; it does not lose its character when temporarily running through covered sections, natural underground cavities or aboveground pipes.
A surface water body is a discrete accumulation of surface water in a defined environment, for example in a lake, water reservoir or in a watercourse.[7]

Groundwater; water naturally occurring below the Earth's surface in the saturation zone in direct contact with rock; water running through drainage systems and well water is also considered to be groundwater.
A groundwater body is a discrete accumulation of groundwater in a given aquifer or aquifers; an aquifer is considered to be a rock stratum or group of strata with sufficient permeability to allow significant continuous accumulation of groundwater or its flow or abstraction. [8]

River basin; an area from which all surface water flows through a network of watercourses to a defined location in a river (normally a confluence with another watercourse or the point of discharge into another water body). A river basin is delimited by a watershed boundary, i.e. a border representing the geomorphological interface between two neighboring river basins. The river basin area also includes the area of surface water bodies within the river basin. [9]

3.2. Water consumption in general

In this thesis "water consumption" is the portion of water use that is not returned to the original water source after being withdrawn. It's water that is no longer available because it has evaporated, been transpired by plants, incorporated into products or crops, consumed

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[6] PROJECT ISA S.R.O. Technické standardy pro vodárenská zařízení ve správě TS Hostivice [online]. Hostivice: Ministerstvo Zemědělství, 2010, , 34 [cit. 2016-01-20]. Available on: http://www.ts.hostivice.cz/wp-content/uploads/VODOVOD_textova_cast.pdf

[7] Zákon č. 254/2001 Sb. o vodách a o změně některých zákonů (vodní zákon). In: . 2001, 254/2001. The Water Act. In: . Prague: The Parliament of the Czech Republic, 2001, 254/2001

[8] Zákon č. 254/2001 Sb. o vodách a o změně některých zákonů (vodní zákon). In: . 2001, 254/2001. The Water Act. In: . Prague: The Parliament of the Czech Republic, 2001, 254/2001.

[9] The Water Act. In: . Prague: The Parliament of the Czech Republic, 2001, 254/2001.

by people or livestock, or otherwise removed from the immediate water environment. It does not include consumption by the public sector nor intermediate consumption of products and services in the productive sector. The term also refers to a sequence of choices and actions by households including the "selection, purchase, use, maintenance, repair and disposal of any product or service".

The difference between water intake (the amount of water withdrawn from the source) and discharge water (the amount that is returned) is the amount consumed.

Formula: Water intake – Water discharge = Consumption [10]

3.3. Economics of water

Water is the number 1 necessity that we need. Households or family farms could not produce and even could not exist, if we had no water. It's a topic that affects everybody; small businesses, major global industries and computer manufactures. Likewise, poor water quality or limited access to water means higher costs for all king of households or businesses, for all who have demand for it. Scarcity of water has a negative impact on their competitiveness among community of rivals. In the 21st century water became "the new oil". Water determines the economy and the position of a certain state. Our job is to manage water properly, so that water scarcity will not affect the local and global ability to grow and create jobs. [11,12]

Demand and supply

Definition of demand

In the Czech market there are people who are willing to buy drinking water for a certain price. These people determine the demand of drinking water in a certain time and at a

[10] Towards Sustainable Household Consumption? [online]. OECD, 2002 [cit. 2016-02-03]. ISBN 9789264175068. Available on: http://www.keepeek.com/Digital-Asset-Management/oecd/environment/towards-sustainable-household-consumption_9789264175068-en#page5

[11] Economic implications [online]. [cit. 2016-02-07]. Available on: http://growingblue.com/implications-of-growth/economic-implications/

[12] HOLMAN, Robert a Dana POSPÍCHALOVÁ. Úvod do ekonomie pro střední školy. 2. Praha: C. H. Beck, 2012. ISBN 978-80-719-304-5.

certain place. Demand for drinking water is a decreasing trend caused by increasing prices. [13]

Definition of supply

Suppliers determine the amount of drinking water in the market in a certain time and at a certain place. In our domestic market there are suppliers of drinking water, who are trying to sell at the best price. [14]

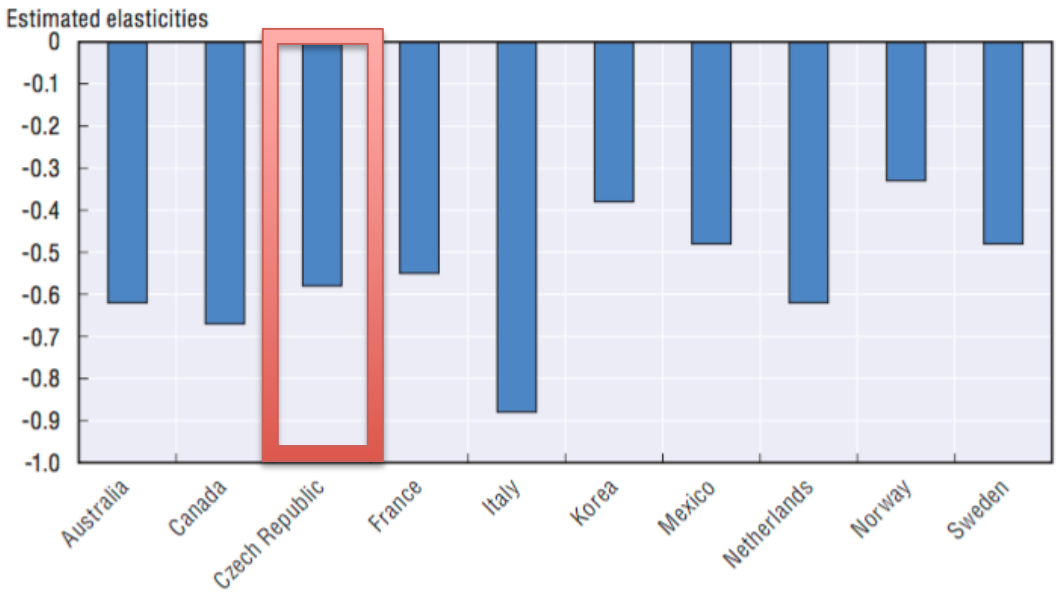
Inelasticity

Drinking water has no subsidy, no alternative choice. We cannot reduce our consumption of drinking water, everybody needs it every day. If the water company increases the cost of water, our consumption would be the same; people would keep buying it. It would have to be very expensive for people to disconnect their water supply. This is why drinking water is inelastic and regulated. [15]

The results in figure no. 1 indicate that a one per cent increase in the average water price across households would lower residential water use by about 0.56 per cent. Water demand of high-income households is less price elastic than the water demand of low and medium-income households.

[13] HOLMAN, Robert a Dana POSPÍCHALOVÁ. Úvod do ekonomie pro střední školy. 2. Praha: C. H. Beck, 2012. ISBN 978-80-719-304-5.
[14] HOLMAN, Robert a Dana POSPÍCHALOVÁ. Úvod do ekonomie pro střední školy. 2. Praha: C. H. Beck, 2012. ISBN 978-80-719-304-5.
[15] HOLMAN, Robert a Dana POSPÍCHALOVÁ. Úvod do ekonomie pro střední školy. 2. Praha: C. H. Beck, 2012. ISBN 978-80-719-304-5

Figure 1, Estimated elasticity in the CR



Source: OECD Project on Household Behavior and Environmental Policy [16]

3.4. Price stability and competitiveness of the Czech Republic's water market

During the last few decades, prices for drinking water have been increasing, which has lead to a consecutive decrease in price. Price stability is one of the central goals of most governments and central banks.

Nowadays we are not aware what the price stability of water is. Water was an indicator for public welfare. In the past, if there was a drought, the price went immediately up. There were no water reservoirs. So in the past people had to collet water in all possible ways, which today's people can't imagine doing.

The price of water has subordinate commonly known rules, which have to observe all operators of water pipelines and sewerage systems. Its price can be changes only through strictly set regulations by the Ministry of Finance.

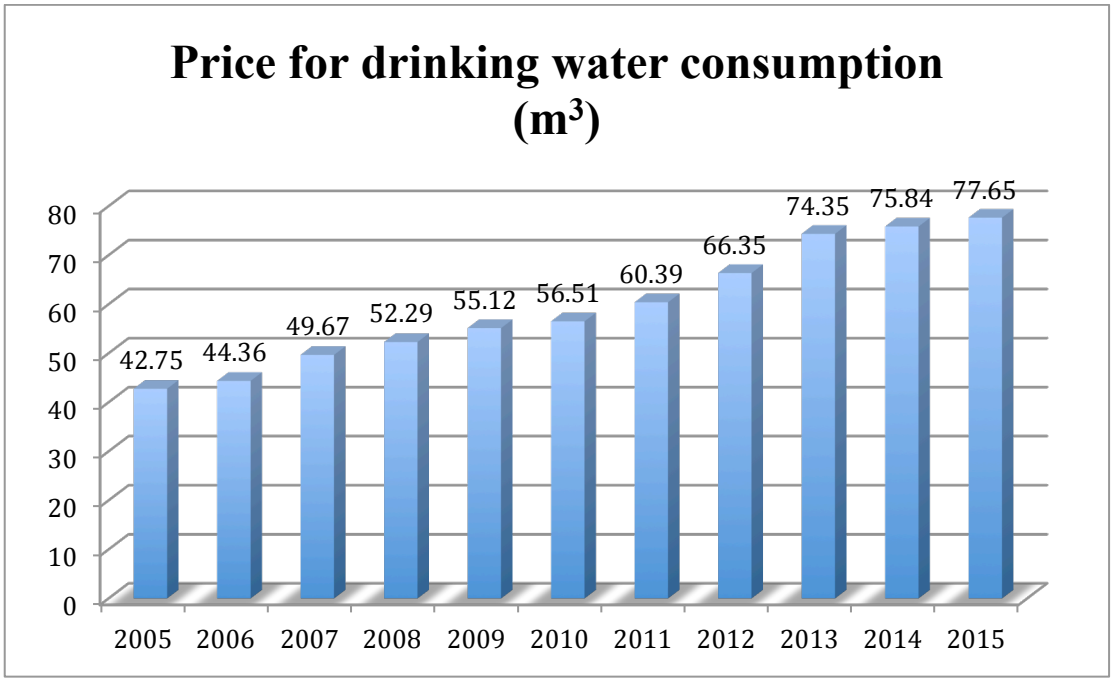
The State's Ministry of Finance regulates water and sewer rates, because water companies derive prices from price notice by he Ministry of Finance, which is set always to the 1st of January for the next calendar year. The price of water and sewer rates are usually set once

[16] OECD (2011), Greening Household Behavior: The Role of Public Policy, OECD Publishing. http://dx.doi.org/10.1787/9789264096875-en

a year and apply to all customers in a certain region. [17] [18]

In figure no. 2 below we can see water and sewer rate prices per 1 cubic liter (price includes tax). Prices are constantly rising over the years.

Figure 2, Price per cubic liter for drinking water consumption



Source: For processing of the graph, were used data from PVK, a.s.[19]

3.5. Impacts of water consumption on the environment

There are two main environmental impacts of water consumption: water abstraction and depletion and water pollution. Although the Czech Republic does not face water scarcity problems, extensive arid or semi-arid areas exist where development is restricted by water supply. Urban and rural communities are also increasingly competing with other water

[17] Ministry of Finance [online]. [cit. 2016-01-13]. Available on: http://www.mfcr.cz/en/
[18] Prague water mains and sewerage. Pvk.cz [online]. [cit. 2016-12-06]. Available on: http://www.pvk.cz/vse-o-vode/pitna-voda/
[19] Prague water mains and sewerage. Pvk.cz [online]. [cit. 2016-12-06]. Available on: http://www.pvk.cz/vse-o-vode/pitna-voda/

users, while cities in the CR are facing rising costs to supply water of drinking quality and sanitation facilities to urban residents. [20]

3.6. Water consumption and economy in the Czech Republic

There are many ways to save your household consumption. Savings are achievable through installation of armatures e.g. (lever batteries or economical shower head) or buying new eco-friendly and save-efficient facilities such as washing machines or dishwashers. [21]

The basic unit, which measures water consumption is 1 liter. The water industry is using 1 cubic liter = $1m^3$ = 1000l. The first measurement of water consumption in the Czech Republic is dated in 1760. In the 18^{th} century daily consumption was 20 liters per capita. Consumption was rising till 1965, when it reached 300liters/day/capita. After The Velvet Revolution, water consumption has been decreasing until now, because the price of water was made by its expenditures. In 2010, our daily consumption was 120liters/day/capita in comparison to the USA, which was 300liters/day/capita. The hygienic minimum, which was set by the WHO is 100liters/day/capita.

We can say that water consumption has been increasing since the 18^{th} century till the era of communism. This was caused by progress and development of the water industry and water pipelines in all villages in the Czech Republic. In the era of communism the main problem was the negligible price of water, which led us to the highest consumption of water in the Czech Republic. [22]

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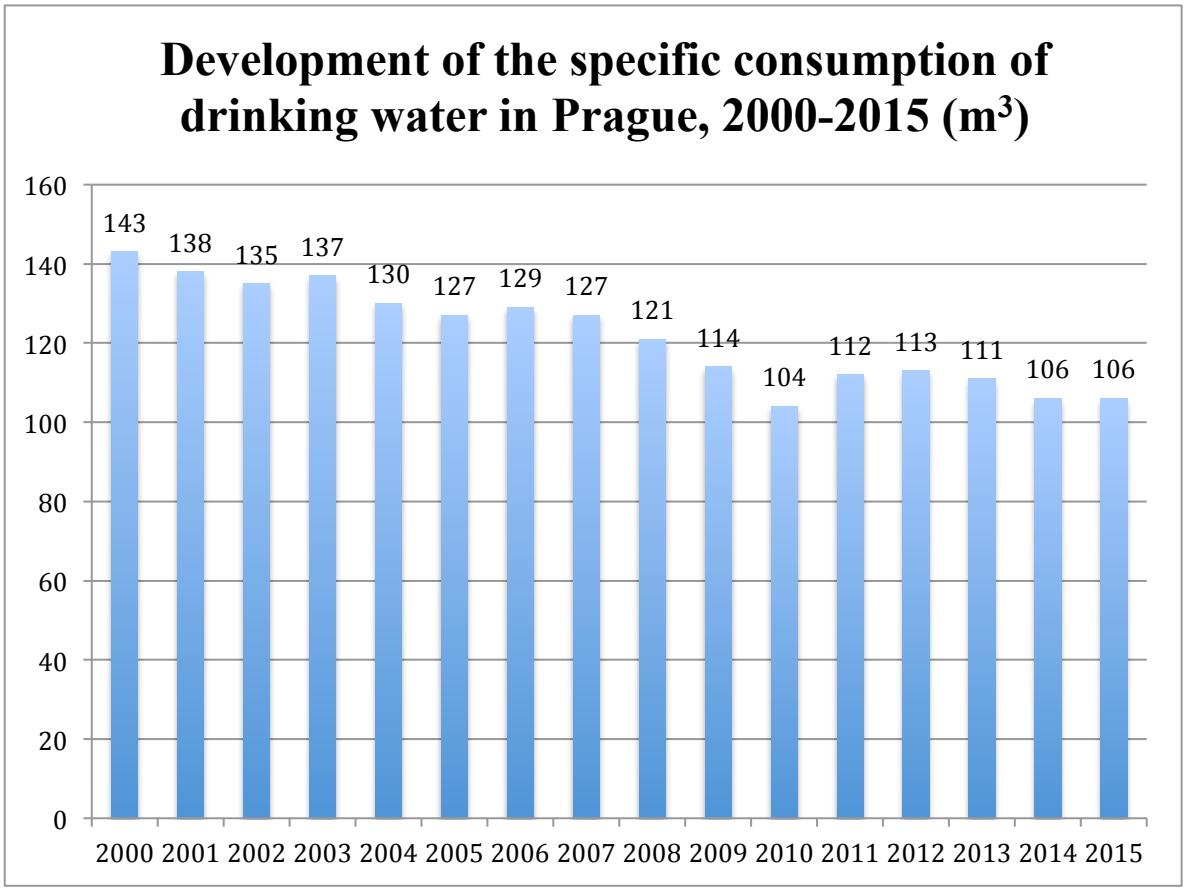
[20] OECD (2011), Greening Household Behaviour: The Role of Public Policy, OECD Publishing. http://dx.doi.org/10.1787/9789264096875-en

[21] Water consumption. Voda.tzb-info.cz [online]. [cit. 2015-11-25]. Available on: http://voda.tzb-info.cz/7546-vyrazne-snizeni-smernych-cisel-potreby-vody

[22] Water consumption. Ondeo.cz [online]. [cit. 2015-11-20]. Available on: http://www.ondeo.cz/cs/co-chcete-vedet-o-vode/informace-spotrebitelum-vody/spotreba-vody

Prague water mains and sewerage. Pvk.cz [online]. [cit. 2016-12-06]. Available on: http://www.pvk.cz/vse-o-vode/pitna-voda/

Figure 3, Development of specific consumption of drinking water in Prague[23]



Source: For own processing of the graph, were used data from PVK, a.s.[24]

3.7. Use of rainwater

In our houses we use drinking water for activities which could be replaced by rainwater. Toilet flushing, washing machines, gardening, car washing these are all activities, which could be replaced by rainwater instead of drinking water.

In the Czech Republic households on average consume only 8% of total fresh water withdrawals, compared to 65% for industry and 27% for agriculture. [25]

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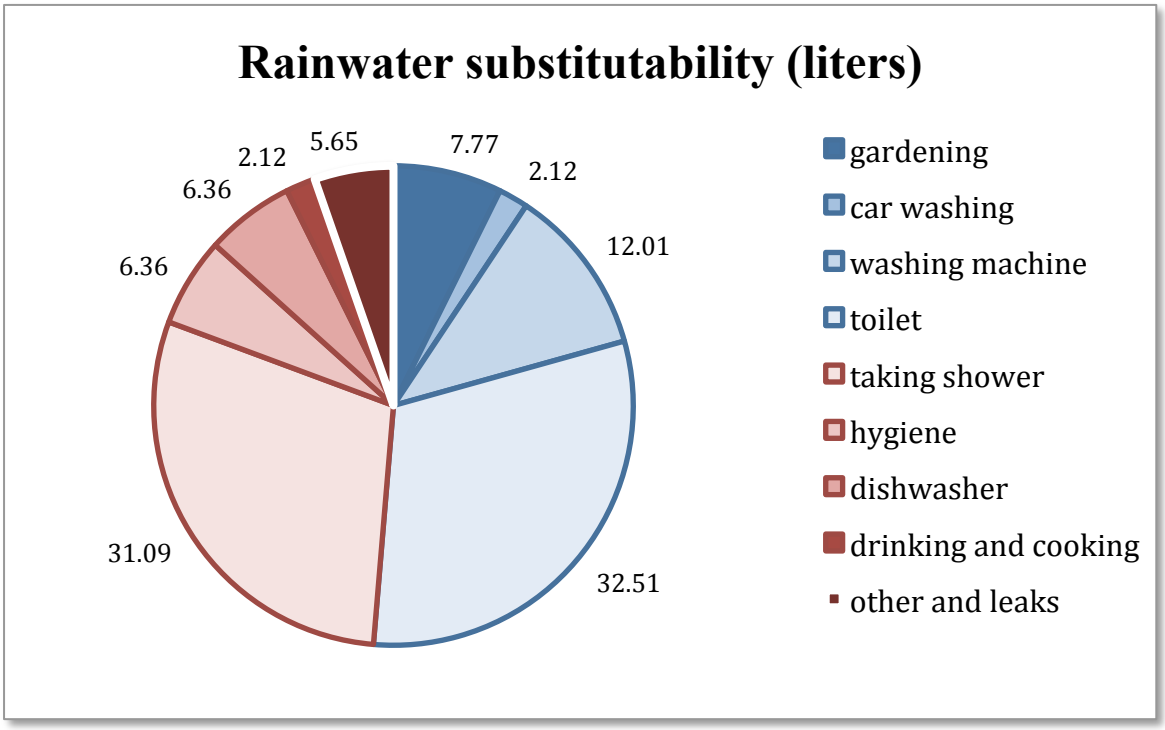
[23] CITY OF PRAGUE – PRAGUE CITY HALL. Prague Environment 2012 [online]. Prague: Aladin Agency, 2014 [cit. 2016-01-15]. Available on: http://envis.praha-mesto.cz/(hywt1045wxfwsx550gkyka55)/rocenky/Pr12_pdf/RZP12_strucna.pdf

[24] Prague water mains and sewerage. Pvk.cz [online]. [cit. 2016-12-06]. Available on: http://www.pvk.cz/vse-o-vode/pitna-voda/

[25] OECD (2011), Greening Household Behavior: The Role of Public Policy, OECD Publishing. http://dx.doi.org/10.1787/9789264096875-en

The figure no. 4 below shows the usage of drinking water consumption. More than a half (77 liters) of used drinking water can be replaced by rainwater. This includes toilet flushing, washing machines, gardening and car washing. [26]

Figure 4, Rainwater substitutability in liters per day



Source: For own processing of the graph, were used data from PVK, a.s and idnes.cz[27]

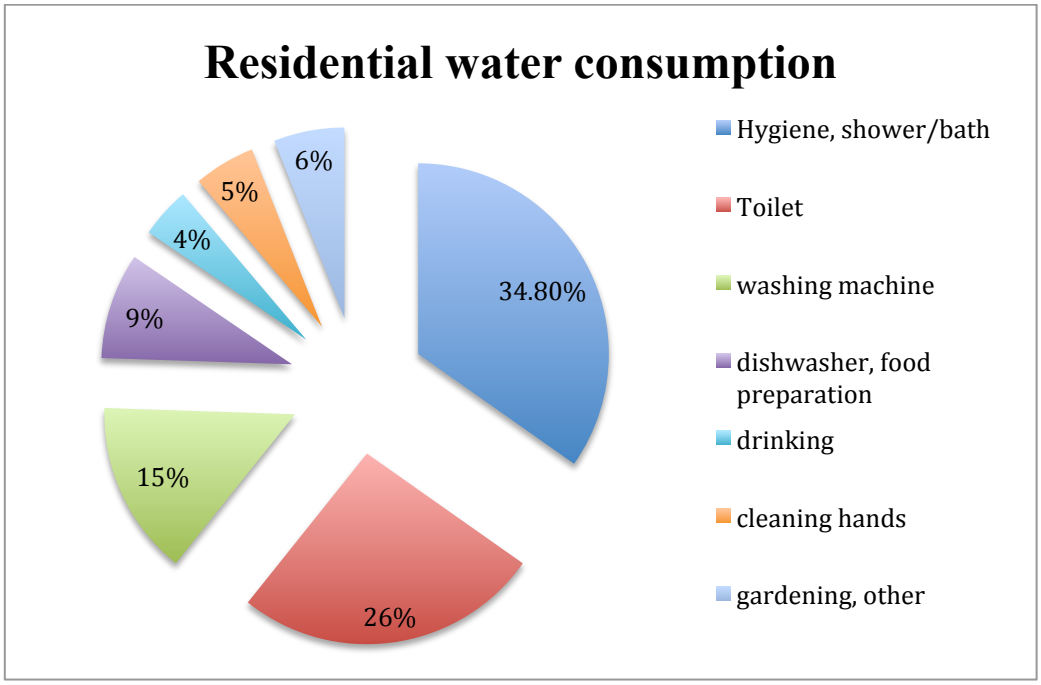
[26] Use of rainfall water. Idnes.cz [online]. 2012 [cit. 2016-12-03]. Available on: http://sdeleni.idnes.cz/destova-voda-dokaze-usetrit-pres-polovinu-vasi-spotreby-vody-p6y-/eko-sdeleni.aspx?c=A120530_123339_eko-sdeleni_ahr

[27] Use of rainfall water. Idnes.cz [online]. 2012 [cit. 2016-12-03]. Available on: http://sdeleni.idnes.cz/destova-voda-dokaze-usetrit-pres-polovinu-vasi-spotreby-vody-p6y-/eko-sdeleni.aspx?c=A120530_123339_eko-sdeleni_ahr
Prague water mains and sewerage. Pvk.cz [online]. [cit. 2016-12-06]. Available on: http://www.pvk.cz/vse-o-vode/pitna-voda/

3.8. Types of water consumptions in households

There are several types of water consumption in households. In this thesis the author split them into kitchen consumption, bathroom consumption and other residential consumption.
Kitchen consumption consists of sinks, dishwasher/washing up, water leaks during food preparation, drinking of water and cooking.
Bathroom consumption consists of toilet flushing, washings machines, showers and baths, teeth cleaning, leg/face shaving, hand/face washing
Other residential consumption consists of gardening, filling up a pool, washing a car and household leaks. [28]

Figure 5, Residential water consumption per day



Source: Data was used from OECD to process the graph[29]

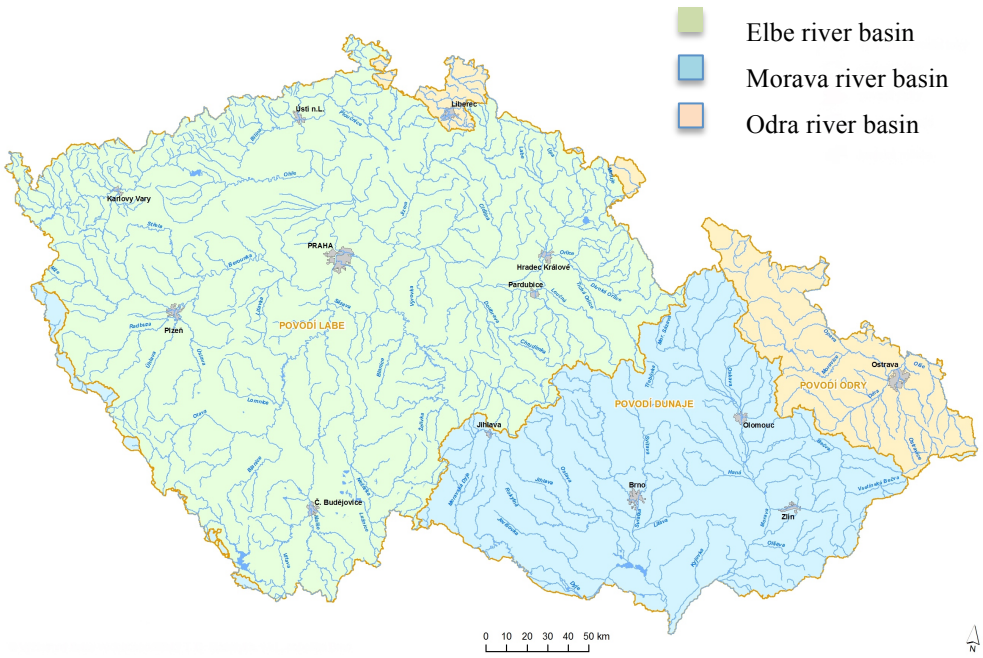
[28] OECD (2011), Greening Household Behaviour: The Role of Public Policy, OECD Publishing. http://dx.doi.org/10.1787/9789264096875-en
[29] OECD (2011), Greening Household Behaviour: The Role of Public Policy, OECD Publishing. http://dx.doi.org/10.1787/9789264096875-en

3.9. Water industry

Localization of the Czech Republic is in the middle of Europe. Despite the fact there are no big mountains, rivers in the CR flow into three seas. The area of the river basin is divided into the relevant sea. The Elbe and its basin river flow into the North sea, the Morava river and its basin flow into the Black sea and the Odra river and its basin flow into the Baltic sea.

The most important rivers are the Vltava and the Elbe in Bohemia, the Morava and the Dyje in Moravia and the Odra and the Opava in Silesia. [30]

Figure 6, Areas of the river basins divided into the relevant sea



source: Ministerstvo změdělství (2006) [31]

[30] MINISTERSTVO ZEMĚDĚLSTVÍ. Voda v ČR do kapsy [online]. Praha: LITERA Brno, 2006 [cit. 2016-03-01]. ISBN 80-7084-498-1. Available on: http://eagri.cz/public/web/file/21689/Voda_v_CR.pdf

[31] MINISTERSTVO ZEMĚDĚLSTVÍ. Voda v ČR do kapsy [online]. Praha: LITERA Brno, 2006 [cit. 2016-03-01]. ISBN 80-7084-498-1. Available on: http://eagri.cz/public/web/file/21689/Voda_v_CR.pdf

The basic characteristics of the water industry in the CR include basic hydrologic information, main water basin, sampling of surface and ground water, water waste, quality, flooding and water reservoirs.

Water owners and operators have 93,4% of length of all watercourses in the Czech republic. Other subjects, which includes the Ministry of Defense, National Parks or physical or legal persons have 6,6%.

Watercourses in the CR are divided into major flows in total length of 16 326km and minor flows in total length 86 553 km. Major flows and approximately half of minor flows are managed by state enterprises watershed. Such as the Elbe river board, the Vltava river board, the Ohře river board, the Odra river board and the Morava river board. Another important operator of minor water flows is the state enterprise Lesy, ČR. [32]

Table 1, Division of watercourses in the CR

Category	Operator	Length of watercourses in km	
		2013	2014
Major watercourses	Elbe river board s.p.	3667	3667
	Vltava river board, s.p.	5418	5493
	Ohře river board, s.p.	2377	2377
	Odra river board, s.p.	1111	1111
	Morava river board, s.p.	3753	3748
	Total	**16326**	**16396**
Minor watercourses	Lesy ČR, s.p.	38260	38491
	s.p. river board total	41888	39657
	Other operators [1)]	5961	5857

[32] EAgri Voda. Eagri.cz [online]. 2011 [cit. 2016-01-07]. Available on: http://eagri.cz/public/web/mze/voda/spravci-vodnich-toku/

	Others [2)]	444	5
	Total	**86553**	**84010**
Watercourses total		**102879**	**100406**

Source: data was used from eagri.cz and Voda v ČR do kapsy to process the table no. 1[33,34]

[1)] *Cover National Parks, Ministry of Defense, villages and other physical and legal person.*

[2)] *Since 2013 cover areas minor watercourses, which are without operator and are known as solitaire.*

Water supply system

Thanks to pipelines, water was supplied to 9,854mil. people in the Czech Republic, in 2013. Which is 93,8% of all inhabitants.

600,2 mil. m^3 of drinking water was produced in all water pipelines. Then 313,6 mil. m^3 was delivered to households.

Losses of drinking water reached 106,7 mil. m^3, which is 17,9% from water produced. [35]

There is a decreasing trend of drinking water supplied and invoiced price to the households in 2013.

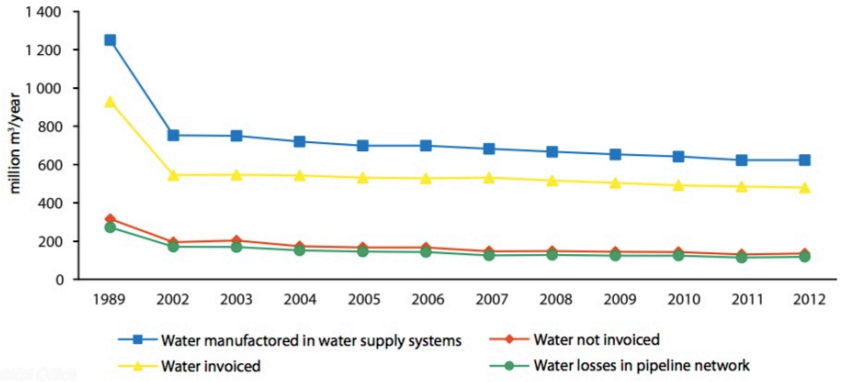
[33] MINISTERSTVO ZEMĚDĚLSTVÍ. Voda v ČR do kapsy [online]. Praha: LITERA Brno, 2006 [cit. 2016-03-01]. ISBN 80-7084-498-1. Available on: http://eagri.cz/public/web/file/21689/Voda_v_CR.pdf

[34] EAgri Voda. Eagri.cz [online]. 2011 [cit. 2016-01-07]. Available on: http://eagri.cz/public/web/mze/voda/spravci-vodnich-toku/

[35] POKORNÝ, Daniel. Stručně o vodě [online]. Praha: Ministerstvo Zemědělství, 2015, , 38 [cit. 2016-01-20]. Available from: http://eagri.cz/public/web/file/388899/Strucne_o_vode.pdf

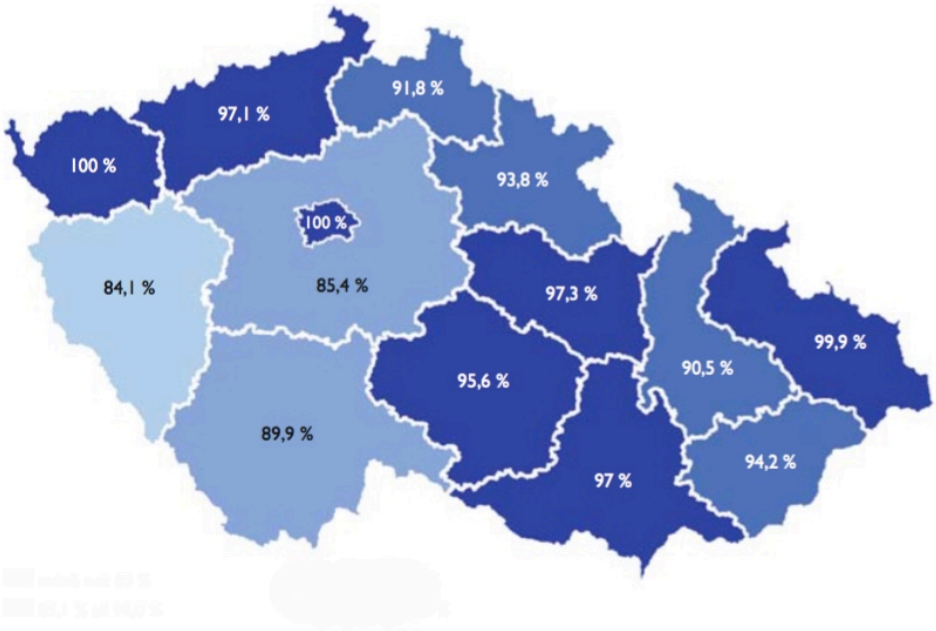
Development in the quantity values of water produced in water supply systems and water invoiced in total in the years 1989 and 2002 – 2012

Figure 7, Development in the quantity water production



Source: Data was used from Czech Statistical office to process the graph [36]

Figure 8, Percentage of supplied people in certain area of the CR in 2014



source: Vodovody a kanalizace ČR 2014 [37]

[36] Czech statistical office. Czso.cz [online]. [cit. 2016-11-12]. Available on: https://www.czso.cz/csu/czso/home

Owners and operators

Number of owners and operators water supplies and sewerage and their registration from data VÚME and VÚPE.

Table 2, Number of owners and operators in the CR

Indicator	2009	2010	2011	2012	2013	2014	Index 2014/2013
Owners	4828	5139	5521	5728	5953	6270	1,05
Operators	2130	2222	2334	2389	2468	2571	1,04
Total	6958	7361	7855	8117	8421	8841	1,05

Source: Data was used from "Vodovody a kanalizace ČR 2014" to process the table[38]

Table 3, Number of Top 10 owners and operators

Top 10 owners	Top 10 operators
Severočeská vodárenská společnost, a. s.	Pražské vodovody a kanalizace, a.s.
Hlavní město Praha	Severočeské vodovody a kanalizace, a.s.
Severomoravské vodovody a kanalizace Ostrava, a. s.	Severomoravské vodovody a kanalizace Ostrava, a.s.
Statutární město Brno	Brněnské vodárna a kanalizace, a. s.
Statutární město Ostrava	CEVAK, a. s.
Vodohospodářské sdružení obcí západních Čech	Vodárenská akciová společnost, a.s.

[37] DUDA, Jiří. Vodovody a kanalizace České republiky 2014 [online]. Praha: Ministerstvo zemědělství, 2015 [cit. 2016-12-20]. ISBN 978-80-7434-264-6. Available on: http://eagri.cz/public/web/file/434039/Rocenka_VaK_2014.pdf

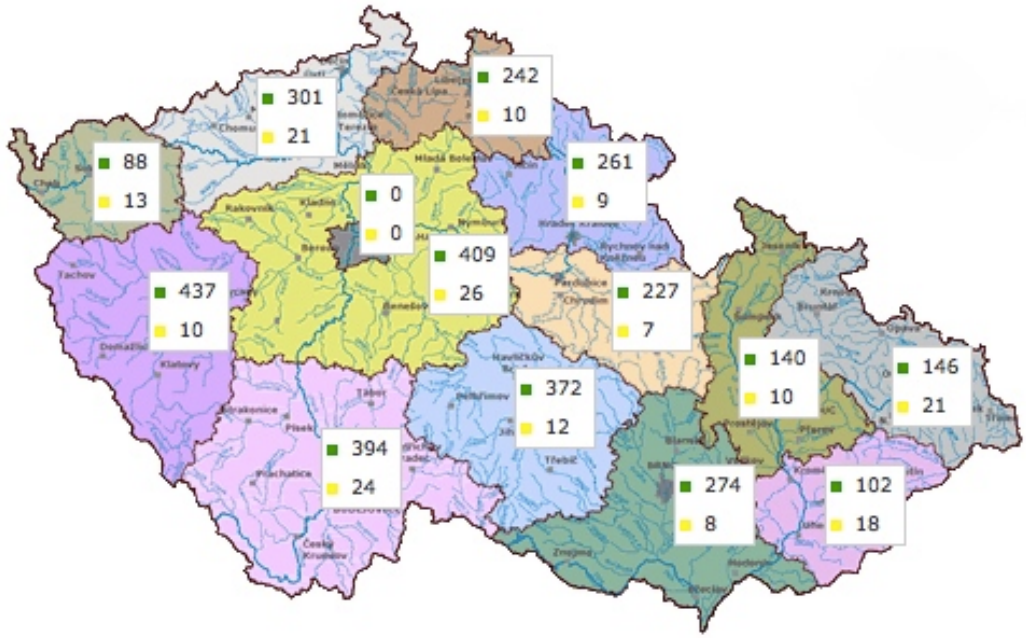
[38] DUDA, Jiří. Vodovody a kanalizace České republiky 2014 [online]. Praha: Ministerstvo zemědělství, 2015 [cit. 2016-12-20]. ISBN 978-80-7434-264-6. Available on: http://eagri.cz/public/web/file/434039/Rocenka_VaK_2014.pdf

Statutární město Plzeň	Moravská vodárenská, a.s.
Vodárny Kladno-Mělník, a. s.	Ostravské vodárny a kanalizace, a.s.
Úpravna vody Želivka, a. s.	Vodárna Plzeň, a.s.
Vodovody a kanalizace Zlín, a. s.	Středočeské vodárny, a.s.

Source: Data was used from "Vodovody a kanalizace ČR 2014" to process the table[39]

Sources of drinking water

Figure 9, Sources of drinking water in the CR



Legend: Sources of groundwater (3393)

Sources of surface water (189)

Total 3582 sources

As figure no. 9 shows, there are more of groundwater sources almost 95% and only 5% of surface water sources in the Czech Republic. Hovewer the amount of water gained from surface water is higher with 51% compared to 49% of groundwater.

[39] DUDA, Jiří. Vodovody a kanalizace České republiky 2014 [online]. Praha: Ministerstvo zemědělství, 2015 [cit. 2016-12-20]. ISBN 978-80-7434-264-6. Available on: http://eagri.cz/public/web/file/434039/Rocenka_VaK_2014.pdf

Groundawater is gained from wells and drills. On the other hand surface water is gained by water reservoirs. Other types of gaining surface water is directly from rivers, ponds or different water reservoirs. [40]

Production of drinking water

Drinking water is made in waterworks, where it is stored for several weeks in special reservoirs. During storage the majority of pathogenic organisms die. The majority of pollutants is metabolized and heavier particles go down to the bottom, where they sediment. Chemical flocculation follows and during this stage nontoxic salt of metals is added, such as iron and aluminum. Chemicals are then added, which create so-called heavy precipitation. Heavy precipitation catches particles including viruses and bacterium which sediment also at the bottom. Clear liquid is filtrated through layers of sand and gravel, because it will destroy all pathogenic microorganisms left behind. Water modified by all these processes is still not sterile, because some of pathogenic microorganisms are resistant to chlorine, which is basically used.

Waterworks produce drinking water with complicated facilities and it is done by the above processes. Sand floors, which filtrate water are placed in several layers one above the other. This process does not destroy pollutants such as radioactive elements, synthetic-organic substances and some of the heavy metals. Rarely there is a situation of highly polluted water sources and this is overcome by water waste treatment systems. This problem can be solved by adding a higher concentration of chlorine. But this modified water might have other negative effects on consumer health. [41]

Alternative delivery

In the past there was not any other option to consume different water than water from a tap, and also in a case, where a person was not satisfied with the quality.

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[40] KLECZEK, Josip (ed.). Voda ve vesmíru, na zemi, v životě a v kultuře. První. Praha: Radioservis, a.s., 2011. ISBN 978-80-86212-98-2.

[41] KLECZEK, Josip (ed.). Voda ve vesmíru, na zemi, v životě a v kultuře. První. Praha: Radioservis, a.s., 2011. ISBN 978-80-86212-98-2.

The situation changed during the early 1990's in the Czech Republic, when unsatisfied consumers started to look for other alternative choices. [42]

Alternative choices[43]:

Bottled water – decreasing nowadays, (80-85 liters per person per year)
Baby water - fulfill strict quality criteria and it is suitable for baby consummation. Cannot be chlorinated.
Spring water - suitable for permanent use by everybody, except babies. Slight change of chemical composition is allowed.
Drinking water – usually from public water pipelines
Soda water – produced with the addition of carbon dioxide (CO_2)
Household water treatment – water filters (obligatory to control and regularly change)
Water machine – sporadic way of quality drinking water distribution, artificially installed tank of drinking water, which is not directly connected to a water pipeline. Water is from another suitable source, while water output is being done by usual way of automatic or manual dosage.
Coin water machine in a public area – quality non-chlorinated groundwater, lower price than in a supermarket
Import from wells and springs – quality of water unknown

3.10. Temperature in relation to water consumption

Water consumption is expected to be positively related to average temperature, in celsius, per year recorded in each region. However, since households with gardens and swimming pools have to be included in water consumption we can say: the higher the temperature is, the higher the garden watering and topping-up of swimming pools is.
The water temperature is measured every day at 7 a.m. several centimeters under the water level near a dam. It is a practical indicator of the arrival and retreat of ice phenomena,

[42] KLECZEK, Josip (ed.). Voda ve vesmíru, na zemi, v životě a v kultuře. První. Praha: Radioservis, a.s., 2011. ISBN 978-80-86212-98-2.
[43] KLECZEK, Josip (ed.). Voda ve vesmíru, na zemi, v životě a v kultuře. První. Praha: Radioservis, a.s., 2011. ISBN 978-80-86212-98-2.

indicating the conditions at the dams suitable for swimming. The temperature of water is measured by means of a manually calibrated thermometer. [44]

3.11. Quality of water

The water quality evaluation data presented in this Chapter is based on the ČSN 75 7221 Czech National Standard, Classification of Surface Water Quality. In terms of their quality, surface waters are divided into five classes. The factor determining the class into which a particular stream belongs is based on a 90% quantil over a two-year (1997 - 1998) period. There are five groups of criteria (A - E). Within each of the groups, the most unfavorable criterion prevails.

The ČSN 75 7221 has been amended. The amendment has resulted in significant changes in the division of criteria into the five groups mentioned above, as well as in an addition of some new criteria. A whole new group of organic substances which have, until now, not been determined on a systematic basis or have not played a crucial role in the quality class determination has been added. There also has been a substantial reduction of limits governing the class determination (especially metals and oxygen-related criteria); on the other hand, some limits have been increased (e.g. calcium, magnesium, chlorides, manganese, but also enterococci). [45]

Surface water quality classes according to the ČSN 75 7221 in the table no. 4

Table 4, Surface water quality classes

Class number	Classification	Description
I.	Unpolluted/clean water	Surface water condition that has not been substantially affected by human activities; water quality criteria do not exceed values consistent with normal natural background in surface streams
II.	Slightly polluted water	Surface water condition that has been affected by human activities; however, water quality criteria attain values that enable the existence of a rich, balanced and sustainable ecosystem
III.	Polluted water	Surface water condition that has been affected by human activities to

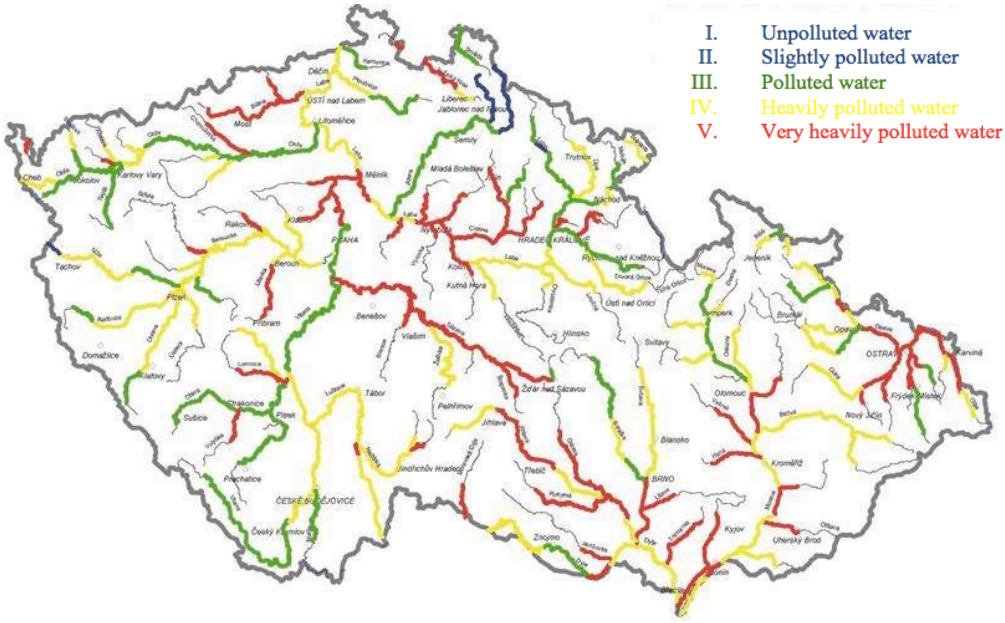
[44] Water quality. Voda.gov.cz [online]. [cit. 2016-02-03]. Available on: http://voda.gov.cz/portal/en/jakost_vody.htm

[45] MINISTERSTVO ZEMĚDĚLSTVÍ. Zpráva o stavu vodního hospodářství České republiky v roce 2014 [online]. První. Praha: Ministerstvo zemědělství, 2014 [cit. 2016-01-18]. ISBN 978-80-7434-239-4. Available on: http://eagri.cz/public/web/mze/voda/osveta-a-publikace/publikace-a-dokumenty/modre-zpravy/zprava-o-stavu-vodniho-hospodarstvi-1.html

		such an extent that water quality criteria attain values which need not necessarily provide prerequisites for the existence of a rich, balanced and sustainable ecosystem
IV.	Heavily polluted water	Surface water condition that has been affected by human activities to such an extent that water quality criteria attain values which permit the existence of an unbalanced ecosystem only
V.	Very heavily polluted water	Surface water condition that has been affected by human activities to such an extent that water quality criteria attain values which permit the existence of a very unbalanced ecosystem only

Source: Data was used from "Czech Hydrometeorological Institute" to process the table[46,47]

Figure 10, Watercourse quality in the CR in 1991 – 1992



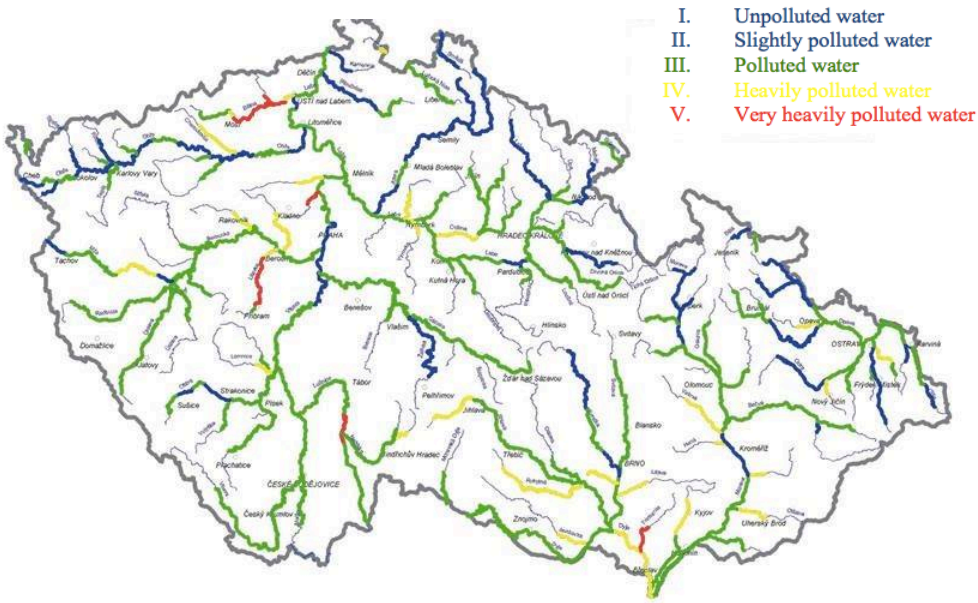
source: Ministry of agriculture, 2014 [48]

[46] Czech Hydrometeorological Institute. Portal.chmi.cz [online]. [cit. 2016-01-18]. Available on: http://portal.chmi.cz/?l=en

[47] MINISTERSTVO ZEMĚDĚLSTVÍ. Zpráva o stavu vodního hospodářství České republiky v roce 2014 [online]. První. Praha: Ministerstvo zemědělství, 2014 [cit. 2016-01-18]. ISBN 978-80-7434-239-4. Available on: http://eagri.cz/public/web/mze/voda/osveta-a-publikace/publikace-a-dokumenty/modre-zpravy/zprava-o-stavu-vodniho-hospodarstvi-1.html

[48] MINISTERSTVO ZEMĚDĚLSTVÍ. Zpráva o stavu vodního hospodářství České republiky v roce 2014 [online]. První. Praha: Ministerstvo zemědělství, 2014 [cit. 2016-01-18]. ISBN 978-80-7434-239-4. Available on: http://eagri.cz/public/web/mze/voda/osveta-a-publikace/publikace-a-dokumenty/modre-zpravy/zprava-o-stavu-vodniho-hospodarstvi-1.html

Figure 11, Watercourse quality in the CR in 2013-2014



Source: Ministry of agriculture, 2014 [49]

The figures no. 11 and no. 12 show that even though there is a significant improvement between years 1992 and 2014, there are still (even if very short) ranges of watercourses, which are included into V. class of surface water quality.

From a total number of 847 743 data from the year 2014, exceed limit values by decree only 2,04% of data during the evaluation of all monitored quality indicators. During the evaluation of health important or affecting sensory properties indicators exceed limit values in 1,02% cases. We can say, that the water supply network belonging to the highest quality in Europe is in the CR and its quality continues to improve. [50]

[49] MINISTERSTVO ZEMĚDĚLSTVÍ. Zpráva o stavu vodního hospodářství České republiky v roce 2014 [online]. První. Praha: Ministerstvo zemědělství, 2014 [cit. 2016-01-18]. ISBN 978-80-7434-239-4. Available on: http://eagri.cz/public/web/mze/voda/osveta-a-publikace/publikace-a-dokumenty/modre-zpravy/zprava-o-stavu-vodniho-hospodarstvi-1.html

[50] DUDA, Jiří. Vodovody a kanalizace České republiky 2014 [online]. Praha: Ministerstvo zemědělství, 2015 [cit. 2016-12-20]. ISBN 978-80-7434-264-6. Available on: http://eagri.cz/public/web/file/434039/Rocenka_VaK_2014.pdf

Requirements on the quality

Drinking water from a water pipeline for public use is supplied by (Pražské vodovody a kanalizace, a.s.). This water is environmentally safe and fits parameters of the notice from the Ministry of Health of the Czech Republic no. 252/2004 Sb., as amended by decree 187/2005 Sb.[51]

[51] Water quality. Vodovod.info [online]. [cit. 2016-01-28]. Available on: http://www.vodovod.info/index.php/clanky/vodarenstvi/184-jakost-vody-v-distribucnich-systemech-pitne-vody#.VuSYL7yY9SV

4. Analytical part/Case study

In the analytical part of the thesis the author processed data obtained with primary and secondary data research.

The primary data has not been previously collected and the author is the first person who has collected it. Primary data is first-hand information collected though direct observations, interviewing the respondents and conducting experiments.

The advantage of primary data research is, that the data perfectly fits to the research and its collection is for a specific purpose. The data is also highly controlled over its collection.

One of the disadvantages is that its collection is very difficult and time consuming. It's more expensive and the obtained outcome is just raw data without seasonal adjustment or extreme values.

The secondary data was collected by someone else. The researcher, in this case the author of the thesis, does not have any control over its collection. Examples of its source might be statistical office, OECD, database of company or personnel records.

One of the advantages is obtaining data in a shorter time period, accessibility, it's cheaper and the process of its collection might have been guided by an expert or professional organization.

There are also disadvantages of secondary data usage. The data was collected for another purpose; thus it does not perfectly fit to the research question. Also, data quality is poorly controlled or can be biased. [52]

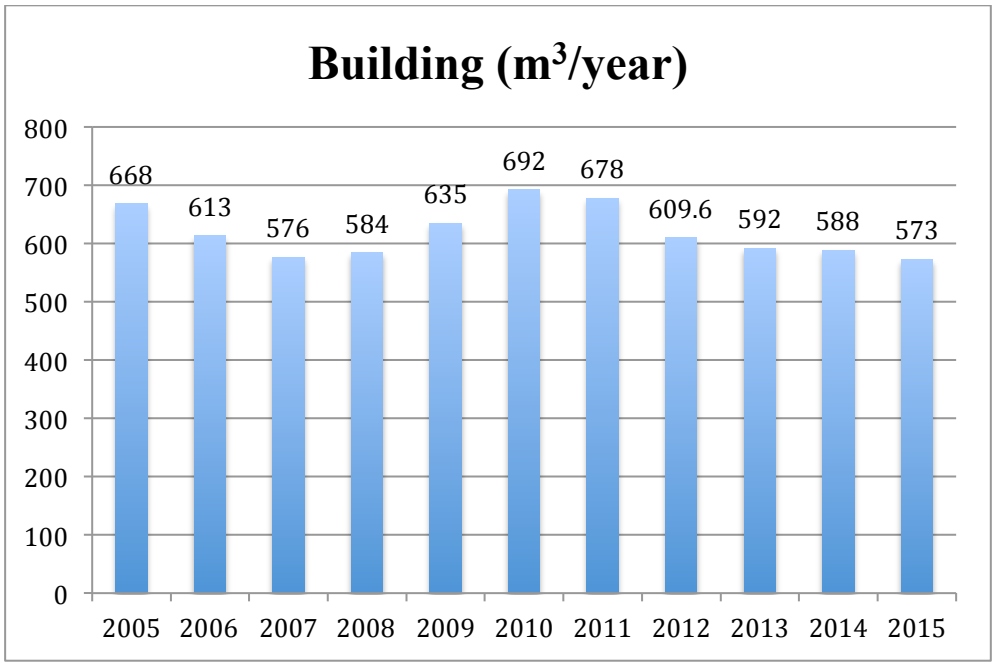
The author used data collected from six apartments in one building. The number of members in each family are different each year and have been added in the appendix of the thesis. However, the numbers are between 18 – 21 inhabitants in building. The data has been divided into overall building consumption and into individual apartments; apartment 1 (apt.1), apartment 2 (apt. 2), apartment 3 (apt. 3), apartment 4 (apt .4), apartment 5 (apt. 5) and apartment 6 (apt. 6).

[52] BOBÁKOVÁ, Petra. Empirical Research in Economics. První. Praha: Reprografické studio PEF ČZU v Praze, 2014. ISBN 978-80-213-2508-1.

In the third part of the analytical section the author used “normal mode” and “saving mode” over the 10 days of measuring the data. “Normal mode” includes all activities, doing them as you normally would. “Saving mode” includes doing all activities with water saving behavior.

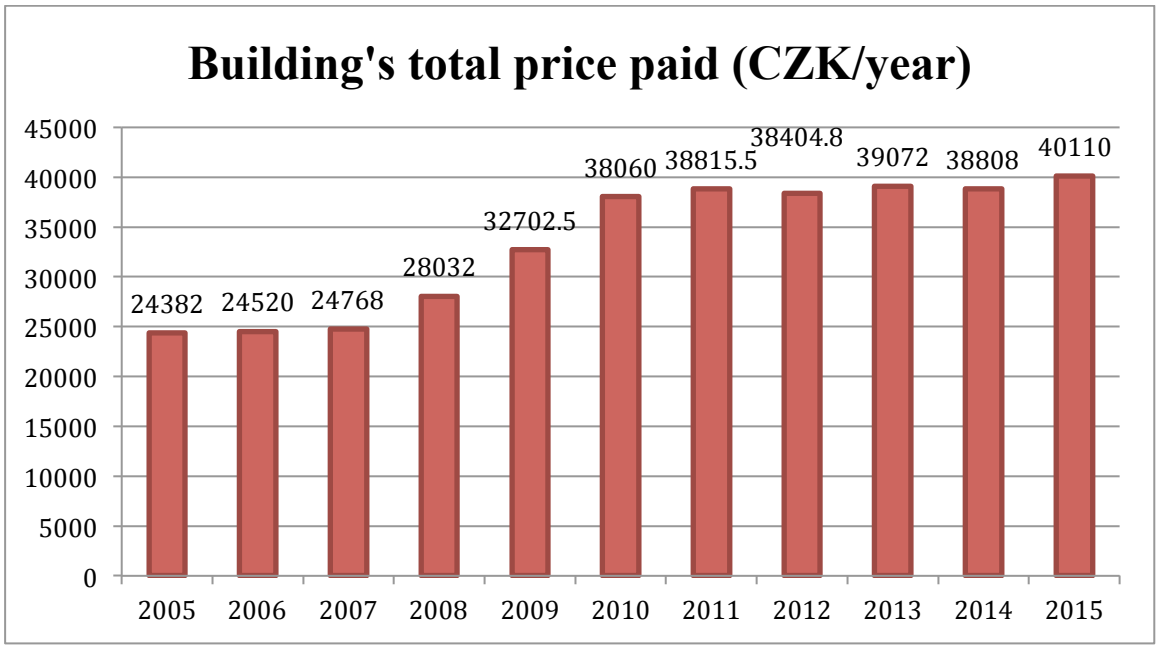
4.1. Evaluation of residential drinking water consumption in years 2005-2015 and its trends

Figure 12, Buildings overall consumption of drinking water



source: Hojsák, Evaluation of drinking water consumpiton by households in the CR, 2016

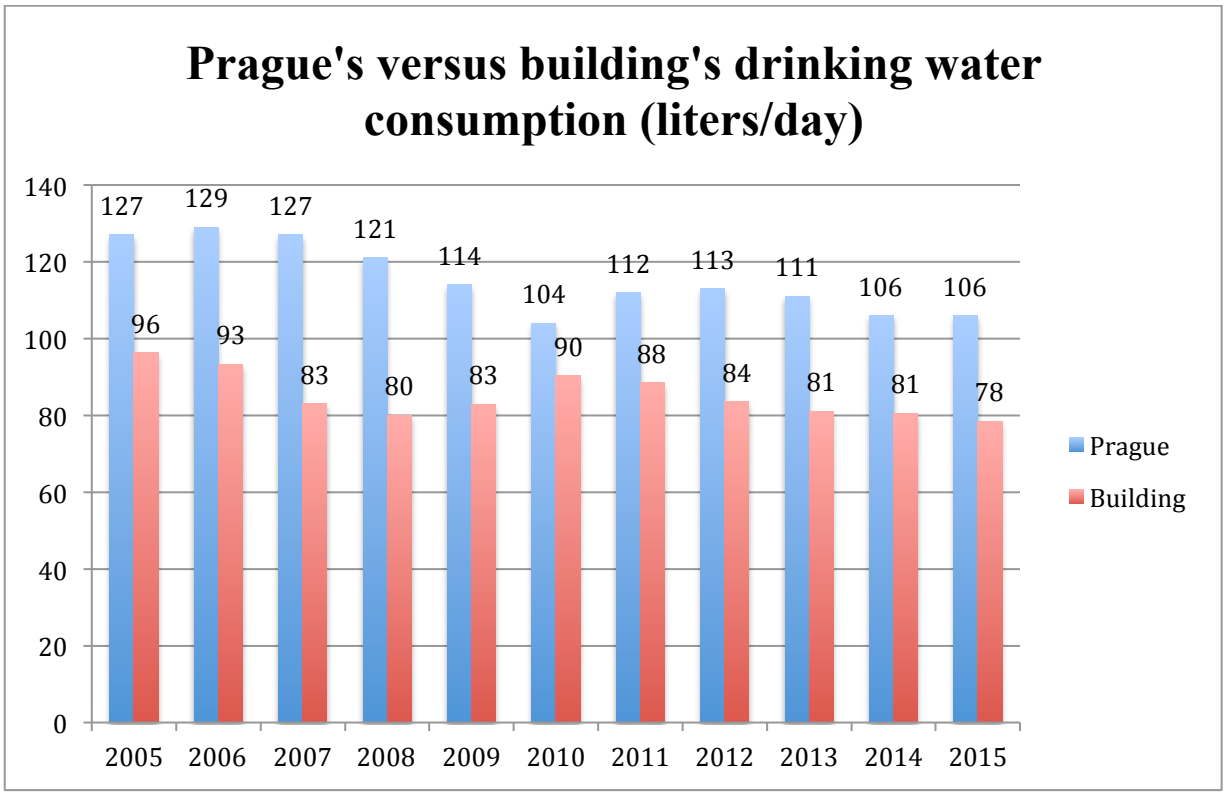
Figure 13, Buildings total price paid for consumption of drinking water



source: Hojsák, Evaluation of drinking water consumpiton by households in the CR, 2016

In figure no. 12 you can see the overall drinking water consumption of 6 apartment buildings during years 2005 – 2015. The author was trying to find a descending trend line compared to what was written in the theoretical part of this thesis. However, the buildings overall consumption does not show a descending trend line, but fluctuating type. The increasing chart is shown in figure no. 13, where the author showed data of the total price paid. The highest drinking water consumption was in 2010 during measured years, which is a surprise as the economy of the Czech Republic was in recession caused by the economic crisis in 2008. But we can assume that this value can be added to the price per cubic liter, which was 55 CZK per cubic liter per year compared to nowadays 70 CZK per cubic liter. The main reason is the number of inhabitants in the building, which was the highest in the year 2010. Despite the fact that the highest consumption was in 2010, the total price paid for consumption was the highest in 2015 (40 110 CZK) and was 119 cubic liters less than in 2010. This was caused by rising prices of water and sewer rates.

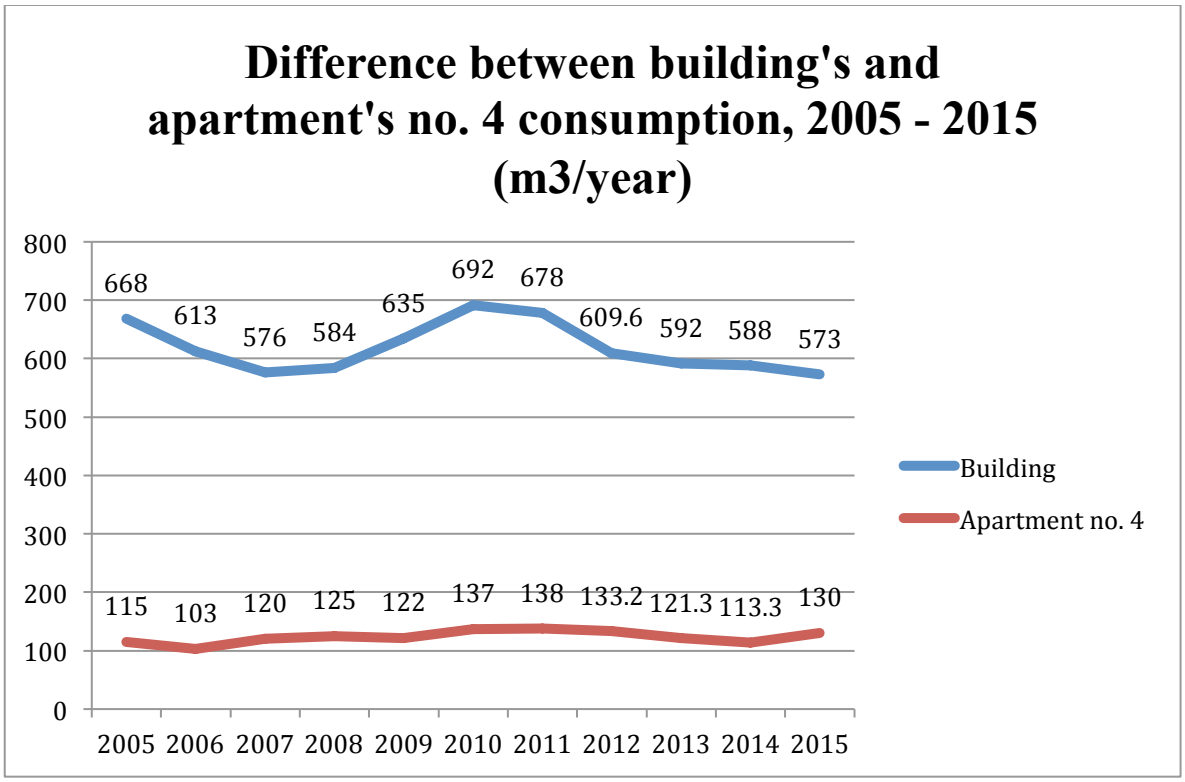
Figure 14, Difference between Prague's and building's drinking water consumption



source: Hojsák, Evaluation of drinking water consumpiton by households in the CR, 2016; data was used from PVK, a.s. to process the graph

As it is written in the theoretical part, the overall consumption of drinking water per day per capita has been decreasing since the Velvet Revolution. In this figure no. 14 the author compared Prague's drinking water consumption per day per capita with building water consumption per day per capita. **The building's drinking water consumption is on average 30 cubic liters (2100CZK) lower than Prague's**. The author spoke with all inhabitants in the building where the data was measured and all of them except two (in apartment 2.) responded that they are aware of water scarcity and rising prices of water. **So in this case 18 inhabitants out of 20 demonstrated water saving behavior.**

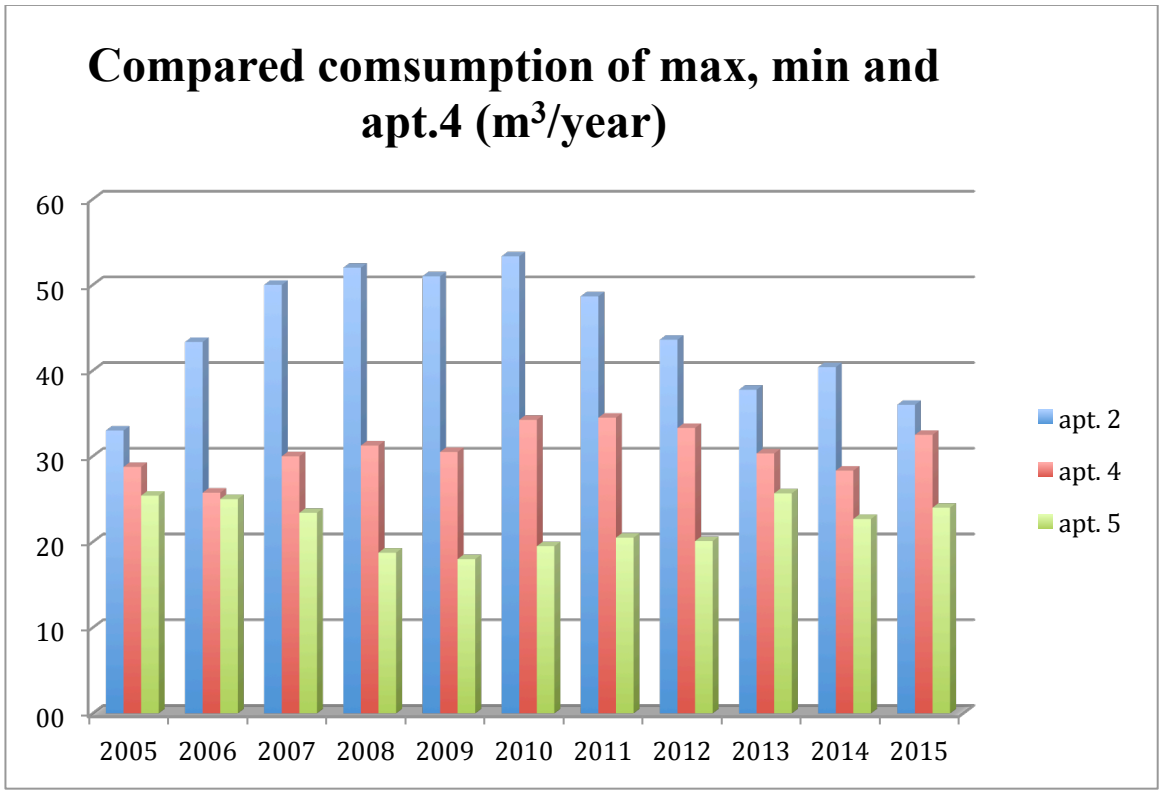
Figure 15, Difference between building's and apartment's no. 4 drinking water consumption



source: Hojsák, Evaluation of drinking water consumpiton by households in the CR, 2016

In apartment no. 4, the apartment where author is living, there is a balanced situation of drinking water consumption. Although its trend line is slightly increasing and decreasing which contradicts the overall decrease in consumption in the Czech Republic. It is caused by the raising of their children and sports activities of all members in the family since 2010 and of course the price of drinking water per cubic liter. Because the price in 2005-2010 wasn't as high as it is nowadays, it didn't influence the family budget as much.

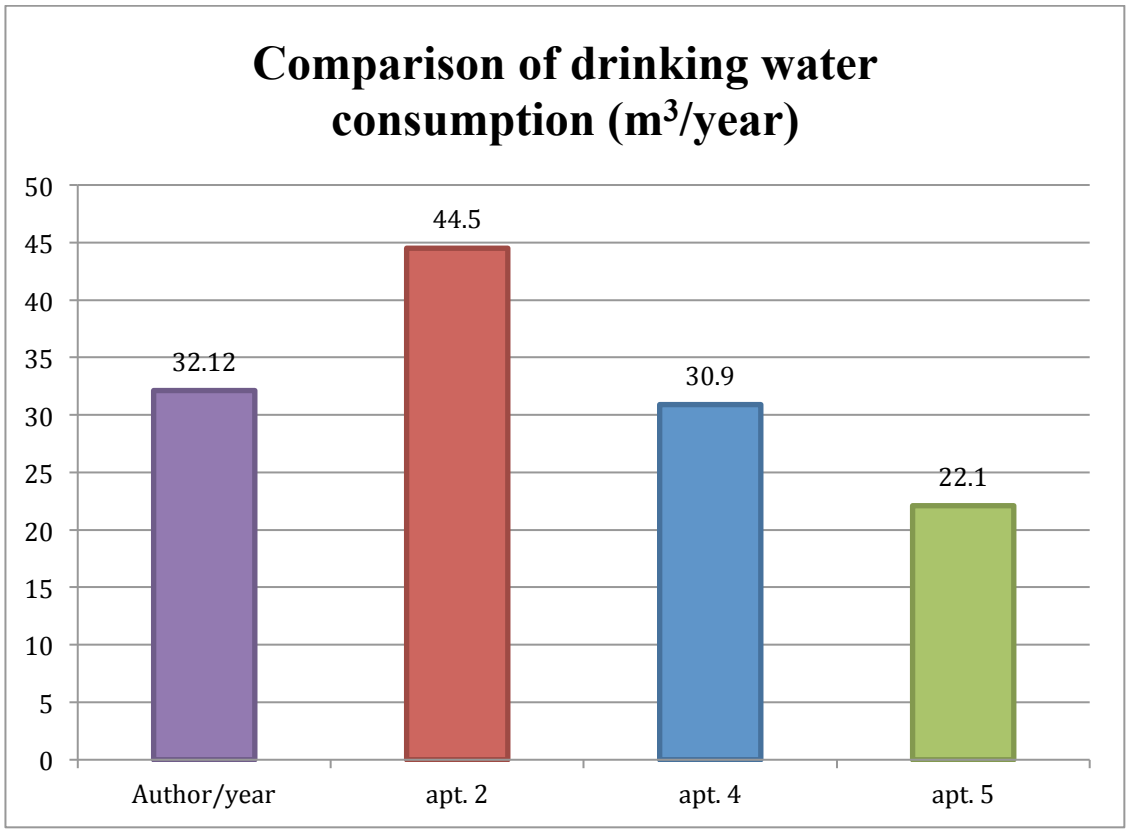
Figure 16, Compared drinking water consumption of max, min and apt. 4 in cubic liters



source: Hojsák, Evaluation of drinking water consumpiton by households in the CR, 2016

In figure no. 16 we can see a difference between apartment 2 (with the highest consumption), apartment 4 (where the author is living) and apartment 5 (which has the lowest consumption of all apartments in the building). Values in this graph are in cubic liters per year per capita. Apartment no. 5 demonstrates water saving behavior e.g. the author was told that when they are taking a shower they go in to get wet, turn the water off, wash themselves, then turn the shower on again, then go out. This way of showering is very economical and saves water. On the other hand apartment no. 2 demonstrates slight water wasting behavior. The author was told by the respondent from the apartment no. 2 that they are a cleanly family. They wash dishes/use the dishwasher, wash clothes in washing machine, clean the floor very often and prefer to take a bath than a shower. But as the respondent mentioned, they must take into account that the price of water has gone up over the years and it has become a bigger and bigger part of their family's budget.

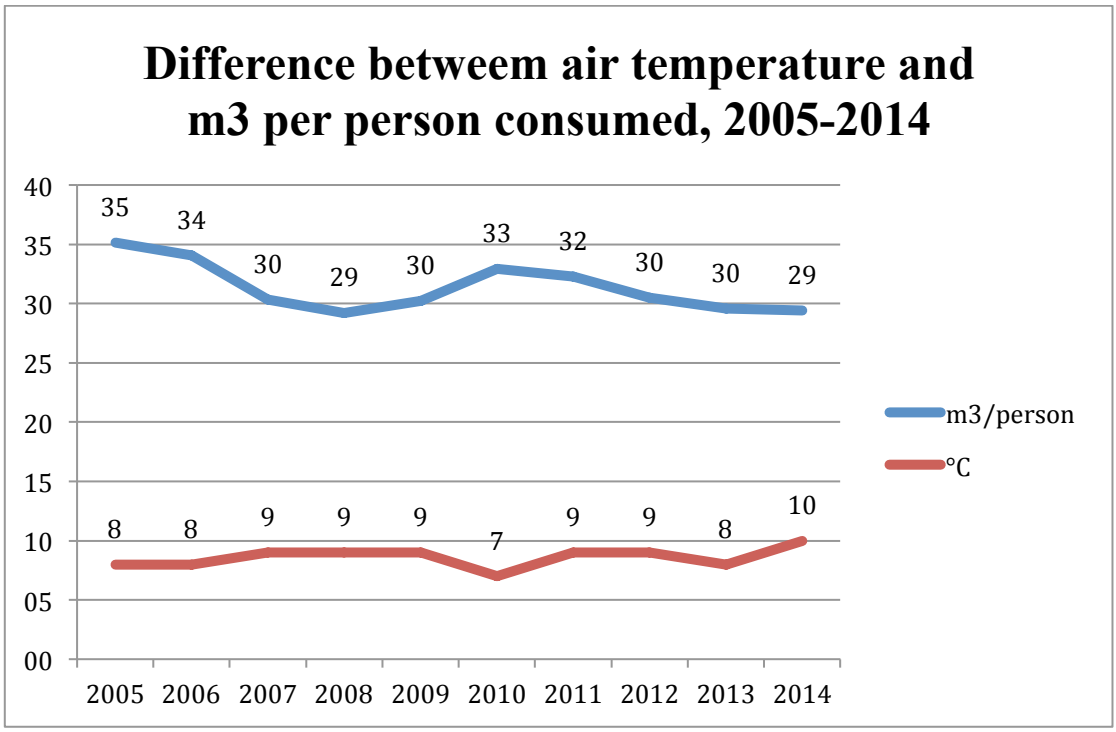
Figure 17, Comparison of drinking water consumption



source: Hojsák, Evaluation of drinking water consumpiton by households in the CR, 2016

Here is the author's annual drinking water consumption in figure no. 17 is compared to apartment no. 2 (most consumed liters), apartment no. 4 (author's family's apartment) and apartment no. 5 (least consumed liters). The author's consumption is slightly higher than in the apartment, where he lives. We can claim that his consumption is the highest of his family despite the fact he cares about water scarcity. The difference of author's consumption and apartment no. 5 is 10,02 m^3 which is approximately 700 CZK per year. On the other hand the difference of author's consumption and apartment no. 2 is 12,38 m^3 which is approximately 867 CZK per year.

Figure 18, Difference between air temperature and cubic liter per person consumed



source: Hojsák, Evaluation of drinking water consumpiton by households in the CR, 2016; data was used from Czech Hydrometeorological Institute to process the graph

Correlation analysis

Correlation analysis measures the strength of dependence between variables.

A correlation coefficient is a statistical measure of the degree to which changes to the value of one variable predict change to the value of another. In positively correlated variables, the value increases or decreases in tandem. In negatively correlated variables, the value of one increases as the value of the other decreases.

Correlation coefficients are expressed as values between +1 and -1. A coefficient of +1 indicates a perfect positive correlation. A change in the value of one variable will predict a change in the same direction in the second variable. A coefficient of -1 indicates a perfect negative correlation. A change in the value of one variable predicts a change in the opposite direction in the second variable. Lesser degrees of correlation are expressed as

non-zero decimals. A coefficient of zero indicates there is no discernable relationship between fluctuations of the variables. [53]

Table 5, Correlation analysis

	temperature	*consumption*
temperature	1	
consumption	-0,11264055	1

source: Hojsák, Evaluation of drinking water consumpiton by households in the CR, 2016

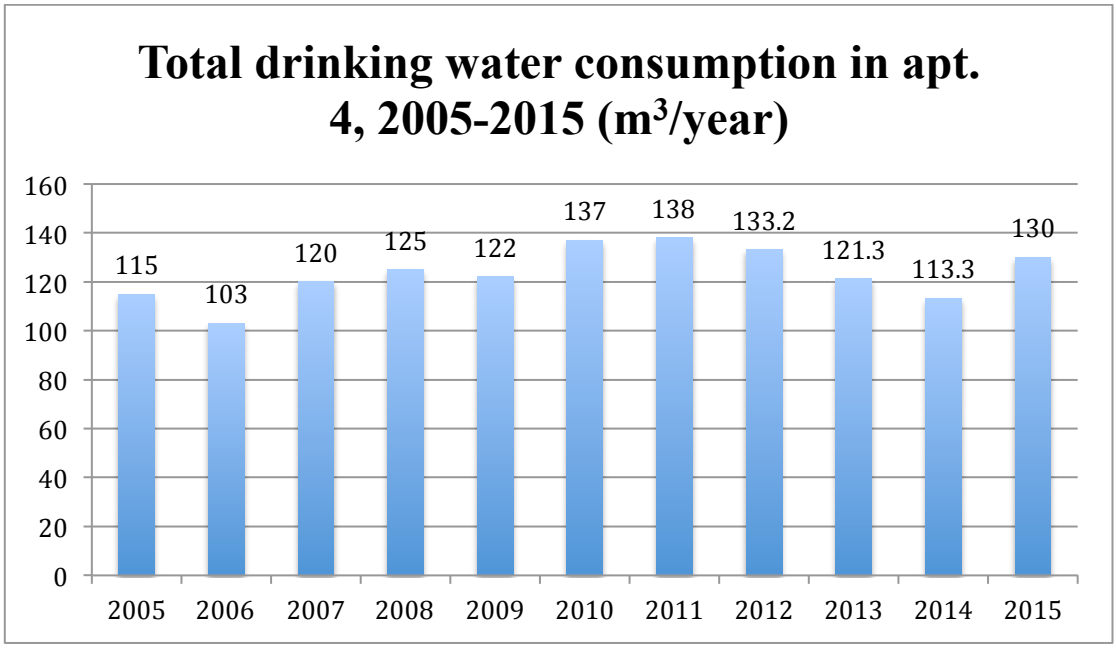
In figure 18 the author tried to consider air temperature as one of the relevant impacts on water consumption. However, since the building has no garden, pool or place to wash your car the air temperature has been rejected. Correlation analysis was only proof to prove that air temperature has no impact on cubic liters consumed per person during the years 2005-2014. Result -0,11264055 showed us that there is a negative correlation between these two variables.

However, by only looking, we can see in the graph a completely different thing that the author was trying to prove. There is a high value of water consumption while the temperature was low and vice versa. The best example was in 2010, where the values of consumption reached 33 cubic liters per person per year and the temperature in that certain year was 7 degrees Celsius. However, since the correlation analysis didn't work and the temperature is average during the whole year we can say this is only an interesting point of view.

[53] Correlation analysis. Whatis.techtarget.com [online]. [cit. 2016-03-01]. Available on: http://whatis.techtarget.com/definition/correlation-coefficient

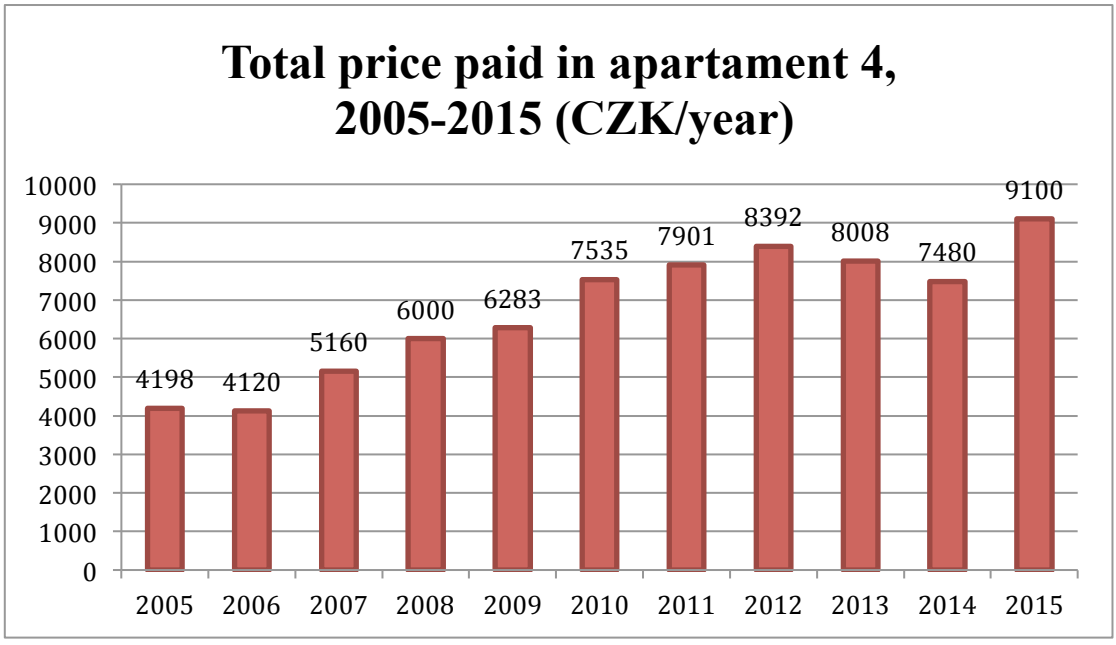
4.2. Apartment's 4. drinking water consumption

Figure 19, Total drinking water consumption in apartment 4



source: Hojsák, Evaluation of drinking water consumpiton by households in the CR, 2016

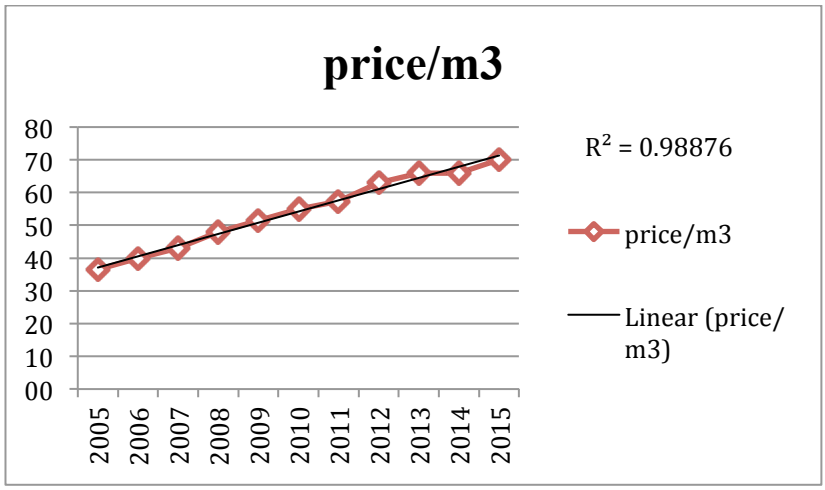
Figure 20, Total price paid in apartment 4



source: Hojsák, Evaluation of drinking water consumpiton by households in the CR, 2016

In apartment 4., where author is living, there is fluctuating consumption of drinking water over the years. The consumption went down to 103 cubic liters in 2006, the lowest during last 10 years. The highest value is 138 cubic liters in 2011 over the measured time. Despite the fact that consumption is fluctuating between those two values invoiced price by operators of water pipelines has gone up one more time since 2005. From 36,5 CZK per m^3 in 2005 to 70 CZK per m^3 in 2015 and it has an increasing trendline as shown in figure no. 20 with 98,876%, which is almost perfect.

Figure 21, Trend line of increasing price paid per cubic liter



source: Hojsák, Evaluation of drinking water consumpiton by households in the CR, 2016; data was used from PVK, a.s. to process the graph

Table 6, Selected unit's consumption of drinking water

Difference between types of toilet flushing and peple, who use it								
	1 person				Family (4 people)			
times/day	dual flush			single flush (8 liters)	dual flush			single flush (8 liters)
	normal mode	saving mode	max (9,2 liters)		normal mode	saving mode	max (9,2 liters)	
4	25,2		36,8	32,0	100,8		147,2	128,0
6	32,7		55,2	48,0	130,8		220,8	192,0
5	27,0		46,0	40,0	108,0		184,0	160,0
4	23,3		36,8	32,0	93,2		147,2	128,0
4	22,6		36,8	32,0	90,4		147,2	128,0
5		25,0	46,0	40,0		100,0	184,0	160,0
4		20,7	36,8	32,0		82,8	147,2	128,0
6		30,4	55,2	48,0		121,6	220,8	192,0
4		20,6	36,8	32,0		82,4	147,2	128,0
4		20,2	36,8	32,0		80,8	147,2	128,0
avg/day	26,2	23,4	42,3	36,8	104,6	93,5	169,3	147,2
a month	784,8	701,4	1269,6	1104,0	3139,2	2805,6	5078,4	4416,0
a year	9548,4	8533,7	15446,8	13432,0	38193,6	34134,8	61787,2	53728,0
in m3	9,5	8,5	15,4	13,4	38,2	34,1	61,8	53,7
in CZK	668,4	597,4	1081,3	940,2	2673,6	2389,4	4325,1	3761,0
Difference (CZK)	-71,0	0,0	-483,9	-342,9	-284,1	0,0	-1935,7	-1371,5
Difference (m3)	-1,0	0,0	-6,9	-4,9	-4,1	0,0	-27,7	-19,6

source: Hojsák, Evaluation of drinking water consumpiton by households in the CR, 2016

In table no. 6 different types of data between two types of toilet flushing systems and different number of people who used it are processed. Nowadays it's almost obligatory to have a dual flush system on your toilet. In the table the author chose four types of flushing – normal mode (people who have a dual flush system, but does not really care that much), saving mode (people who have a dual flush system and also use it), max mode (using all water in your toilet's tank for one flush) and single flush system (old system of flushing, which the author measured on toilet, which had an 8 liter tank). The author himself tried to use normal and saving mode and found interesting results in total consumed water and also the price paid.

In this example the author will use the "4 people type". The best choice for flushing is obviously the "saving mode" and then the consumed liters are very different. With the "normal mode" of flushing the difference is 284,1 CZK, which is 4,1 cubic liters. When thinking about the payback period when buying a new toilet, this type will be the longest. However when you are using the maximal amount of your tank as it is shown in "max mode" you lose 1935,7 CZK compared to the saving mode and furthermore you will

consume 27,7 cubic liters more! Or similar to this is still using one choice flush toilet. This type of toilet will annually cost you 1371,5 CZK compared to the saving one.

Payback period on dual toilet system

The usage of a toilet is a different in every family. In this example of the payback period, the author used the data collected in an experiment of his own consumption. The results were 53,7 cubic liters per year, equating to 3761 CZK using the single flush system. If an investment into a dual flush system of type 1 (a tank only - 1990 CZK) or type 2 (a tank, a dual button, a bowl and a seat – 3290 CZK) was made, the consumption would decrease by 15,5 cubic liters (28,9%).

With an investment into a dual flush system your yearly consumption would be 38,2 cubic liters (2673,6 CZK). **This is a 1087 CZK change in price and 15,5 in cubic liters per year per 4 people**. The payback period would be for this example in type 1, **1,83 year** and in type 2, **3,03 years.**

Figure 22, Dual flushing system

source: type 1 [54]

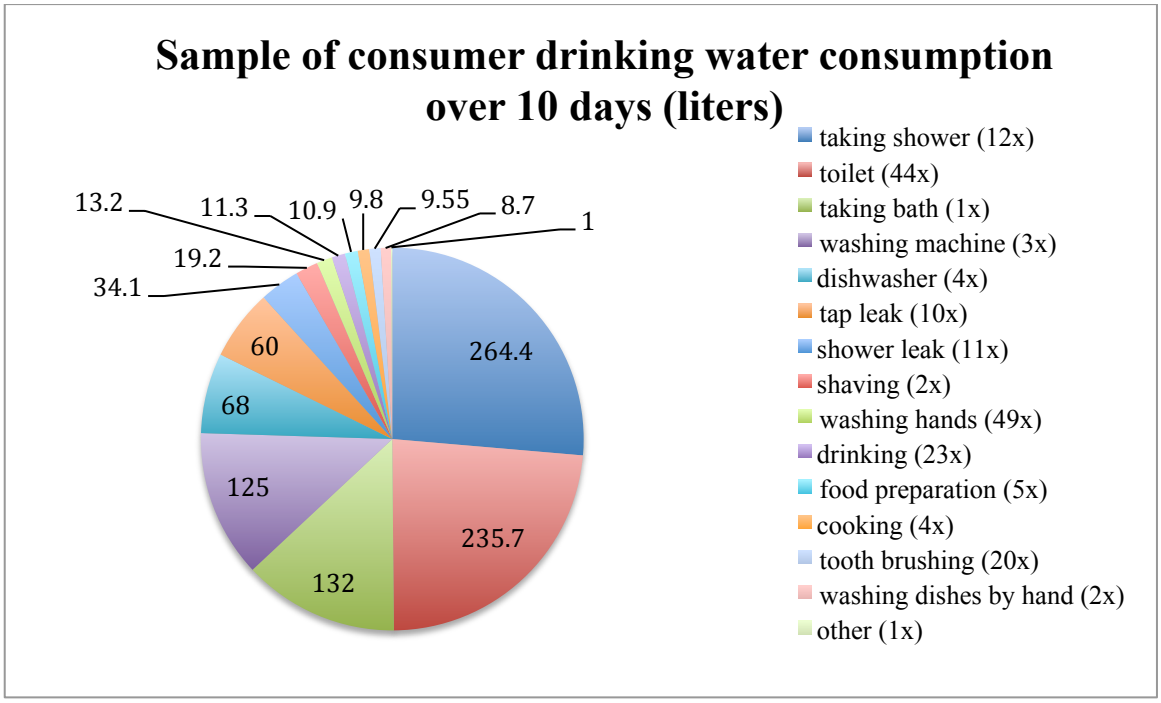
[54] Dual flushing toilet system [online]. [cit. 2016-02-08]. Available on: http://www.koupelny-online.cz/podomitkova-nadrzka-hloubka-120-mm/d-86954/

Figure 23, Dual flushing system (a tank, a dual button, a bowl and a seat)

source: type 2 [55]

4.3. Sample of consumer drinking water consumption

Figure 24, Sample of consumer drinking water consumption over 10 days



source: Hojsák, Evaluation of drinking water consumpiton by households in the CR, 2016

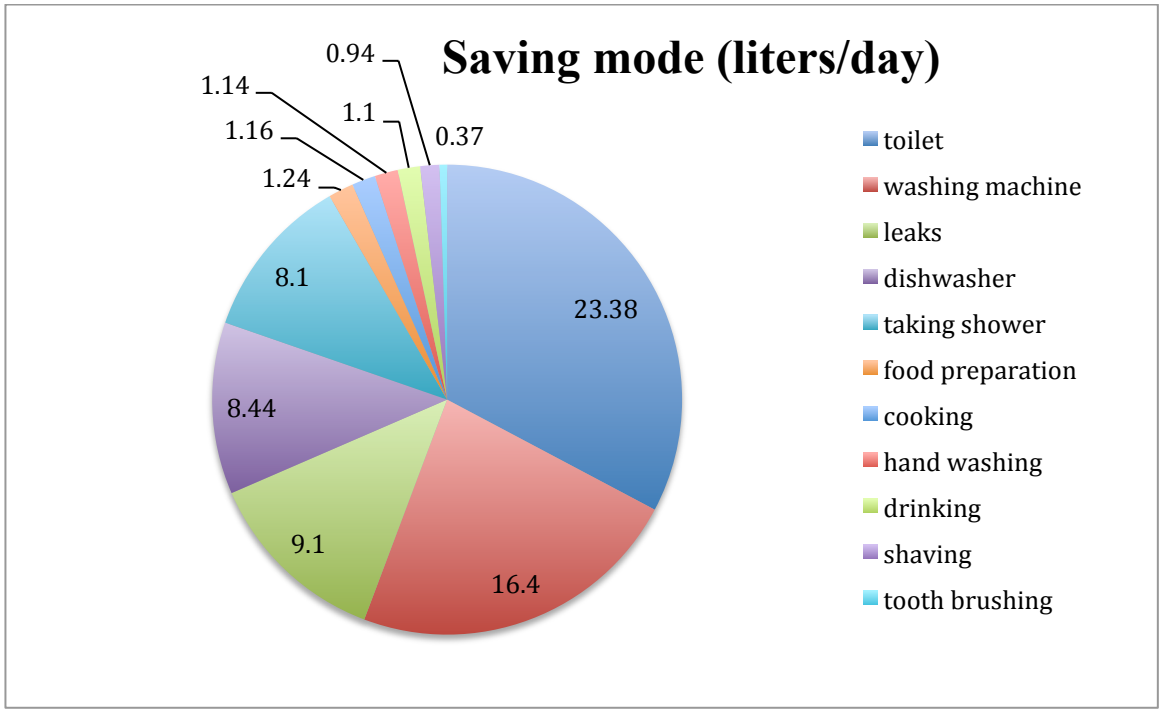
[55] Dual flushing toilet system [online]. [cit. 2016-02-08]. Available on: http://www.koupelny-online.cz/zvyhodneny-setwc-taurus-nadrzka-tlacitko-sedatko-vlozka/d-86955/

The author conducted research on his own drinking water consumption over 10 days. As the author has only one way to measure the consumption and it is in an apartment which is 140 m^2. The measured data will mostly fit to apartments without a garden and no place to wash their car. The author records those 15 activities, which are shown in figure no. 24. In the figure no. 24 there are two types of leaks (shower and tap), which is worth mentioning. The author measured one day of a dripping tap with a utensil under it and reached a value of **6 liters per a day**, which is added into each of the 10 days.

A shower leak or any other type of leak where you have to wait for hot water come out of the showerhead was measured by a water meter installed in the apartment.

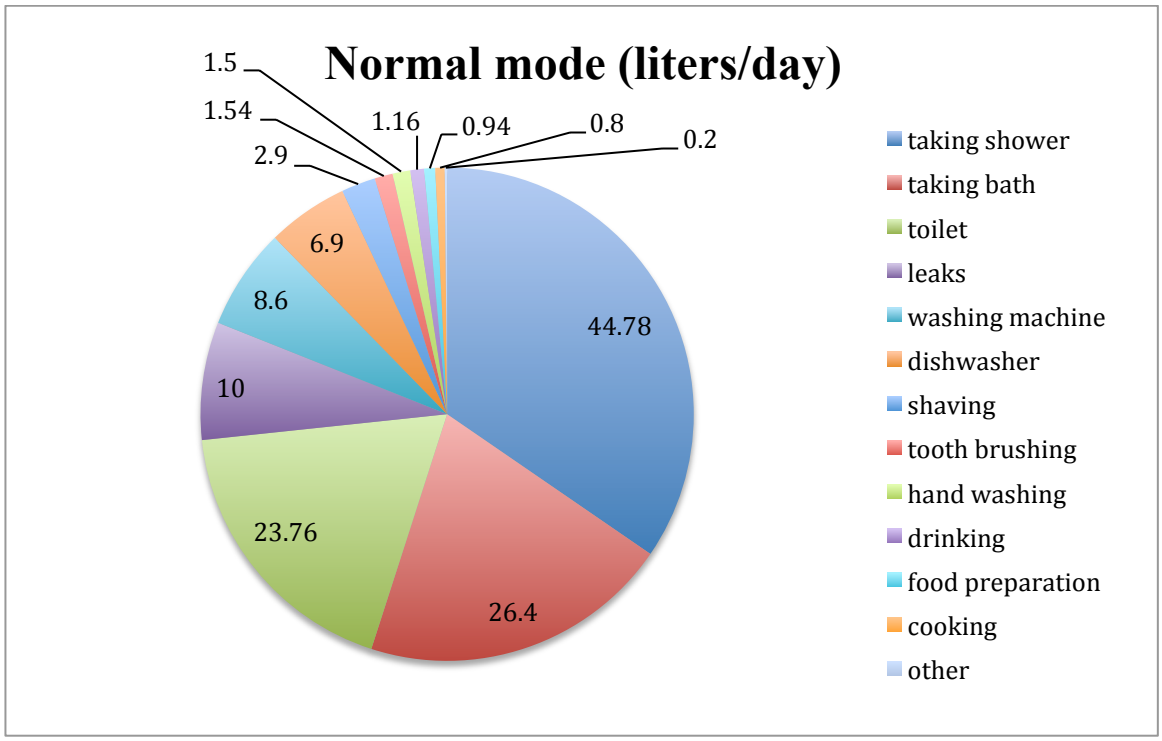
Daily water consumption

Figure 25, Saving mode



source: Hojsák, Evaluation of drinking water consumpiton by households in the CR, 2016

Figure 26, Normal mode

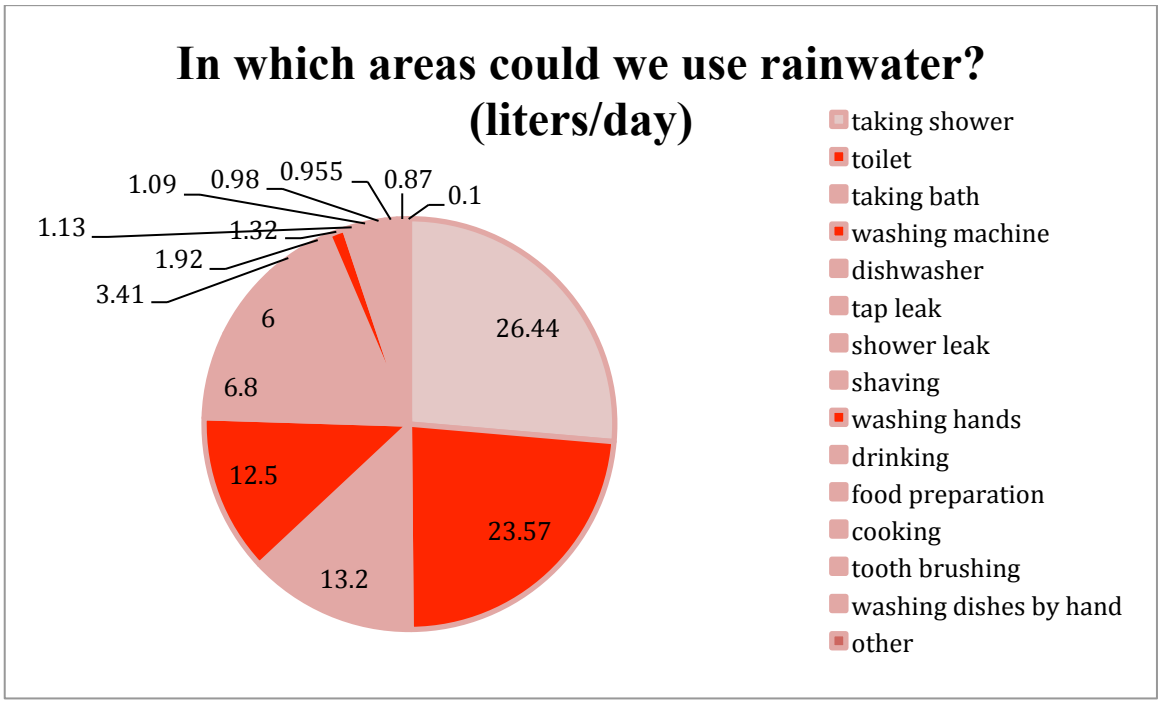


source: Hojsák, Evaluation of drinking water consumpiton by households in the CR, 2016

In figures 25 and 26 above we can see the author's 10 day consumption divided into two graphs. One with "saving mode" consumption, where the author tried to save drinking water consumption among all activities and one with "normal mode" consumption, where the author tried to use all activities normally. The outcome is very different from one another. **Total consumed liters using "saving mode" 71,37 liters and 129,48 liters using "normal mode". The overall difference is 58,11 liters per day per capita**. In the following examples is the approach shown in closer detail. While taking a shower is on the 5th place with 8,1 consumed liters in "saving mode", it is on the 1st place with 44,78 consumed liters in "normal mode". There you can see a huge change in water consumption. Only the toilet among the higher consuming activities stays almost the same between those two modes with consumption approximately 23 liters per day.

Substitutability

Figure 27, Usage of rainwater



source: Hojsák, Evaluation of drinking water consumpiton by households in the CR, 2016

Here we can see the areas in which we could use rainwater instead of drinking water. The figure no 27, is based on the author's data measured in consumption, which was done by himself. **The author found that two activities, which form 36,07 liters per day out of 100,285 liters are typical examples of water substitutability.** We are speaking of toilet flushing and the washing machine. One questionable activity is washing hands. The author included washing hands into water substitutability but since we all wash our hands in sinks with water from taps, it would be hard to manage hand washing only by rainwater. The graph is missing drinking water consumption from gardening and washing the car.

Table 7, Replaceable versus irreplaceable water consumptions

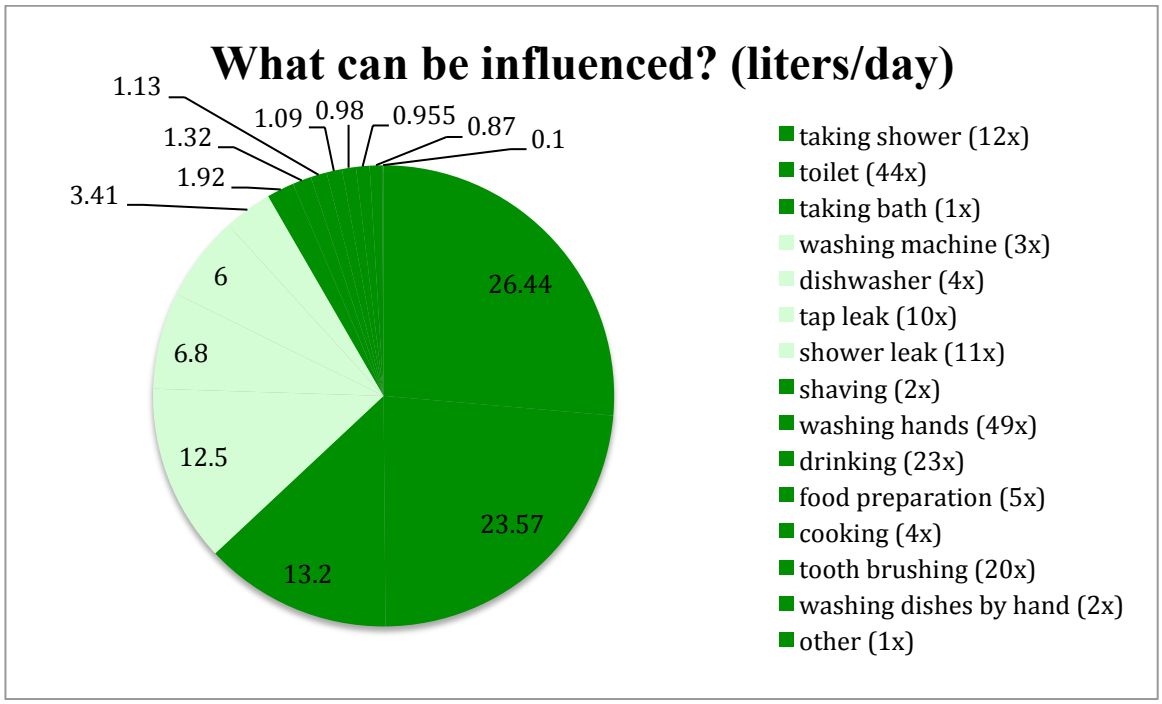
type	set numbers			own processed numbers		
	no. of activities	in liters	percentage	no. of activities	in liters	percentage
replaceable	4	51,59	48,67%	3	37,39	37,28%
irreplaceable	5	54,51	51,33%	12	62,895	62,72%
total	9	106,1	100%	15	100,285	100%

source: Hojsák, Evaluation of drinking water consumpiton by households in the CR, 2016

In table no. 7 data from the theoretical part is collected, which was set by Prague waterworks as daily consumption and the author's processed data, which he collected. Firstly the total numbers are not that different. We can mention that the author during his research consumed 100,285 liters per day, which is 5,815 liters less than what the daily consumption in Prague is.

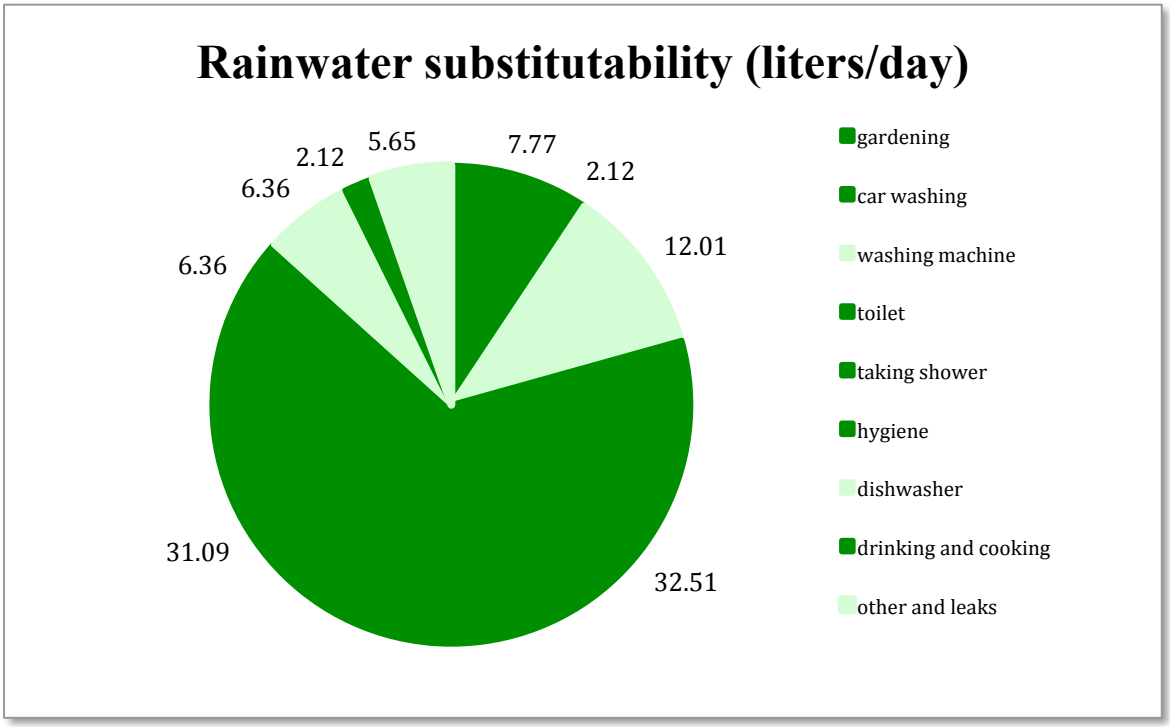
Secondly, water substitutability is different because they included in their research gardening and car washing. However, into water irreplaceability they included 5 activities and the author 12 activities and we can see the change of percentage of water substitutability and irreplaceability.

Figure 28, Consumption of drinking water influenced by people (own research)



source: Hojsák, Evaluation of drinking water consumpiton by households in the CR, 2016

Figure 29, Consumption of drinking water influenced by people (set numbers)



source: Hojsák, Evaluation of drinking water consumpiton by households in the CR, 2016

When the households do not have an option to change their water substitutability. The author shows in figure 28 activities in which we all can influence our drinking water consumption. From one fourth of the graph we can see the consumption of taking a shower, which can be much less. Also, toilet flushing can be influenced depending on how hard you pull/push it. Bath taking is a generally known problem of water consumption and nowadays is being replaced by quicker and more economically friendly shower. Table no. 8 shows numbers obtained by PVK, a. s. and the author's own research. As you can see, the percentage of numbers differ with 10% each, but in overall we can claim that processed numbers fit into set numbers.

Table 8, Difference between set and own numbers

type	set numbers		own numbers	
	liters/day	percentage	liters/day	percentage
influenced	24,02	22,66%	28,71	28,63%
not influenced	81,97	81,97%	71,57	71,37%

source: Hojsák, Evaluation of drinking water consumpiton by households in the CR, 2016

5. Conclusion

Drinking water, even though in our climatic belt is everywhere, is a very rare raw material. With this knowledge, everyone should manage their consumption of drinking water well, because it matters. Prices of this essential commodity have rapidly increased in the last 20 years.

An important aim of this thesis was to describe and show the increasing prices of drinking water as well as the consumption itself. The author focused on actual drinking water consumption in Czech households and types of consumption, which have been demonstrated in the analytical part.

Secondary data research and the evaluation of the data confirms that the consumption of drinking water collected in apartments showed an increasing trend of water usage up until the year 2011. Since the year 2011 the data has been decreasing. In comparison, the consumption of drinking water in the apartments shows that water saving behavior matters with a high difference in cubic liters consumed and price paid.

Using the correlation analysis, it is demonstrated that there is no connectivity between air temperature and drinking water consumption in the apartments without a garden, pool and place to wash the car.

An example of consumer consumption by unit - in this case toilet flushing, shows huge differences between a dual flush system and a single flush system. The price annually reaches the value of 1371,5 CZK when comparing a single flush system and a dual flush system with “saving mode” used by 4 people. With this price, the payback period would be 3,03 years, if a whole set of a dual flush system is bought for the price of 3290 CZK.

Based on primary data research collection of drinking water consumption over the 10 days of the author’s experiment, a difference between using the “saving mode” or the “normal

mode" was found. The consumption differed by 58,1 liters per day per capita. This is an annual value of 21,2 cubic liters.

Last but not least is the usage of rainwater and its suggestibility. We can replace drinking water with rainwater in almost 40% of our consumption – mainly in toilet flushing and with the use of the washing machine. If an investment into new rainwater appliances can't be made, we can still think about influencing our water consumption as influenced consumption of water could be almost 30%.

If consumers want to pay the same prices for water despite continually rising prices of water and sewer rates, decreasing their consumption or investing into economically friendly appliances is the only way.

In conclusion, it is important to remember that we are consuming **drinking water** in the daily household activities that are written in the above thesis

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7. Apendix

Apendix 1, Collected data for drinking water consumption over 10 days

1.	toilet	8,7	3.	toilet	4,2	5.	toilet	4,3
1.	hand washing	0,2	3.	hand washing	0,2	5.	hand washing	0,2
1.	tooth brushing	0,8	3.	tooth brushing	0,8	5.	taking shower	34
1.	drinking	0,5	3.	taking shower	25,9	5.	shower leak	3,1
1.	toilet	5,8	3.	shower leak	3,1	5.	drinking	0,5
1.	hand washing	0,2	3.	drinking	0,6	5.	tooth brushing	0,6
1.	taking shower	69,4	3.	washing machin	43	5.	toilet	5,6
1.	shower leak	3,1	3.	hand washing	1	5.	hand washing	0,3
1.	hand washing	0,2	3.	toilet	6	5.	food preparatior	2,2
1.	toilet	6,6	3.	food preparatior	2,5	5.	cooking	1
1.	hand washing	0,2	3.	washing dishes t	0,5	5.	dishwasher	17
1.	taking shower	20,6	3.	hand washing	0,4	5.	toilet	8,1
1.	shower leak	3,1	3.	toilet	4,8	5.	hand washing	0,3
1.	toilet	4,1	3.	hand washing	0,2	5.	taking shower	26,4
1.	hand washing	0,2	3.	tooth brushing	0,8	5.	shower leak	3,1
1.	drinking	0,5	3.	drinking	0,5	5.	drinking	0,5
1.	tooth brushing	0,8	3.	tap leak	6	5.	toilet	4,6
1.	tap leak	6	4.	toilet	5,5	5.	hand washing	0,3
2.	toilet	4,2	4.	hand washing	0,3	5.	tooth brushing	0,8
2.	hand washing	0,2	4.	tooth brushing	0,7	5.	tap leak	6
2.	tooth brushing	0,8	4.	drinking	0,5	5.	drinking	0,4
2.	drinking	0,6	4.	cooking	3	6.	toilet	4
2.	toilet	7,8	4.	other	1	6.	hand washing	0,2
2.	hand washing	0,2	4.	toilet	6	6.	drinking	0,5
2.	toilet	3,4	4.	hand washing	0,3	6.	tooth brushing	0,2
2.	hand washing	0,2	4.	shaving	14,5	6.	toilet	7,8
2.	toilet	9,2	4.	taking shower	27	6.	hand washing	0,2
2.	hand washing	0,2	4.	toilet	4,8	6.	food preparatior	2,1
2.	toilet	3,8	4.	hand washing	0,2	6.	washing dishes t	8,2
2.	hand washing	0,2	4.	drinking	0,4	6.	toilet	4,4
2.	taking shower	20,6	4.	taking bath	132	6.	hand washing	0,1
2.	shower leak	3,1	4.	bath leak	1,4	6.	toilet	4,1
2.	drinking	0,5	4.	toilet	7	6.	hand washing	0,2
2.	toilet	4,3	4.	hand washing	0,4	6.	taking shower	6,1
2.	hand washing	0,2	4.	tooth brushing	0,8	6.	shower leak	3,1
2.	hand washing	1	4.	tap leak	6	6.	drinking	0,7
2.	tooth brushing	0,8	4.	drinking	0,3	6.	toilet	4,7
2.	hand washing	0,2				6.	hand washing	0,2
2.	dishwasher	17				6.	tap leak	6
2.	tap leak	6				6.	tooth brushing	0,1

Apendix 2, Collected data for drinking water consumption over 10 days

7.	toilet	4,5	9.	toilet	4,5
7.	hand washing	0,1	9.	hand washing	0,2
7.	tooth brushing	0,15	9.	taking shower	7,9
7.	drinking	0,4	9.	shower leak	3,1
7.	taking shower	8,3	9.	tooth brushing	0,2
7.	shower leak	3,1	9.	toilet	5,7
7.	cooking	1,8	9.	hand washing	0,2
7.	hand washing	0,4	9.	food preparatior	1,5
7.	toilet	6,2	9.	cooking	4
7.	hand washing	0,4	9.	drinking	0,4
7.	dishwasher	17	9.	toilet	6,3
7.	washing machin	43	9.	hand washing	0,3
7.	toilet	5,1	9.	taking shower	8,7
7.	hand washing	0,2	9.	shower leak	3,1
7.	toilet	4,9	9.	toilet	4,1
7.	hand washing	0,3	9.	hand washing	0,2
7.	tooth brushing	0,2	9.	drinking	0,6
7.	drinking	0,5	9.	tooth brushing	0,2
7.	tap leak	6	9.	tap leak	6
8.	toilet	5	10.	toilet	4,2
8.	hand washing	0,2	10.	hand washing	0,3
8.	tooth brushing	0,2	10.	tooth brushing	0,2
8.	toilet	5,3	10.	drinking	0,4
8.	hand washing	0,3	10.	shaving	4,7
8.	drinking	0,5	10.	toilet	5,3
8.	toilet	4,2	10.	hand washing	0,2
8.	hand washing	0,2	10.	food preparatior	2,6
8.	toilet	6	10.	dishwasher	17
8.	hand washing	0,3	10.	drinking	0,5
8.	toilet	5,1	10.	toilet	6,7
8.	hand washing	0,2	10.	hand washing	0,4
8.	drinking	0,7	10.	taking shower	9,5
8.	washing machin	39	10.	shower leak	3,1
8.	toilet	4,8	10.	drinking	0,3
8.	hand washing	0,2	10.	toilet	4
8.	tooth brushing	0,2	10.	hand washing	0,2
8.	tap leak	6	10.	tooth brushing	0,2
			10.	tap leak	6

Apendix 3, Collected data for drinking water consumption over 10 days

Days	total (litres)	toilet	hand washin	tooth brushi	drinking	showering	leaks	dishwasher/	washing mac	food prepara	cooking	shaving	taking bath	other	Checking
1.	131	25,2	1	1,6	1	90	12,2								131
percentage		19	1	1	1	69	9								
2.	84,5	32,7	2,4	1,6	1,1	20,6	9,1	17							84,5
percentage		39	3	2	1	24	11	20							
3.	100,5	15	1,8	1,6	1,1	25,9	9,1	0,5	43	2,5					100,5
percentage		15	2	2	1	26	9	0	43	2					
4.	212,1	23,3	1,2	1,5	1,2	27	7,4				3	14,5	132	1	212,1
percentage		11,0	0,6	0,7	0,6	12,7	3,5	0,0	0,0	0,0	1,4	6,8	62,2	0,5	
5.	**119,3**	**22,6**	**1,1**	**1,4**	**1,4**	**60,4**	**12,2**	**17**		**2,2**	**1**				**119,3**
percentage		**19**	**1**	**1**	**1**	**51**	**10**	**14**	**0**	**2**	**1**				
6.	52,9	25	0,9	0,3	1,2	6,1	9,1	8,2		2,1					52,9
percentage		47,3	1,7	0,6	2,3	11,5	17,2	15,5	0,0	4,0					
7.	102,55	20,7	1,4	0,35	0,9	8,3	9,1	17	43		1,8				102,55
percentage		20,2	1,4	0,3	0,9	8,1	8,9	16,6	41,9	0,0	1,8				
8.	78,4	30,4	1,4	0,4	1,2		6		39						78,4
percentage		38,8	1,8	0,5	1,5	0,0	7,7	0,0	49,7						
9.	57,2	20,6	0,9	0,4	1	16,6	12,2			1,5	4				57,2
percentage		36,0	1,6	0,7	1,7	29,0	21,3	0,0	0,0	2,6	7,0				
10.	**65,8**	**20,2**	**1,1**	**0,4**	**1,2**	**9,5**	**9,1**	**17**		**2,6**		**4,7**			**65,8**
percentage		**30,7**	**1,7**	**0,6**	**1,8**	**14,4**	**13,8**	**25,8**	**0,0**	**4,0**	**0,0**	**7,1**			
TOTAL	1004,25														1004,25
Average	100,425														
Avg except d4	88,0	except day with bathing (very rare)													

Apendix 4, Collected data for drinking water consumption (saving and normal mode)

		total	toilet	hand wasing	tooth brushi	drinking	taking showe	leaks	dishwasher	washing mac	food prepara	cooking	shaving	taking bath	other	
saving mode	5 days	356,85	116,9	5,7	1,85	5,5	40,5	45,5	42,2	82	6,2	5,8	4,7	0	0	
normal mod	5 days	647,4	118,8	7,5	7,7	5,8	223,9	50	34,5	43	4,7	4	14,5	132	1	
saving mode	1 day	71,37	23,38	1,14	0,37	1,1	8,1	9,1	8,44	16,4	1,24	1,16	0,94	0	0	saving mode
normal mod	1 day	129,48	23,76	1,5	1,54	1,16	44,78	10	6,9	8,6	0,94	0,8	2,9	26,4	0,2	normal mode

Apendix 5, Saving versus normal mode

saving	toilet	23,38
	hand washin	1,14
	tooth brushi	0,37
	drinking	1,1
	taking showe	8,1
	leaks	9,1
	dishwasher	8,44
	washing mac	16,4
	food prepara	1,24
	cooking	1,16
	shaving	0,94
	taking bath	0
	other	0
normal	toilet	23,76
	hand washin	1,5
	tooth brushi	1,54
	drinking	1,16
	taking showe	44,78
	leaks	10
	dishwasher	6,9
	washing mac	8,6
	food prepara	0,94
	cooking	0,8
	shaving	2,9
	taking bath	26,4
	other	0,2

Apendix 6, Difference in apartments

	in apartment per person (m3)						
	apt. 1	apt. 2	apt. 3	apt. 4	apt. 5	apt. 6	author
	26,5	33,0	29,3	28,8	25,4	34,7	
	23,5	43,3	16,8	25,8	25,0	31,3	
	25,5	50,0	5,0	30,0	23,4	27,3	
	23,8	52,0	27,5	31,3	18,8	26,0	
	23,8	51,0	25,3	30,5	18,0	30,7	
	27,0	53,3	22,8	34,3	19,5	29,5	
	29,5	48,7	21,3	34,5	20,5	31,8	
	26,4	43,6	38,4	33,3	20,1	30,3	
	27,0	37,8	36,0	30,3	25,7	27,7	
	26,0	40,4	38,7	28,3	22,7	30,0	
	24,8	36,0	27,0	32,5	24,0	28,3	
total	283,7	489,1	287,9	339,5	243,0	327,5	
average	25,8	44,5	26,2	30,9	22,1	29,8	32,12
		most		our	less		

Apendix 7, Apartment 4 data collection

Apt. 4				Source: czech hydrometeorogical station			
years	total m3	total CZK	price/m3	average tem	°C		
2005	115	4198	36,5	8-9°C	8		
2006	103	4120	40,0	8-9°C	8		
2007	120	5160	43,0	9-10°C	9		
2008	125	6000	48,0	9-10°C	9		
2009	122	6283	51,5	9-10°C	9		
2010	137	7535	55,0	7-8°C	7		
2011	138	7901	57,3	9-10°C	9		
2012	133,2	8392	63,0	9-10°C	9		
2013	121,3	8008	66,0	8-9°C	8		
2014	113,3	7480	66,0	10-12°C	10		
2015	130	9100	70,0	/	/		

Apendix 8, Buildings data collection

								in m3	in liters	in liters	
Years	Building	Total CZK	changes	no. Inhab.	changes apt.	m3/person	°C	Apartment n	Prague	Building	difference
2005	668	24382		19		35,2	8	115	127	96	31
2006	613	24520	change of pe	18		34,1	8	103	129	93	36
2007	576	24768	plus child	19	plus 1, apt. 6	30,3	9	120	127	83	44
2008	584	28032	plus child	20	plus 1, apt. 2	29,2	9	125	121	80	41
2009	635	32702,5	plus child	21	plus 1, apt. 6	30,2	9	122	114	83	31
2010	692	38060		21		33,0	7	137	104	90	14
2011	678	38815,5	garden	21		32,3	9	138	112	88	24
2012	609,6	38404,8	minus adult	20	min 1, apt. 1	30,5	9	133,2	113	84	29
2013	592	39072		20		29,6	8	121,3	111	81	30
2014	588	38808		20		29,4	10	113,3	106	81	25
2015	573	40110		20		28,7	/	130	106	78	28