Water use efficiency and economic approach

National study Turkey

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Final version

Plan Bleu
UNEP/MAP Regional Activity Centre

Sophia Antipolis
July 2011

CONTENTS

Abbreviations and acronyms

DSI	General Directorate of State Hydraulic Works
dWTP	Drinking Water Treatment Plant
EIB	European Investment Bank
EU	European Union
EUROSTAT	European Statistics
NRW	Non-revenue water
MESKIMersin	Water Supply and Sewerage Administration
O&M	Operation and Maintenance
SPO	State Planning Organization
TASKI	Tarsus Municipality's Water and Sewerage Operating Enterprise
TUBITAK	National Research Council
TURKSTAT	Turkish Statistical Institute
VAT	Value Added Taxe
WUA	Water User's Association

I. Municipal water use

1. Comments on definitions

Ref. Doc. Methodological note of water efficiency index calculation

(2.1 Drinking water efficiency)

Epot = V1/V2

V1 = drinking water volume invoiced and paid by consumer km^3/year

V2 = total drinking water volume produced and distributed in km^3/year

Invoiced (billed) water does not necessarily mean paid water. The billing/collection ratio reflects the financial performance of the municipality's related department for domestic (drinking and household) water management.

In other words Vp>Vd>Vb>Vc where Vp= volume of water produced; (abstracted, treated); Vd = volume of water distributed, Vb= Volume of water billed (invoiced); Vc=Volume of water corresponding to the volume sold (fee collected).

Vp reflects water measured at the outlet of either the water treatment plant or storage tank (if abstracted from wellfield) before the distribution.

Vp-Vd = asset losses (treatment plant + transmission line, storage tank).

Vd-Vb = physical losses (real) +non-physical (apparent or commercial) losses.

Vb-Vc = billed but unpaid[1] (Vc may correspond in some cases to gross invoice issued by a municipality for bulk water).

2. Definitions and method used in municipal water management

The water use efficiency index indicates how to measure progress in water savings through demand management, by reducing losses and wasteful use mainly during its transmission and distribution. It covers total and sectoral efficiency in domestic (municipal), agricultural and industrial water use. The municipal water use efficiency index, the subject of this present section is defined as the ratio of the 'total drinking water volume billed' to the 'total volume supplied (abstracted/treated and distributed)' to the customers by the municipalities as formulated below:

$$Emun = \frac{Vb}{Vs}$$

; Where *Emun* (%): Municipal water use efficiency index, Vb: volume billed to the customers by the municipalities (m^3/year) and Vs: volume supplied to the customers (m^3/year) by the municipalities.

The municipal water in Turkey stands for potable water supplied by the water authority (the water department of the municipality) via the municipal network to various customers (housing areas, commercial districts, institutional and recreational facilities) that may use this water for drinking, washing, bathing, culinary, waste removal, yard, cemetery and garden watering purposes. The customers are divided in three groups as domestic (household), commercial/industrial and public according to the purpose of their main utilization. It also includes unaccounted system losses and leakage.

The sectoral efficiency index indicates both the physical efficiency of municipal drinking water network in terms of physical losses and commercial efficiency, reflecting the institutional capacity of the water authority

[1] This may be due to free water in some cases

concerned to recover operation & maintenance costs through water bills. Revenue collection performance defines revenues collected divided by revenues billed in a specific year.

The sources of non-revenue water (NRW) are mainly physical (real) and non-physical (apparent or commercial). The physical losses constitute that portion of water that is produced but not consumed, whereas the non-physical portion is consumed but it is either unbilled metered or unbilled unmetered as a result of unauthorized consumption, which implies illegal connection to the municipal network. NRW components are similar to water loss definitions and classifications as given in Figure 1.

$$NRW = \frac{(\mathrm{Vs} - \mathrm{Vb})}{\mathrm{Vs}}$$

Figure 1 - Water loss definitions and classifications

<table>
<tr><td rowspan="9">System Input Volume (corrected for known errors) (Water Produced + Water Imported)</td><td rowspan="4">Authorized Consumption</td><td rowspan="2">Billed Authorized Consumption</td><td>Billed Metered Consumption (including water exported)</td><td rowspan="2">Revenue Water</td></tr>
<tr><td>Billed Un-metered Consumption</td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption</td><td>Unbilled Metered Consumption</td><td rowspan="7">Non-Revenue Water (NRW)</td></tr>
<tr><td>Unbilled Un-metered Consumption</td></tr>
<tr><td rowspan="5">Water Losses</td><td rowspan="2">Apparent Losses</td><td>Unauthorized Consumption</td></tr>
<tr><td>Customer Metering / Billing Inaccuracies</td></tr>
<tr><td rowspan="3">Real Losses</td><td>Leakage on Transmission and/or Distribution Mains</td></tr>
<tr><td>Leakage and Overflows at Utility's Storage Tanks</td></tr>
<tr><td>Leakage on Service Connections up to point of Customer metering</td></tr>
</table>

Source: Alegre et al., 2006

3. Sectoral analysis based on national policy and planning documents and case studies

Based on the Turkish Institute of Statistics (TURKSTAT) data it can be stated that data collection from municipalities was not efficient in 2004. Out of 3215 municipalities where questionnaire was sent, only 1605 have responded. Billing and collection data are the least clear process to understand. Irrigation of parks and gardens that belong to municipalities utilize free-of charge water but there is an uncertainty whether this amount of water is metered and billed or not. Some municipalities apply bulk collection. Some domestic customers may use free-of charge water upon the decision taken by the relevant municipality. In Istanbul, in the early 1990s, the first part of the consumption, up to $10m^3$ was free-of charge in order to subsidize low-income groups for low consumption rate. This strategy has been abandoned afterwards, because this management approach has generated a big hole in the municipal revenues.

Free-of charge consumption, comprising the mosques, gardening water for municipal parks, cemeteries and fire fighting, is estimated to be 2% in three case studies carried out between 2004 and 2007, this ratio is confirmed through the compilation of data issued by TURKSTAT in 2006 for volume of water distributed (not necessarily sold/ water fee collected) and for volume of water sold/water fee collected. The total volume distributed by 2695 municipalities[2] (municipalities that have responded to the questionnaire).

TURKSTAT has the information about the total water abstracted from surface water resources (dams, lakes, rivers or wells) through records provided by the State Hydraulic Works that meter withdrawals for all uses. In

[2] Total number of municipalities in Turkey based on the census results of 2000 is 3228 (TURKSTAT, 2007)

theory, distributed water equals to sold water but in practice there is a discrepancy between the two values due to the difference of water distributed and water sold which equals to free-of charge public and municipal consumption. Municipal parks and gardens utilize free-of charge water but it is not clear whether this amount of water is metered or not. As given in (TableT4 in the Annex) the volume distributed in 2695 municipalities is 2 375 043 316 m^3/year in 2006; the corresponding income generated equals to 3 096 377 755 YTL (excluding VAT) whereas sold volume of water equals 2 315 942 300 m^3/year;[3] which means that the difference of approximately 2% between volume of water distributed and volume of water sold reflects commercial NRW (free-of charge consumption).

TURKSTAT started in 2006 to collect financial data from municipalities based on questionnaire; therefore data related to previous years are not available.

In order to be able to follow-up customer service expenditures, a system of reliable record comprising technical measurement and monitoring must be set up/improved in municipalities (e.g. failure in monitoring efficiently municipal water services may generate large amount of wasted water as it was the case in a city located in Central Anatolia where 67% of the abstracted volume was lost due to the uncontrolled overflow from the storage tank, in which case water was withdrawn directly from the river, stored in the main tank and withdrawn from the tank for distribution through the municipal network)[4]. The reason for this failure was that water wasted was not metered as stored volume in the municipal accounting system.

In general there is a discrepancy between data since administrations have their own method of management that is not necessarily similar with the others and each administration (each department in some cases) knows in details its own projects and as regular institutional exchange of information is limited to case-by-case need, a widespread application is missing. Iller Bank and DSI may conduct water projects on behalf of municipalities; in addition, union of municipalities and/or water and sewerage administrations of metropolitan municipalities may also receive international or bilateral loan for the implementation of water works that lead to difference in the source of data. Therefore TURKSTAT compiles statistical data based on the records provided by these municipalities.

Common understanding and standards must be elaborated and accepted to avoid any further differences in data compilation, generation and processing[5].

Technical details concerning municipal water use are given in tables and figures below:

Table 1 - Water abstraction by resources for municipal use 2004 (1000m^3/year)

Water source	Total (including industry and energy producers)	Municipalities
Total	8 761 262	4 956 437
Sea	3 153 096	----
Dam	2 115 362	1 986 882
Spring	1 393 813	1 363 360
Well	1 650 601	1 375 737
River	218 640	143 064
Lake & artificial lakes	111 385	87 394
Others	118 365	----

Source: TURKSTAT, 2004

[3] These data have been calculated by TURKSTAT specifically upon request for the present study

[4] TURKSTAT has noticed this case since the per/capita consumption figure of this city was approximately 450 l/cap-d compared to the national average of 245 l/cap-d

[5] For instance deep-sea outfall that is simply a physical way of sewage disposal mean is still conceived as a sewage treatment technique by certain water professionals

Table 2 - Comparison of water supply data of 2001 & 2004

Statistical value on water supply	Year	
	2001	2004
Municipality water abstraction	4.66 billion m3	4.96 billion m3
Municipalities with drinking water supply systems *	3092	3159
Population served by drinking water supply systems (%)	95	99
Number of municipalities with dWTP **	236	304
Amount of drinking water treated	1.66 billion m3	2.08 billion m3
Population served by a dWTP (%)	35	42
Number of dWTPs	113	140

* Out of the total 3213 municipalities; ** : Drinking Water Treatment Plant.
Source: TURKSTAT, 2004

Table 3 - Per-capita water consumption in Turkey's geographical regions

Geographic Regions	Per capita Consumption (liter/day)
Mediterranean	113
Eastern Anatolia	107
Aegean	110
Southeastern Anatolis	81
Central Anatolia	96
Marmara	104
Black Sea	71
Average	88

Source: SPO, 2002

Table 4 - Member/family distribution based on geographical region

Geographic Regions	1985	1990	1994
Mediterranean	5.16	4.91	4.13
Eastern Anatolia	6.66	6.48	5.45
Aegean	4.48	4.31	3.63
Southeastern Anatolis	6.45	6.58	5.54
Central Anatolia	5.32	5.09	4.28
Marmara	4.43	4.21	3.54
Black Sea	5.71	5.42	4.56
Average	5.46	5.29	4.45

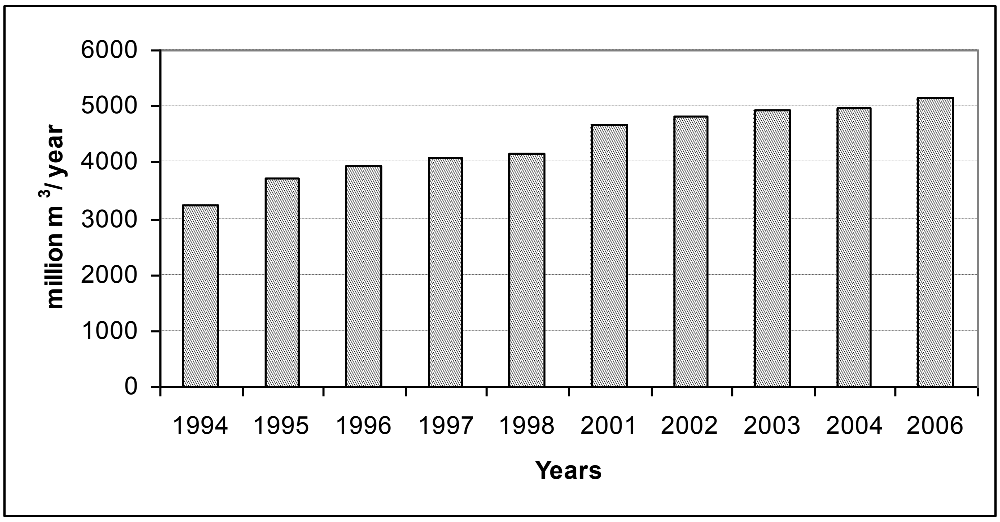
Source: SPO, 2002

Table 5 - Water consumption per household in each geographical region

Geographic Regions	Consumption/house (l/day)
Mediterranean	467
Eastern Anatolia	584
Aegean	401
Southeastern Anatolis	450
Central Anatolia	412
Marmara	368
Black Sea	324
Average	409

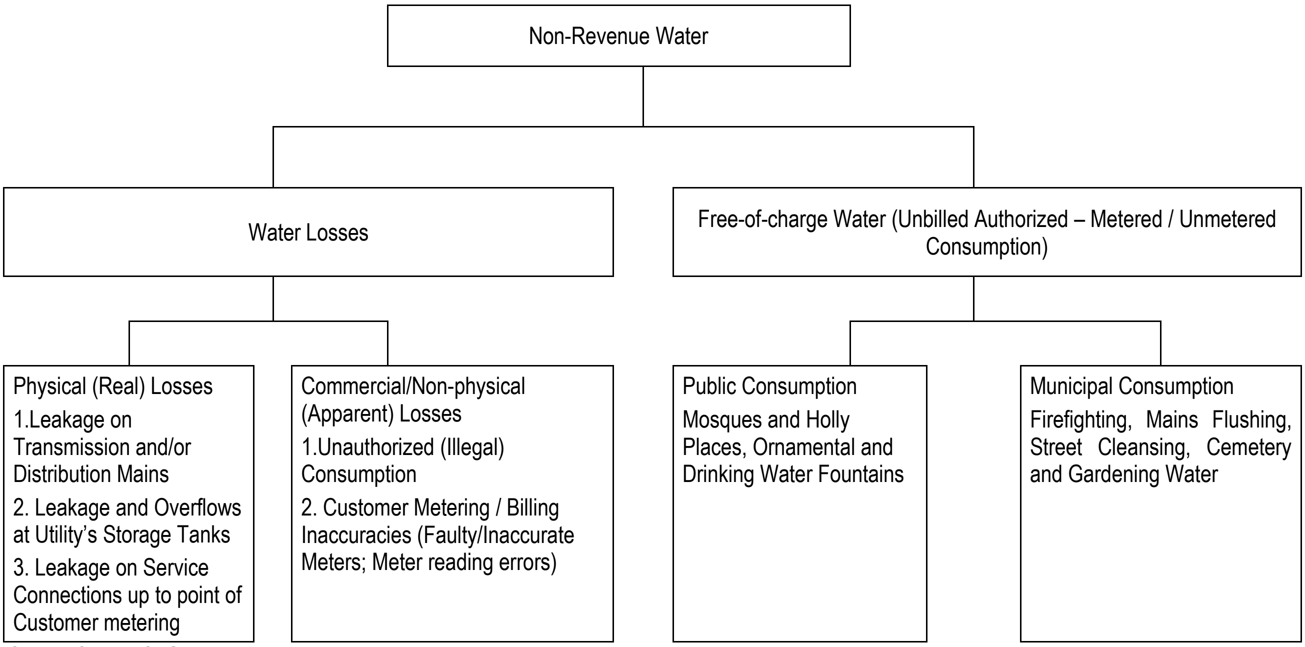
Source: SPO, 2002

Figure 2 - Evolution of water supplied for municipal use (million m³ /year)



Source: Source: SPO, 2002

Figure 3 - Sources of non-revenue water in municipalities in Turkey



Source: Source: SPO, 2002

4. Case Studies

Inset 1 - Case study 1

Many municipalities located in coastal areas of Turkey still discharge their wastewaters untreated to the sea mainly via deep sea discharges which is against both local environmental regulations and, being an EU accession country, EU environmental acquis. The main reason for this violation of environmental regulations is the financial constraints of the municipalities involved. Central governmental support is limited, political concerns play key roles in municipal decision making as well as overestimation of socio-economic difficulties, especially about the tariff affordability of the low-income groups which reduce willingness-to-charge the full cost recovery tariffs in accordance with the “polluter pays” principle by the elected Mayors and the members of the Municipal Councils.

Disposing urban wastewater collected via deep-sea outfalls has been selected as the most economical solution by the governments in Turkey and applied by Iller Bankası (Bank of Provinces which provides technical, financial and implementation support to Turkish municipalities for local infrastructure development) so far. However, to be able to comply with the EU environmental acquis the central government has decided to declare all seas (Black Sea, Marmara, Aegean and Mediterranean) as sensitive areas which will require application of advanced wastewater treatment processes including nitrogen and phosphorus removal by all coastal municipalities in Turkey. This will be a big challenge for the protection of the marine environment which, at the same time, necessitates implementation of operationally and financially sustainable measures.

The financial impact of implementing advanced wastewater treatment technologies on the municipalities and, especially on the households to which incremental costs would be reflected as tariff increases to ensure full cost recovery, have been analyzed by making use of the real-life examples of three medium-sized Turkish municipalities discharging their wastewaters untreated to the sea. Figure 4 shows the location of the municipalities:

- Ordu Central District Municipality of Ordu Province discharging directly to the Black Sea;
- Çarşamba District Municipality of Samsun Province discharging to Kızılırmak River flowing to the Black Sea (1 km upstream);
- Ceyhan District Municipality of Adana Province discharging to Ceyhan River flowing to the Mediterranean (25 km upstream).

Figure 4 - Location of the municipalities

Source: Burak, 2008

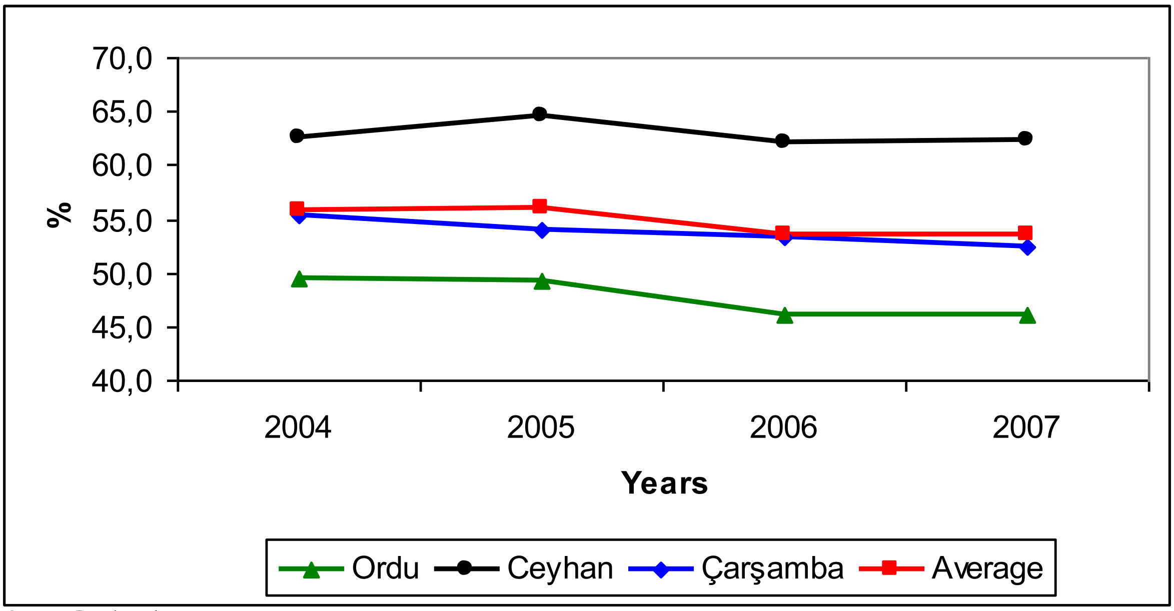
The NRW is above 50% which is typical for Turkey. The highest NRW among the case studies belongs to Ceyhan Municipality, with 62.4% as shown in Table 6 and Figure 5 below, due to major leaks and cracks in the main transmission line.

Table 6 - Non-revenue water (%)

Municipalities	2004	2005	2006	2007
ORDU	49.5%	49.2%	46.2%	46.1%
CEYHAN	62.5%	64.6%	62.0%	62.4%
ÇARŞAMBA	55.3%	54.0%	53.2%	52.4%
AVERAGE	55.7%	56.0%	53.6%	53.6%

Source: Burak and Mat, 2008

Figure 5 - Non-revenue water trend in case study areas



Source: Burak and Mat, 2008

Inset 2 - Case study 2

Project Title: Tarsus Municipality (TASKI) Consulting Services for management assistance and training/complementary measures

Overall Project Value: 737,915 Euro

Start – End Dates: December 2000 / August 2005

Partners: Deutsche Abwasser Reinigungs-gesellschaft (DAR) (Germany) / Berliner Wasser Betriebe (BWB) (Germany)

Project Description:

- Enable Tarsus Municipality's Water and Sewerage Operating Enterprise (TASKI) to implement a large scale Water/Wastewater Project co-financed by German Development Bank (KfW) and European Investment Bank (EIB) by improving its institutional capacity
- Advise the management in organizational and conceptual matters
- Support the construction department during the implementation of the project
- Advise and train the accounting staff of TASKI in their new commercial and accounting tasks, develop the accounting system, introduce a financial management information system
- Qualify the key staff for wastewater treatment plant management

Support the development of an effective environmental control system including drafting of a polluter register and internal regulations and control routines for monitoring industrial polluters.

Inset 3- Case study 3

The Government of the Republic of Turkey has received a loan from the International Bank for Reconstruction and Development (IBRD-World Bank) towards the cost of Municipal Services Project with the objective of improving and rehabilitating water supply, sewerage, storm water, solid waste and treatment works of selected municipalities in Turkey. The general management of this extensive project is carried out by the Management Unit established within the organizational structure of Iller Bank. A portion of this loan is allocated to the Mersin Water Supply and Sewerage Administration (MESKI) towards the cost of the services of Mersin Drinking Water Rehabilitation Project. The scope of the Project covers specifically MESKI Water Network Rehabilitation. To improve the existing 67% of Non-Revenue-Water (NRW) level of MESKİ, the training program focuses on three main topics as: 1) Recording, records keeping and documentation; 2) NRW management; 3) Operation and maintenance. (WB, 2008)

5. Finance

In the EU Integrated Environmental Approximation Strategy prepared for 2007-2023 by the Turkish Ministry of Environment and Forests, the following issues have been reported: Especially lack of adequate enforcement principles in broad terms (due to duplication/overlapping of the activities related to the permissions, monitoring, controlling and sanctions by different institutions), hinders the implementation of an effective environmental management plan.

The institutional infrastructure of the Ministry of Environment and Forestry must be developed especially with respect to the capacity related to emission permission, monitoring, pollution prevention and control, reporting and enforcement issues. The overlaps in the legislation cause the loss of labor, time and skills and as such reduce the efficiency.

Due to the fact that small and medium sized municipalities do not hold sufficient financing and institutional capacity, water and wastewater management becomes a concern. The insufficient level of tariffs and cross-subsidy between different groups of customers and also between departments/administrations create a severe bottleneck in the financial assessment of water services in order to evaluate cost-recovery of corresponding municipal services. Institutional strengthening must be supported and improved with appropriate legal and technical means.

Table 7 reflects the financial requirements in the water sector. As it can be seen, the highest investment package relates to network renewal investments.

At present, master plan and feasibility studies related to water services are being carried out in 15 municipalities with a financing of 3 Million Euros by the EC. In order to achieve the ultimate task of pollution control of water resources, wastewater treatment plants have to be built and properly operated in these selected municipalities. In order to ensure the recovery of the implementation cost, water customer services must be improved which means that water efficiency must be increased. This requires institutional strengthening and capacity building of the related municipalities with also raising public and political awareness in order to facilitate willingness to pay for the services they receive. The scope of master plans and feasibility studies relate also to these issues. COWI Consult-Turkey is in charge of these projects within the scope of EU approximation efforts of Turkey. In several Eastern cities NRW detection studies have started.

6. Recommendations

Based on various case studies, the following recommendations are proposed:

An overall institutional capacity improvement is required to overcome the prevailing weakness related to the enforcement of the regulations governing the water use. The key components of this change should be:

1) to determine of the current level of NRW and its components with the object of identifying effective measures to reduce physical and non-physical losses;
2) to assess NRW trends in the past and make comparisons with the best performing utilities so as to get feed-back on performance improvement as well as on O&M practices and training;
3) to take affordability into account for the vulnerable sectors of the population while setting up appropriate tariffs and support measures (Burak and Mat, 2008).

While measure 1) and 2) above would be instrumental in reducing physical losses; measure 3) would contribute to the prevention of illegal losses by introducing affordable tariffs and selective support measures.

Non-revenue water (NRW) including both physical (real) and non-physical (apparent) water losses can be reduced by taking the following specific actions:

- install bulk water meters at source to measure the volume of water supplied to the city precisely;
- perform water balance calculations by reading source, bulk and customer meters regularly;
- prevent reservoir overflows;
- synchronize district water supply and district meter readings (establish controlled supply zones).
- conduct leak detection studies regularly;
- replace outdated pipes and repair leaking house connections;
- perform checks on customer meter-reading and customer meter accuracy (test, change, repair, install meters);
- replace meters regularly after 5 to 7 years to ensure meter accuracy;
- measure the consumption of non-revenue (free-of-charge) customers;
- detect, correct and prevent illegal connections
- verify and update the customer database (if needed by conducting door-to-door customer surveys);
- identify vulnerable consumers and develop selective support measures (e.g. provide water free-of-charge for lifeline consumption but transfer the cost to the water department from the municipal budget allocated for social and support services to ensure transparency and fair treatment among beneficiaries).

Table 7 - Drinking Water Investment Need (2007 – 2023) (Million Euro)

	Total	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Treatment Plant Investments	1.510	74	87	91	109	87	89	90	89	106	122	77	115	94	93	91	72	24
Network Investments	1.147	26	41	62	63	77	64	66	59	55	72	141	101	118	118	19	24	41
Treatment Plant Renewal Investments	3.822	136	147	158	170	181	192	203	214	225	236	247	258	269	280	291	302	313
Network Renewal Investments	6.264	224	242	260	278	296	314	332	350	368	387	405	423	441	459	477	495	513
Total	12.743	461	516	571	619	641	659	691	712	755	817	869	897	922	950	879	893	891

Source: Ministry of Environment and Forestry, 2006

II. Industrial water use

1. Comments on definitions

According to EUROSTAT Water Statistics Manual, reuse (water used and treated to some extent to be reused) is questioned in countries; internal industrial recycle is not the subject of the questionnaire as commented by TurkStat. Differentiation between definitions is made as the following:

- if used water remains within the factory fence, it is called recycled water which depends on production technology, methods used, raw materials and substances used during the process;
- if the factory treats the water used to reuse it (outside the factory fence) then it is considered in the statistics.

2. Present Situation

In Turkey there are 1,890,785 establishments as of end of 2005. 277,502 of these establishments are active in manufacturing sector. According to 1996 Manufacturing Industry Waste Inventory results, it was determined that 18% of the establishments have wastewater discharge permits. The results of the evaluation conducted on the basis of the receiving water environments are given in Table 8.

The industrial wastewater that constitutes less than 1% of the total wastewater discharged contains very poisonous substances such as mercury, lead, chromium and zinc. Within the scope of Manufacturing Industry Waste Inventory survey results conducted in 2004, it was reported that 4030 establishments were discharging 1.145billion m^3 of wastewater and out of these, 2112 were discharging 760 million m^3 of wastewater to the receiving environments without any treatment. 1918 of the industrial facilities were discharging 385 million m^3 of wastewater to the receiving environments after treatment. From these results it can be seen that 66% of all the wastewater originating from the manufacturing industry is discharged into the receiving environments without any treatment.

Table 8 - Disposal of manufacturing industry wastewater with regard to the receiving media in (%)

	Sea	City Sewage	River	Septic Tanks	Lake, Land. Dam and Others
Waste water discharged without treatment	82,01	6,85	8,67	0,17	2,21
Total waste water discharged	62,20	8,21	23,98	0,07	5,54

Source: TURKSTAT, 2004

Water abstracted for industrial use is recorded by DSI. TURKSTAT conducts regular study to assess industrial water utilized per industrial sector. Large industrial premises having a share of 80% (approx. 3000) in the total production industry are questioned in Table 9.

Table 9 - Basic environmental indicators of industrial production in 2004

No of industries questioned	3 217
Water supplied (1000 m^3/year)	1 223 620
Water consumed (1000 m^3/year)	1 215 060
Water reused (1000 m^3/year)	410 300
Total discharged wastewater (1000 m^3/year)	637 756
Treated	228 440
Untreated	409 316

Source: TURKSTAT, 2004

Turkey is committed to transpose its legislation with that of the EU and within this context Integrated Pollution Prevention and Control Directive (IPPC 96/61/EC) is the main document to comply with.

Integrated Pollution Prevention and Control Directive (IPPC 96/61/EC), constitutes the basis of European Union's Industrial legislation from an environment perspective because the Directive has replaced the previous EU legislation that was structured on a receiving media basis, and it brings forward a permit procedure that evaluates all the receiving media in a comprehensive manner.

Still, there is not any integrated permit system related to the environment in Turkey. A different permit system is implemented for each receiving medium. Legislative arrangements need to be undertaken that allow for granting or coordination of related permits by one competent authority during the EU harmonization process and the formation of technical and administrative structures in line with this purpose. Work by the Ministry of Environment and Forestry on the topic of "Capacity Building Project from Human Resources Aspect on the adoption of Integrated Pollution Prevention and Control Directive (IPPC-96/61/EC) to Internal Legislation" was completed in 2004, "Project for IPPC Implementation in Turkey" is still ongoing. The implementation strategy of the afore-mentioned directive within the scope of the project and constituting the draft legislation is targeted (MoEF, 2006).

3. Case Studies

Case studies have been carried out supported by TUBITAK (The National Research Council) and research funds of universities with the coordination of the Ministry of Environment.

Inset 4 - Case study 1

Textile wastewater minimization and reuse

Project Summary: Harmonization Study with EU IPPC Directive in the Textile Industry: BAT Application

Project duration: 15.10.2005 - 15.01.2008

Objective: Application of best available techniques as requested by the IPPC Directive, application of alternative treatment technologies in the selected textile factory, cost estimate and analysis of replicability in the textile industry.

Scope of works: Wastewater characterization study, pollution control and minimization, treatability studies have been conducted. In line with these studies, significant decrease in water volume was realized. Advanced technologies like ozonization and membrane filtration were applied mainly to dye process and mixed wastewater for reuse purpose.

No data available for V5 at TURKSTAT, it is not even envisaged to issue questionnaire to query recycled water in the short-run according to TURKSTAT.

Inset 5 - Case study 2

Project Title: Land-Use, Environmental Concerns and Optimization of Water Demand Management in the Gebze Industrial Area

Project Duration: 10/01/2004-10/06/2006

Objective: The objective of this project is to determine the total water demand of the industrial premises located in the industrial areas of Gebze, Dilovası and Çayırova, estimate the water demand variation and source of utilization (municipal network, groundwater or tanker) in accordance with the capacity utilization rate changes of the industries and to identify the potential of environmental stress generated by these activities both on fresh water resources and the marine environment.

During the field study, after having obtained the required authorization by the institutions concerned, pre-scheduled appointments were made with the nominated staff by the companies and face to face interviews were carried out with a structured questionnaire. Out of 686, 229 representative companies were sampled. In addition to this study, fifty large companies were analyzed separately within the sample of 98 which are determined as 'large-size' companies by the Industrial Chamber of Commerce of Kocaeli. All the data collected are statistically analyzed by using the 'Quantum' computer program and the detailed statistical output results were obtained. Tabulated findings are presented and commented in the 'Evaluation' chapter of the report.

The total water consumption of these 50 companies is computed and the related industrial categorization according to the 'Water Pollution Control Regulations' of the 'Environment Act' is made.

The operational practices of the existing wastewater treatment plants run by the industries, the pollution potential in the 'Dilderesi Creek' and the shoreline of the study area, are assessed at six representative stations. The analyses were carried out with a HACH DR- 2400 spectrophotometer and also at the laboratory of the Institute of Marine Sciences and Management.

As in other previous studies carried out for the environment of Izmit and Izmit Bay, the findings of the field survey at the industries and analyses of the samples have proven that the study area is subject to a severe environmental stress both with regard to fresh water resources and also with regard to the pollution of the receiving media. Overexploitation of the freshwater resources and industrial pollution of the marine environment are the two most important problems of the study area.

In the light of the present and previous studies, it is recommended that an integrated environmental study covering the identification of industrial pollution at source should be initiated with regular monitoring so as to start installing an industrial pollution abatement program on a voluntary agreement basis by the industrial premises.

III. Irrigation water use

1. Overview of irrigation management

Piped system instead of open channels has been adopted as a better approach with regard to water savings by DSI. As of 2007, 11% of 2,573,801 ha area is equipped with piped system. The target of the central government (DSI) is to increase this ratio to 40% in 2025.

Out of approximately 2,5 million ha land equipped with irrigation system 60-70% (approximately 1,7 million ha) was irrigated in 2007. The reasons can be enumerated as follows:

- water shortage
- fallow land
- sufficient rain
- inadequacy of irrigation projects
- soil salinity
- economic and social reasons
- loss of agricultural land in favour of urbanization and/or industrialization

The highest water loss occurs in the farm after the intake point. This is estimated to be between 64% (individuals irrigation) and 55% (on DSI and WUAs irrigation) wasted water (which corresponds to an irrigation efficiency of 36% and 45% for surface irrigation that constitutes 92% of the equipped land). Piped transmission system leak is almost 0% (efficiency almost 100%) whereas open channel wastage varies between 5-15% (efficiency 85-95%) based on the quality of the main transmission line.

Average irrigation requirement is 10 000 m^3/ha on the average.

The total irrigable land is computed as 8.5 million ha; out of this area, 5 million ha is actually equipped for irrigation. Approximately 50% is operated by DSI (DSI and/or WUAs).

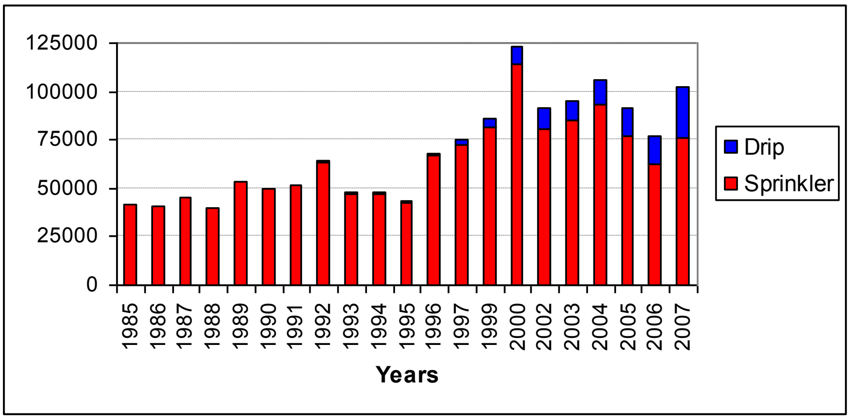
Based on these data irrigation efficiency can be computed as follows:

$$\mathbf{0.11x1.0x0.36+0.89x0.85x0.36=0.312\ (31.2\%)}$$

Based on the assumption that in 2025, piped system will increase to 40%, irrigation efficiency ratio may increase to 41%.

Considering that the present ratio of surface irrigation of 92% may decrease in favor of, sprinkler irrigation amounting to 6% and drip irrigation of 2%, the overall irrigation efficiency may be improved still further.

Figure 6 - Irrigated land (≥1000ha) equipped with sprinkler and drip irrigation systems operated by DSI and WUAs



Source: Burak, 2008

Table 10 - Irrigated land (≥1000ha) equipped with sprinkler and drip irrigation systems operated by DSI and WUAs

Years	Sprinkler (ha)	Drip (ha)	Total (ha)	Surface Irrigation (ha)	Grand Total (ha)
1985	41450	0	41450		
1986	41015	0	41015		
1987	45133	0	45133		
1988	39554	0	39554		
1989	53734	0	53734		
1990	49994	0	49994		
1991	51698	210	51908		
1992	63849	382	64231		
1993	47429	989	48418		
1994	46685	877	47562		
1995	42501	1381	43882		
1996	66667	1576	68243		
1997	72345	2751	75096		
1999	81847	3909	85756		
2000	114479	8268	122747		
2002	80535	10669	91204		
2003	85239	10188	95427		
2004	93729	11837	105566		
2005	77070	14741	91811		
2006	62256	14714	76970	1146188	1223158
2007	76375	26070	102445	1125021	1227466

Source: Burak, 2008

Table 11 - Drip irrigation method at DSI irrigation areas

	Years						
Regions	1991	1992	1993	1994	1995	2006	2007
1							
2	127	127	120	15	39		
3							
4							
5							
6*	83	255	764	862	1228	10456	14851
7							
8							
9							
10							
11							
12							
13			20				
15							
17							
18							
19							
20							
21			85		106		
23							
25							
Total	210	382	989	877	1381	14714	26070

* Kucuk Menderes Basin located on the Aegean Geographic Region
Source: Burak, 2008

2. Evaluation of water use in irrigation system

DSI reported that in 2007, the overall irrigation performance in plots[6] was 45% at DSI schemes and transferred schemes by DSI and the unit water rate utilized per plot was 10 007m^3/ha. The close percentage of the targeted value of 50-60% by DSI for irrigation performance is considered to be satisfactory. Based on water consumption and water requirement analyses the ratio 1.2 gives evidence of over-irrigation. (Chart 20, DSI, 2007).

A statistical analysis carried out by DSI on 265 irrigation schemes shows that 40% of them are under operation since 30 years and they constitute 53% of the equipped surface (Chart 19 and Graph 2, DSI, 2007).

As stated in the Turkey National Report of 2007 in order to improve water use efficiency, DSI adopted the policy of developing piped transmission and the use of modern techniques in plot irrigation like sprinkler and drip irrigation. The policy of DSI is expanding quite satisfactorily which can be assessed by incentives provided to individual farmers by the Ministry of Agriculture. Table 10, Table 11 and Figure 6show the evolution of less-water consuming techniques. However, after 2004 a slow-down is being experienced in the irrigation investments (the reasons may be due to the general economic situation of the country, EU Accession process which do not encourage agricultural/irrigation investments, socio-political situation in the Southeastern Anatolian Project (GAP) region).

92% of irrigated areas is equipped with surface irrigation system with 45% plot efficiency, 6% of irrigated areas is equipped with sprinkler and 2% is equipped with drip irrigation with a corresponding theoretical efficiency of 70-80% and 80-90% respectively.

The overall national target in irrigation is to increase surface irrigation efficiency to 50-60% on the average, (at present it is reported to be 45% on DSI and WUAs irrigations) to increase piped irrigation to 40% (from the present percentage of 11%) and finally decrease the irrigation sectoral use from 74% to 65% by 2023 (DSI, 2007).

[6] Irrigation performance is defined as the ratio of water consumed by crops in irrigated farms, fields or projects to the quantity of water diverted from the source of supply, 50% of irrigation performance means that for one unit water demand of the crops two units are needed.

IV. Conclusion

Sectoral review shows that water use efficiency improvement measures are gradually introduced in project implementation. These measures are increasingly adopted in municipal water use because this domain further attracts international funding organizations for fund raising issues.

Table 12 reflects the evolution over time of water used/allocated for each sector. The ultimate objective for 2030 is to decrease the use for irrigation to 64% out of the overall use. The share of household use in the overall use is expected to increase to 16%. Based on the population projections for 2030 and 2050 that are according to TurkStat 90 million and 96 million respectively, a considerable efficiency improvement can be foreseen.

Table 12 - Water use[7] per sector

Year	1990	%	1992	%	1994	%	2000	%	2004	%
Agriculture	22,016	72	22,939	72,5	24,623	73,5	29,3	75	29,6	74
Industry	3,443	11	3,466	11	3,584	11	4,2	10	4,3	11
Household use	5,141	17	5,195	16,5	5,293	15,5	5,8	15	6,2	15
Total	30,600		31,600		33,500		39,300		40,100	
Development		27		28		30		35		36

Source: This table is computed with the DSI figures, 2007 www.dsi.gov.tr/toptaksu.htm[8]

The overall water use efficiency can be calculated based on field data, representative case studies and where data are not available, on assumptions. In the municipal water use Epot indicator is quite reliable since several case studies and statistics results are almost the same individually, it is within the range of approximately 50% on national scale, irrigation efficiency is estimated to be ***45% based on plot efficiency (plots irrigation carried out by WUAs and/or DSI (Eirr indicator recorded by DSI is 45%)*** and since no data is available for industrial use, 25% of recycling may be assumed (Eind=V5/V6=0.25) the following overall national efficiency can be computed as:

$$E= (6{,}200 \times 0.5+29{,}6 \times 0.45+4{,}3 \times 0.25)/40{,}1=0.43$$

92% of irrigated areas are equipped with surface irrigation system with 45% plot efficiency, 6% of irrigated areas is equipped with sprinkler and 2% is equipped with drip irrigation with a corresponding theoretical efficiency of 70-80% and 80-90% respectively.

[7] water use means water allocated by DSI that is used in the fulfillment of sectoral activities; this term may be lower than the demand, it comprises effected consumption and physical losses.

References

Alegre H., Baptista J.M., Cabrera E. Jr., Cubillo F., Duarte P, Hirner W., Merkel W. and Parena R. (2006). *Performance Indicators for Water Supply Services.* IWA Publishing.

Burak S. and Mat H. (2008). *Municipal Water Demand and Efficiency Analysis: Case Studies in Turkey*. (Unpublished paper, accepted by ASCE)

DSI (2006). *Evaluation Report related to irrigation facilities operated and transferred by DSI* (DSI'ce İşletilen ve Devredilen Sulama Tesisleri Değerlendirme Raporu).

DSI (2007). *Evaluation Report related to irrigation facilities operated and transferred by DSI* (DSI'ce İşletilen ve Devredilen Sulama Tesisleri Değerlendirme Raporu).

SPO (2000). *Water, Sewerage and Solid Waste Special Expertise Commission Report* (Sekizinci Beş Yıllık Kalkınma Planı İçmesuyu, Kanalizasyon ve Katı Atık Denetimi Özel İhtisas Komisyonu Raporu).

SPO (2002). *Urban Environmental Infrastructure of Turkey for 2002-2023, Expertise Report.*

SPO (2006). *9th Development Plan (2007-2013).*

Turkey, Ministry of Environment and Forestry (2006). *EU Integrated Environmental Approximation Strategy (UCES) 2007-2023.*

Turkey, Ministry of Environment and Forestry (2007). *Environment Operational Program 2007-2009.*

TurkStat (2004). *Turkey's Statistical Yearbook*

TurkStat (2007). *Turkey's Statistical Yearbook*

World Bank (2008). *Mersin drinking water rehabilitation project consultancy services for implementation of non-revenue water reduction training program (MES-C5) TOR*

Interview with officials and experts at DSI Planning Dep. and Operation and Maintenance Department, Ministry of Environment and Forests, TURKSTAT, World Bank Resident Mission

Appendices

Sprinkler and drip irrigation areas under DSI O&M systems

1996

Region	Sprinkler (ha)	Drip (ha)
I	2.393	0
II	4	39
III	17.555	0
IV	15.206	0
V	640	0
VI	12.493	1.422
VII	1.246	0
VIII	0	0
IX	-	-
X	0	0
XI	4.904	0
XII	4.702	0
XIII	470	81
XV	2.900	0
XVII	-	-
XVIII	3.299	0
XIX	461	0
XX	93	0
XXI	50	22
XXII	0	0
XXIII	0	0
XXIV	-	-
XXV	252	12
Total	**66.667**	**1.576**

1999

Region	Sprinkler (ha)	Drip (ha)
I	4 838	27
II	0	0
III	22 469	143
IV	13 850	0
V	0	0
VI	20 338	3 289
VII	0	0
VIII	0	0
IX	0	0
X	0	0
XI	3 852	0
XII	7 312	0
XIII	115	236
XV	0	0
XVII	0	0
XVIII	6 292	0
XIX	522	0
XX	924	0
XXI	1 050	171
XXII	0	0
XXIII	0	0
XXIV	0	0
XXV	285	45
Total	**81.847**	**3.909**

2000

Region	Sprinkler (ha)	Drip (ha)
I	2 031	139
II	0	0
III	24 690	793
IV	7 185	
V	0	
VI	15 276	7 067
VII	3422	
VIII		
IX		
X		
XI	4 323	
XII	16 894	
XIII	115	215
XV	8 000	
XVII		
XVIII	4 810	
XIX	417	
XX	4 725	
XXI	22 450	15
XXII		
XXIII		
XXIV		
XXV	141	38
Total	**114 479**	**8 268**

2002

Region	Sprinkler (ha)	Drip (ha)
I	3 240	2872
II	0	0
III	17 056	226
IV	16 504	
V	0	
VI	17 819	6 465
VII	2273	
VIII		
IX		
X		
XI	4 225	
XII	6 968	
XIII	230	563
XV	6 980	
XVII		
XVIII	800	
XIX		
XX		
XXI	4 440	544
XXII		
XXIII		
XXIV		
XXV		
Total	**80 535**	**10 669**

2003

Region	Sprinkler (ha)	Drip (ha)
I	1 128	429
II	0	0
III	18 069	221
IV	16 398	
V	0	
VI	20 106	6 476
VII	2056	
VIII		
IX		
X		
XI	4 205	
XII	7 224	
XIII	236	614
XV	6 918	
XVII		
XVIII	3 535	1 801
XIX		
XX		
XXI	5 130	633
XXII		
XXIII		
XXIV		
XXV	235	13
Total	**85 239**	**10 188**

2004

Region	Sprinkler (ha)	Drip (ha)
I	0	0
II	0	0
III	21 517	171
IV	2 664	
V	0	
VI	23 879	10 127
VII	20436	
VIII		
IX		
X		
XI	4 893	
XII	6 780	
XIII	240	799
XV	5 990	
XVII		
XVIII	2 223	
XIX		
XX		
XXI	4 917	732
XXII		
XXIII		
XXIV		
XXV	191	8
Total	**93 729**	**11 837**

2005

Region	Sprinkler (ha)	Drip (ha)
I	0	0
II	0	0
III	10 940	188
IV	16 708	
V	0	
VI	29 517	11 945
VII	1669	
VIII		
IX		
X		
XI	4 019	
XII	6 534	
XIII	349	805
XV		
XVII		
XVIII	2 508	
XIX		
XX		
XXI	4 580	1 795
XXII		
XXIII		
XXIV		
XXV	246	8
Total	**77 070**	**14 741**

2006

Region	Sprinkler (ha)	Drip (ha)
I	0	0
II	0	1063
III	20 312	449
IV	2 178	
V	0	
VI	20 137	12 605
VII	2788	
VIII		
IX		
X		
XI	3 669	
XII	6 646	
XIII	435	613
XV		
XVII		
XVIII	2 628	
XIX		
XX		
XXI	5 251	2 548
XXII		
XXIII		
XXIV		
XXV	263	53
Total	**64 306**	**17 331**

Drip irrigation areas (ha) under DSI and O&M

	Years										
Region	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**
1	2.939	2.569	2.878	1.632	2.966	2.542	1.698	5.404	1.798	1.888	2.990
2	0	0	0	0	0	0	29	0	0	0	7
3	9.829	11.458	9.504	9.795	17.787	15.616	11.321	12.500	15.942	14.290	13.390
4	3.601	4.173	4.521	4.556	6.234	4.245	5.386	6.427	6.084	6.107	895
5	600	636	1.311	317	147	411	1.096	1.375	2.220	570	359
6	11.573	7.738	12.203	12.541	11.637	12.742	17.371	20.077	5.964	8.560	14.007
7	781	862	727	621	904	600	553	980	611	701	680
8	42	60	80	100	120	140	20	15	17	0	0
9	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0
11	4.129	5.677	5.002	4.559	2.470	3.631	4.378	3.196	3.074	3.041	2.887
12	294	512	606	743	1.387	374	0	1.451	1.451	2.146	1.038
13	0	0	0	35	0	0	72	80	62	415	124
15	5.684	5.246	6.212	2.544	7.729	7.383	6.998	8.407	6.650	4.426	3.743
17	0	0	0	0	0	0	0	0	0	0	0
18	1.682	1.936	1.425	1.255	2.001	1.466	1.827	2.554	2.222	2.707	1.003
19	45	35	60	111	29	135	251	344	257	758	235
20	0	0	0	113	0	176	0	341	435	853	805
21	5	2	0	5	5	0	0	0	2	0	1
23	0	0	0	0	0	0	0	0	0	0	0
25	246	111	604	627	318	533	698	698	640	223	337
Total	41.450	41.015	45.133	39.554	53.734	49.994	51.698	63.849	47.429	46.685	42.501

T1 - Number of municipalities which are connected to drinking and household water use network and water treatment plant and population coverage in 2006

Provinces	Total number of municipalities	Total municipal population	Population connected to drinking and household water			Population connected to treatment plant (1)		
			No of municipalities	No of municipal population	(%) of population over municipal population	No of municipalities	Municipal population	(%) of population over municipal population
TURKEY	3 225	58 581 515	3 167	57 686 003	98	413	28 839 265	49
Adana	53	1 798 916	51	1 792 826	100	10	1 442 179	80
Adıyaman	28	378 554	28	377 426	100	-	-	-
Afyonkarahisar	107	550 886	107	541 002	98	-	-	-
Ağrı	12	292 224	12	288 297	99	1	59 143	20
Amasya	29	236 083	29	235 756	100	-	-	-
Ankara	67	4 365 555	67	4 314 980	99	15	3 900 255	89
Antalya	103	1 511 383	103	1 510 307	100	-	-	-
Artvin	12	100 210	11	96 639	96	3	33 551	33
Aydın	54	688 430	54	684 867	99	3	120 008	17
Balıkesir	53	777 740	52	761 633	98	6	364 088	47
Bilecik	15	160 455	15	160 455	100	1	864	1
Bingöl	13	153 615	13	149 090	97	-	-	-
Bitlis	15	205 644	14	197 637	96	-	-	-
Bolu	13	167 629	13	160 079	95	-	-	-
Burdur	30	179 946	30	179 511	100	-	-	-
Bursa	55	2 198 068	55	2 198 068	100	29	1 534 066	70
Çanakkale	34	307 161	34	304 973	99	3	106 520	35
Çankırı	31	123 726	30	121 735	98	1	1 134	1
Çorum	38	376 282	37	371 558	99	2	172 038	46
Denizli	100	736 379	100	735 831	100	1	2 239	0
Diyarbakır	32	1 078 864	30	996 982	92	7	518 050	48
Edirne	26	293 517	26	293 487	100	3	136 328	46
Elazığ	26	438 834	25	432 303	99	1	5 328	1
Erzincan	29	163 806	29	158 544	97	-	-	-
Erzurum	40	523 363	40	522 800	100	-	-	-
Eskişehir	32	657 347	32	657 085	100	3	570 825	87
Gaziantep	28	1 405 420	28	1 400 559	100	4	890 969	63
Giresun	33	276 661	29	250 338	90	-	-	-
Gümüşhane	18	86 738	18	84 390	97	-	-	-
Hakkari	8	155 643	6	140 645	90	-	-	-
Hatay	76	1 093 666	73	1 068 791	98	-	-	-
Isparta	51	345 267	51	345 097	100	1	125 393	36
İçel	70	1 386 814	70	1 335 393	96	19	880 369	63
İstanbul	74	12 460 170	73	12 440 422	100	67	12 418 845	100
İzmir	89	3 467 834	89	3 349 434	97	15	992 315	29
Kars	10	140 277	10	140 277	100	1	17 915	13
Kastamonu	21	186 092	21	182 388	98	2	34 319	18
Kayseri	68	1 049 128	68	1 047 792	100	-	-	-
Kırklareli	26	261 321	26	259 716	99	4	66 612	25
Kırşehir	30	181 329	30	180 683	100	-	-	-
Kocaeli	45	1 346 092	45	1 346 092	100	45	1 034 074	77
Konya	206	1 753 490	205	1 746 297	100	11	190 721	11
Kütahya	75	447 610	75	445 317	99	3	37 688	8
Malatya	54	599 783	54	596 063	99	-	-	-

Manisa	84	1 019 764	84	1 015 378	100	1	39 230	4
Kahramanmaraş	64	764 676	64	757 550	99	-	-	-
Mardin	31	530 789	29	511 347	96	1	9 710	2
Muğla	61	515 436	61	502 794	98	5	71 269	14
Muş	28	216 507	28	212 046	98	-	-	-
Nevşehir	45	223 284	45	223 029	100	-	-	-
Niğde	52	269 541	52	269 177	100	1	4 703	2
Ordu	72	535 180	63	449 394	84	24	246 299	46
Rize	21	223 132	20	201 701	90	10	141 877	64
Sakarya	40	649 693	40	648 876	100	14	343 965	53
Samsun	51	835 575	50	810 592	97	23	581 618	70
Siirt	13	197 437	12	192 050	97	-	-	-
Sinop	11	102 251	11	101 381	99	-	-	-
Sivas	46	477 233	46	460 930	97	-	-	-
Tekirdağ	33	627 892	33	621 381	99	4	23 160	4
Tokat	77	471 983	77	468 802	99	1	2 394	1
Trabzon	77	565 643	64	498 595	88	21	295 918	52
Tunceli	10	57 208	10	55 782	98	-	-	-
Şanlıurfa	26	997 759	24	981 587	98	2	495 020	50
Uşak	24	247 281	24	241 675	98	-	-	-
Van	20	567 440	18	555 577	98	-	-	-
Yozgat	65	359 003	65	352 093	98	1	13 295	4
Zonguldak	32	411 504	31	394 788	96	10	232 691	57
Aksaray	48	304 416	47	300 999	99	2	111 121	37
Bayburt	9	45 568	9	45 568	100	-	-	-
Karaman	16	168 257	16	167 919	100	-	-	-
Kırıkkale	27	253 991	27	252 920	100	10	229 120	90
Batman	12	358 047	11	354 167	99	-	-	-
Şırnak	20	308 103	18	282 577	92	1	12 617	4
Bartın	9	73 092	9	70 258	96	3	5 305	7
Ardahan	9	41 398	9	39 312	95	-	-	-
Iğdır	8	114 351	7	107 696	94	-	-	-
Yalova	15	153 993	15	153 840	100	12	147 458	96
Karabük	8	168 797	8	166 200	98	2	31 596	19
Kilis	5	84 278	5	84 185	100	-	-	-
Osmaniye	16	351 113	16	348 678	99	-	-	-
Düzce	11	181 948	11	181 596	100	4	145 061	80

(1) Municipalities using another municipality's treatment plant are included in their own provincial population.

0 Less than the half of the quantity used

Source: Burak, 2008

T4 - No of customers connected to drinking water network, water distributed and income generated in 2006

Provinces	Municipalities that have responded (1)	No of customers	Volume distributed (m^3/year)	Income generated from water fees (YTL) (excluding VAT)
TÜRKİYE	**2 695**	**19 358 951**	**2 375 043 316**	**3 096 377 755**
Adana	33	488 459	60 741 017	82 918 889
Adıyaman	25	80 762	18 607 710	13 037 976
Afyonkarahisar	104	192 011	26 792 251	19 462 246
Ağrı	10	45 280	12 346 122	7 236 015
Amasya	29	85 438	9 233 486	9 774 976
Ankara	54	1 420 715	219 725 065	313 977 635
Antalya	87	667 527	85 903 027	84 637 819
Artvin	11	42 094	2 905 219	2 791 922
Aydın	54	335 874	27 863 463	42 207 352
Balıkesir	52	326 752	28 034 972	38 594 797
Bilecik	15	54 043	8 655 974	8 288 204
Bingöl	13	41 829	4 680 303	3 572 300
Bitlis	8	31 089	6 140 824	7 645 541
Bolu	13	57 267	5 956 322	6 479 682
Burdur	30	59 482	7 770 517	7 658 344
Bursa	28	769 435	88 879 985	138 159 955
Çanakkale	34	122 370	12 632 136	19 451 418
Çankırı	29	45 533	4 553 581	4 811 906
Çorum	37	124 419	14 842 768	12 720 867
Denizli	100	476 825	32 163 439	40 631 712
Diyarbakır	22	263 592	32 097 253	29 873 986
Edirne	26	54 228	10 140 669	13 589 619
Elazığ	25	130 920	19 282 319	17 509 983
Erzincan	28	47 503	8 393 503	7 371 338
Erzurum	33	131 899	26 415 571	28 033 035
Eskişehir	29	246 767	23 316 741	22 441 511
Gaziantep	20	320 311	45 580 737	53 891 556
Giresun	20	94 241	8 297 612	11 835 259
Gümüşhane	17	21 977	2 765 916	2 333 047
Hakkari	4	17 250	1 229 320	1 279 855
Hatay	71	300 025	40 648 527	33 334 527
Isparta	50	135 669	10 108 052	12 604 099
İçel	48	422 171	45 062 907	60 282 776
İstanbul	8	4 471 516	527 065 379	906 552 775
İzmir	57	1 112 841	140 665 430	236 490 635
Kars	10	31 001	6 516 751	7 775 510
Kastamonu	21	82 006	6 732 210	10 319 753
Kayseri	43	313 984	44 475 203	57 846 070
Kırklareli	25	87 569	9 030 865	13 304 724
Kırşehir	30	67 973	9 040 706	6 040 704
Kocaeli	1	491 182	64 837 252	74 945 488
Konya	199	692 635	76 049 383	67 270 370
Kütahya	74	217 760	16 749 013	16 874 583
Malatya	51	186 991	32 711 221	25 393 334
Manisa	84	371 026	37 312 146	42 563 011
Kahramanmaraş	62	173 899	25 321 586	25 234 898
Mardin	26	67 726	12 880 665	6 579 837

Muğla	61	213 008	32 287 097	36 963 374
Muş	9	29 452	5 897 948	2 740 554
Nevşehir	45	89 362	11 212 033	10 061 466
Niğde	51	97 878	12 326 081	6 473 857
Ordu	54	176 646	12 891 508	19 539 225
Rize	17	67 151	4 538 172	5 912 166
Sakarya	18	182 949	31 852 403	39 681 687
Samsun	32	303 125	33 025 219	42 501 584
Siirt	11	37 337	6 403 813	2 564 270
Sinop	11	47 165	1 694 773	1 631 082
Sivas	41	204 319	20 468 204	17 503 936
Tekirdağ	31	227 706	23 071 193	32 050 486
Tokat	63	151 376	17 857 698	12 379 500
Trabzon	50	177 769	18 427 900	27 092 800
Tunceli	10	15 574	2 245 933	2 375 382
Şanlıurfa	17	167 148	41 678 124	39 262 507
Uşak	24	84 127	8 072 117	11 752 101
Van	15	93 570	15 160 260	17 094 894
Yozgat	63	150 934	12 454 886	12 750 435
Zonguldak	29	150 794	13 370 810	25 112 224
Aksaray	47	95 093	10 548 905	7 279 780
Bayburt	9	13 691	1 587 958	1 407 647
Karaman	16	58 693	6 904 046	8 962 404
Kırıkkale	26	82 858	17 036 804	8 875 398
Batman	9	62 636	8 336 706	6 782 308
Şırnak	6	16 240	1 714 286	1 898 583
Bartın	9	37 155	3 072 527	4 529 015
Ardahan	9	11 832	2 522 664	1 566 140
Iğdır	7	18 560	4 676 131	3 154 732
Yalova	15	60 568	8 649 974	10 181 529
Karabük	8	65 666	6 551 182	9 965 964
Kilis	5	17 299	2 003 334	1 120 163
Osmaniye	16	68 619	9 954 469	2 559 556
Düzce	11	60 785	5 393 040	7 019 167

(1)District municipalities under Metropolitan municipality's responsibility area and smaller municipalities are not included.
Source: TURKSTAT, 2004

Table of illustrations