

# Investigating of Water Practices and Savings in Istanbul by Means of GIS

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**Keywords:** GIS, conscious level, water culture, Istanbul.

## SUMMARY

Over population, pollution, deforestation and natural disasters are among the current major problems faced by the world. The increasing population and industrial development have put further pressure on the supply of fresh water. Water stress has become an important environmental issue in developing countries like Turkey, and in many countries agricultural and other economic activities can only be successfully carried out if sufficient fresh water is available.

In this study, the four districts of Istanbul, being the most crowded city of Turkey, were selected to determine the conscious level of the public water consumption by utilizing Geographical Information Systems (GIS). A survey was prepared consisting of 20 questions was circulated among the inhabitants. The filled forms were graded according to each neighborhood that was selected as unit in the selected district, and different queries and mappings are realized. The relationship between the conscious level, education and gender were displayed. Findings showed that males have higher conscious level on water consumption than females. Also, it has been displayed that conscious level is increased parallel to the education level.

## ÖZET

Aşırı nüfus, kirlilik, orman arazilerinin yok edilmesi ve doğal afetler dünyanın karşılaştığı en büyük problemler arasındadır. Artan nüfus ve sanayileşme de su kaynaklarına daha da baskı uygulamaya başlamıştır. Su sıkıntısı, Türkiye gibi gelişmekte olan ve başta tarım olmak üzere birtakım ekonomik ihtiyaçlarının suya dayalı olduğu ülkelerde önemli bir çevresel sorun olarak karşımıza çıkmaktadır.

Bu çalışmada Türkiye'nin en kalabalık şehri olan İstanbul'da dört adet ilçe seçilmiş ve bu ilçelerde Coğrafi Bilgi Sistemleri (CBS)'den yararlanılarak su tüketimi değerlendirilmeye çalışılmıştır. Bu bağlamda 20 sorudan oluşan bir anket hazırlanmış ve yürütülmüştür. Bu anketler puanlandırıldıktan sonra her bir ilçedeki mahalleler birim alınarak farklı sorgulama ve haritalamalar yapılmıştır. Böylece bilinç seviyesi, eğitim ve cinsiyet arasındaki ilişkiler belirlenmiştir. Bulgular, erkeklerin kadınlardan daha yüksek bir su bilincine sahip olduğunu ve su bilincinin eğitim seviyesiyle paralel bir eğilim gösterdiği tespit edilmiştir.

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## 1. INTRODUCTION

Almost 97.5% of available water on earth is brackish water, and unfortunately it cannot be directly used by the humans. 70% of the remaining 2.5% of water on earth exists as ice, and 30% of it is in the form of moisture and under-soil water. As a result, the accessible water on earth is only 1%. Therefore, the analysis and improvement of the sensitivity and conscious level on water issue is a crucial concern.

In parallel to technological changes in the world, the triggering effect of global warming indicates the loss of water supplies. Besides, over population is another threat that accelerates water consumption leading to loss of water resources. The water shortage especially causes troubles in countries which are economically based on agricultural and water-induced industries. These factors clearly show that water saving and awareness on water usage is a critical concern for future (Celikkale; 2006).

The water usage habits and water culture have to be determined for every country and for every city. Within this context, Geographic Information System (GIS) with its efficient, proactive structure and ability to reach the people with its visuality; is accepted as one of the best analysis methods regarding water saving and usage. In this study, GIS was used to determine the water consumption tendencies and related analyses were applied in the pre-selected districts of Istanbul. In this study, the analysis of the water consumption tendencies and water culture in GIS environment was intended. With its population over 12 millions, the four districts (Kadikoy, Bakirkoy, Sariyer, and Bahcelievler) of Istanbul were chosen according to general education level of the inhabitants and development status. To determine the conscious level, surveys consisting of 20 questions were used. Totally, 516 surveys were carried out and according to the evaluation grades the analysis was made. Based on these surveys, distribution of conscious level of the parishes, distribution of the educational overview and distribution of gender were recorded and presented visually on GIS environment.

## 2. GENERAL STATUS OF WATER

Water as the essential source of life is the main input of living organisms. However, in the past two decades, the growing population and water demand brought a potential water crisis into agendas. Besides these effects, water demand causes some economical, political and environmental struggles and competitions, and these are wide spreading. Water supplies head lots of problems regarding quantity, quality and sectoral uses. Agricultural use, industrial use, energy production, national security issues are also affected from the water crisis. Water is a

renewable source, but the fast consumption of water resources makes it hard in terms of sustainability.

Today, average annual water consumption is about 800m<sup>3</sup> per capita. About 20% of the world's population (1.4 billions people) is facing potable water shortage, and 2.3 billions people are away from healthy water resources. Some estimations state that in year 2025, more than 3 billions of people will face water shortage. According to FAO (1995), in 1995 the water shortage and water stress living population were respectively 29% and 12%; in 2025 these ratios are estimated as 34% and 15%. Moreover, in year 2050, the quantity of the countries facing water problem will increase to 54 and the population that has to live in these conditions will increase to 3.76 billions. This situation shows that in 2050, as the overall population of the world is said to be 9.4 billions, 40% of the world will face water problems (World Health Organization; 1995).

The accessible water on earth is used 70% in agriculture, 22% in industry, 8% in domestic life. In Europe, 33% is used in irrigation, 51% in industry and 16% is used in drinking and general purposes (World Wildlife Fund, 2007).

In order to be a water-rich country, unit water amount per capita must be at least 8.000-10.000 m<sup>3</sup> annually. As it is 1500 m<sup>3</sup> in Turkey, she cannot be regarded as a water-rich country (World Health Organization; 1995). If no sustainable and rational policies are taken into consideration, Turkey will face serious problems in future. As of today, 33% of the cities and 75% of the rural areas use unhealthy water. Estimating that in 25-30 years time, population will increase to 90-100 millions, only the population growth will cause 37% decrease in water quantity per capita except the agricultural demand. Population in Istanbul increased to 12 millions with the migration especially from the eastern part of the Turkey. Because of that social fact, some ghetto districts with undeveloped infrastructure were formed. In 1981, ISKI (Water and Sewerage Administration of Istanbul) was established and protection of water sources had become the main concern of the administration. According to the strategic plan, simultaneous pollution monitoring system is one of the most important issues. "Protecting and Controlling the Drinking Water Basins Regulation" is set in 2003 and recently revised in 2007 (Istanbul Metropolitan Municipality; 2007). There are 7 surface water reservoirs in Istanbul, 3 in the Anatolian side and 4 in the European side. In order to protect these sources, water must be used more economically and consciously. So in this study, it was attempted to determine how people are aware of the water problem.

### **3. DATA AND METHODOLOGY USED**

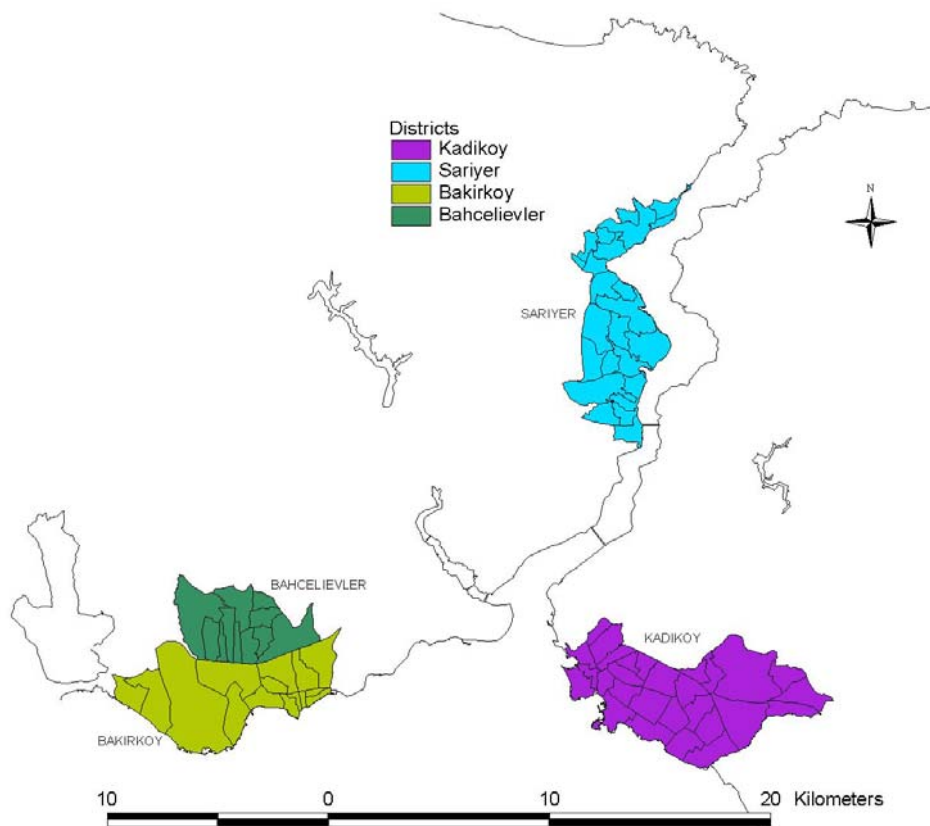
GIS is the usage of the computer hardware, software supporting that hardware and geographic data in coordination in order to acquire, process, manage, analyze and visualize geographical information (ESRI, 2007).

GIS is a system that acquires and re-evaluates the information and records of the related environment and depending on the standards, provides the determination of the areas

belonging to the questioned environment texture, finds the relation between data-sheets about this texture, analyzes the location data, helps the application focused models which evaluates the alternatives causing environmental effect to choose the related data and provides visualization of the questioned location (Huber; 2000).

In this study, for having background information on the water usage habits and water culture in Istanbul, a survey consisting of 20 questions were carried out. While selecting the pilot areas in order to have overall information on Istanbul's tendency, socially and economically different 4 districts (Sariyer, Kadikoy, Bakirkoy, and Bahcelievler) were taken into account (Figure 1). The educational level, age and gender of the subjects were added to the survey as part of the questions. The aim of that was to lighten the correlation between the conscious level and education, age and gender, respectively.

The conducted surveys were evaluated depending on the evaluation chart in which every question had its own mark. Taking these results into account, conscious level intervals were formed and the general conscious level of each selected district and its parishes were gathered. The general evaluation of the surveys is given in Table 1.

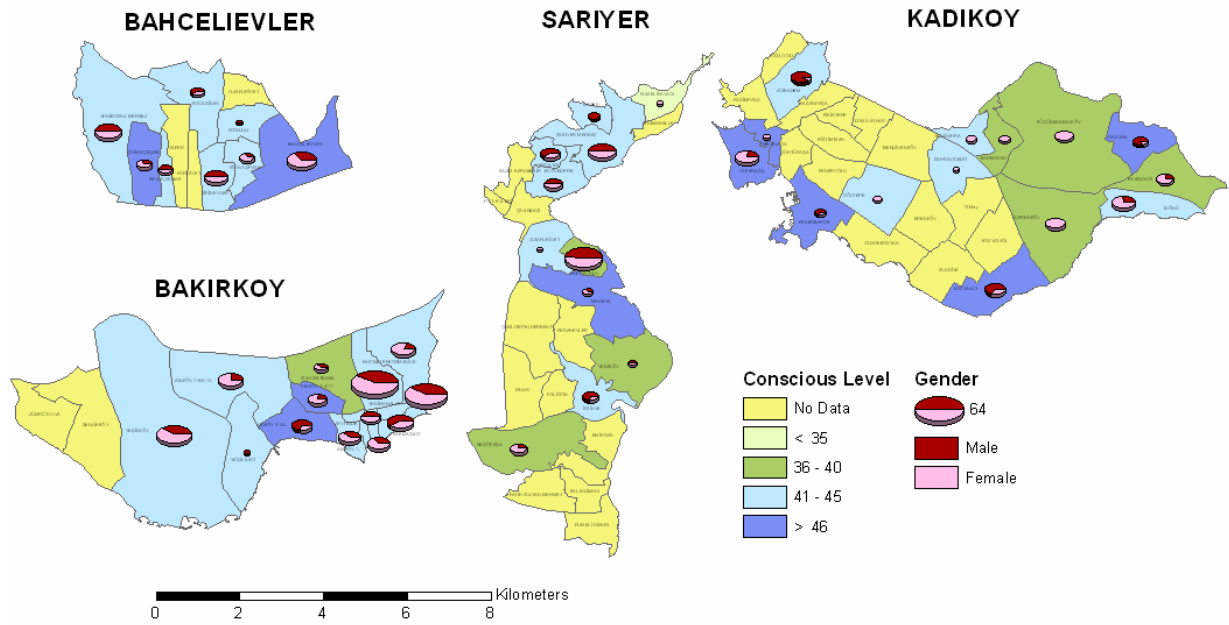


**Figure 1.** Location of the selected districts

**Table 1.** General evaluation of the districts

District	Educational Level					Gender		Survey Number	Consciousness Level
	Parish	University	High School	Elementary School	Primary School	Male	Female		
BAKIRKOY	Atakoy 1.	7	1	4	1	5	8	13	43
	Atakoy 2-5-6.	4	4	1	0	7	3	10	49
	Atakoy 3-4-11.	5	2	2	0	2	7	9	47
	Atakoy 7-8-9-10.	8	2	4	1	4	12	16	45
	Cevizlik	0	2	7	1	5	5	10	43
	Kartaltepe	20	21	8	1	24	33	57	42
	Osmaniye	6	2	5	0	3	13	16	43
	Sakizagaci	5	3	5	2	10	7	17	44
	Yenimahalle	8	10	18	9	20	28	48	42
	Yesilkoy	7	17	8	0	13	19	32	43
	Yesilyurt	1	0	0	0	1	0	1	45
	Zeytinlik	4	8	1	1	5	9	14	45
	Zuhuratbaba	3	2	0	0	2	3	5	40
<b>SUM</b>	<b>78</b>	<b>74</b>	<b>63</b>	<b>16</b>	<b>101</b>	<b>147</b>	<b>248</b>	<b>43.92</b>	
BAHCELIEVLER	Bahcelievler	12	5	1	1	8	14	22	46
	Cobancesme	3	0	1	2	2	4	6	48
	Fevzicakmak	2	4	0	0	3	3	6	43
	Kocasinan	4	1	0	0	3	2	5	42
	Siyavuspasa	3	3	0	0	2	4	6	42
	Soganli	0	0	1	0	1	0	1	41
	Sirinevler	4	5	3	2	7	7	14	42
	Yenibosna	3	11	2	2	9	9	18	45
<b>SUM</b>	<b>31</b>	<b>29</b>	<b>8</b>	<b>7</b>	<b>35</b>	<b>43</b>	<b>78</b>	<b>43.63</b>	
KADIKOY	Acibadem	3	4	3	1	10	1	11	44
	Ataturk	4	0	2	0	5	1	6	46
	Barbaros	0	0	2	0	0	3	3	40
	Bostanci	10	0	0	2	8	4	12	48
	Caferaga	13	0	1	0	3	11	14	47
	Fenerbahce	1	0	1	1	2	1	3	46
	Goztepe	1	0	0	1	0	2	2	43
	Icerenkoy	3	0	0	7	0	10	10	40
	Inonu	2	4	5	3	4	11	15	43
	Kayisdagi	0	5	0	3	2	6	8	38
	Kucukbakkalkoy	0	0	0	5	0	9	9	37
	Osmanaga	1	0	0	0	0	1	0	46
	Sahrayicedit	1	0	0	0	0	1	1	44
Yenisahra	0	0	1	2	0	3	3	44	
<b>SUM</b>	<b>39</b>	<b>16</b>	<b>17</b>	<b>25</b>	<b>34</b>	<b>63</b>	<b>97</b>	<b>43.29</b>	
SARIYER	Buyukdere	2	6	1	1	5	5	10	43
	Cumhuriyet	1	0	0	0	0	1	1	43
	Istinye	2	2	0	3	5	2	7	41
	Kirecburnu	0	11	6	10	7	20	27	40
	Kocatas	10	0	0	0	6	4	10	45
	Maden	1	1	2	0	4	0	4	45
	Resitpasa	8	0	0	0	2	6	8	38
	Rumelikavagi	0	1	0	0	0	1	1	35
	Sariyer Merkez	9	3	4	4	10	10	20	43
	Tarabya	2	1	0	0	1	2	3	46
Yenikoy	2	0	0	0	1	1	2	40	
<b>SUM</b>	<b>37</b>	<b>25</b>	<b>13</b>	<b>18</b>	<b>41</b>	<b>52</b>	<b>93</b>	<b>41.73</b>	

Figure 2 indicates the relationship between the conscious level and the gender of the inhabitants according to the survey result. In this figure, the pie-chart displays the gender distribution and sizes of the charts represent the number of participants in the parishes. Thus, bigger chart indicates the larger amount of survey carried out in the related parishes. If there is no chart in the parishes, it means that no surveys were conducted in that parish. When the relation is examined based on the gender, it can be said that the conscious level of male participants is generally higher than females' on the selected districts.

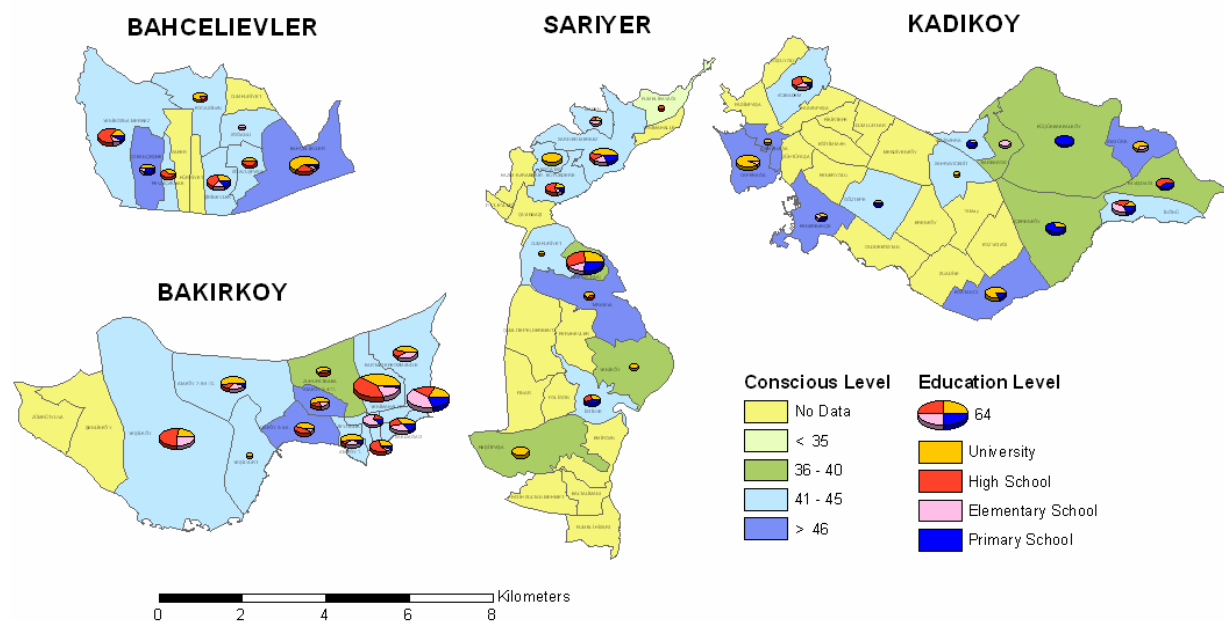


**Figure 2.** Presentation of conscious level and gender in the selected districts

Figure 3 presents the relationship between the conscious level and educational level of participants for each parish. It is clearly seen that the conscious level gets higher parallel to the educational level.

#### 4. RESULTS AND CONCLUSIONS

As the water shortage gets more critical especially in the mega cities like Istanbul, the importance of the education level comes upfront. As it was aimed to obtain the conscious levels in this study, it can be clearly seen that conscious levels are relatively better in highly educated locations as the main identification. Additionally, when Bahçelievler district is examined it will be seen that, the amount of university based subjects and the education campaigns carried out in lower degree schools have increased the conscious level average. Besides, it is seen that male subjects in this project seems to have higher conscious level than the females (Table 2). Although the number of female subjects is more than males and are the main water consumers regarding the social structure in Turkey as they mostly act as housewives, to have a lower conscious level of water usage, must be questioned.



**Figure 3.** Presentation of conscious level and educational level in the selected districts

**Table 2.** General Evaluation of the Surveys

District	Conscious Levels depending on Gender		Conscious Levels depending on Education				District Average
	Male	Female	Primary School	Elementary School	High School	University	
Bakirkoy	44.87	43.26	39.72	43.04	44.79	44.42	43.92
Bahcelievler	43.11	44.06	41.13	42.17	43.00	46.29	43.63
Kadikoy	44.53	42.63	40.67	41.12	42.48	46.20	43.29
Sariyer	41.88	41.57	40.71	39.78	42.41	42.29	41.73
Average	43.60	42.88	40.56	41.53	43.17	44.80	43.14

One of the problems that were encountered during this study was that the surveys were not quite efficient as expected. Because of time and personnel limitation, surveys were carried out in limited areas which effected the data distribution. Besides, incomplete surveys caused some discrepancies such as the inequality at the total number of participants found from gender and education data. But in spite of these facts, it can be said that the study fits the needs as it can clearly state the importance of the education and the water usage consciousness. Furthermore, it was observed that GIS is an efficient tool for conducting such studies. These maps which are produced to determine the conscious level can also be used to pull these levels higher.

In order to carry out such a project in a healthier manner and more efficiently, the data acquisition step must be handled more comprehensively. To obtain more accurate results, the

surveys that can expose the social structure must be designed and they have to be carried out by professionals of the subject of concern and statistical evaluation must be made.

Lastly in order to increase the awareness on water uses, the local authorities, municipalities, universities and NGOs have to come up with permanent, future oriented ideas and projects in co-operation. Changing the current situation into a hopeful future is up to this alliance.

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