Research Article

Drinking Water Treatment Plants in Turkey and Determination of Revision Needs

Türkiye'deki İçme Suyu Arıtma Tesisleri ile Revizyon İhtiyaçlarının Belirlenmesi

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Abstract

Drinking water quality is regulated by Regulation Concerning Water Intended for Human Consumption by Ministry of Health in Turkey. As in the process of becoming a member state of EU, Turkish regulation is compatible with EU Drinking Water Directive. This study revealed that there are 489 drinking water treatment plants, 397 of which are under operation. This work aims to deterrmine the inventory of the drinking water treaatment plants in Turkey, and evaluate the current status of the plants. Within this work, identity cards for these active plants were prepared. Process selection of these plants were specified. A GIS-based program called ISBIS was developed and all data collected within this work was uploaded to the database. Site-visits to 193 selected plants were conducted and site-visit reports focusing on operational and structural issues at these plants were issued. As a result of this work, it appeared that 37 drinking water treatment plants out of 193 site-visited need to be reconstructed. Also, it was observed that most of the drinking water treatment plants are not capable of removing micropollutants, and will need major revisions.

Keywords: *Drinking water treatment, water quality, regulation, operational issues, revision*

Öz

Türkiye'de içme suyu kalitesi, Sağlık Bakanlığı tarafından hazırlanan İnsani Tüketim Amaçlı Sular Hakkında Yönetmelik ile yönetilmektedir. Avrupa Birliği'ne tam üyelik sürecinde olan Türkiye'nin mevzuatı, AB İçme Suyu Direktifi değerlerine uygundur. Bu çalışma ile Türkiye'de 397'si çalışmakta olan 489 içme suyu arıtma tesisi tespit edilmiştir. Bu çalışma boyunca her bir aktif içme suyu arıtma tesisi için kimlik kartları hazırlanmıştır. Bu tesislerin proses seçimleri incelenmiştir. ISBIS isimli CBS-tabanlı bir yazılım geliştirilmiş, çalışma boyunca toplanan tüm veri bu programın veri tabanına yüklenmiştir. 193 adet seçilmiş içme suyu arıtma tesisine saha ziyaretleri düzenlenmiş, bu tesisler hakkında işletme ile ilgili ve yapısal sorunların değerlendirildiği saha ziyaret raporları düzenlenmiştir. Sonuç olarak, ziyaret edilen 193 içme suyu arıtma tesisinden 37'sinin yeniden inşa edilmesi gerektiği tespit edilmiştir. Ayrıca, mevcut içme suyu arıtma tesislerinin çoğunun mikrokirletici giderimi yapmasının mümkün olmadığı ve revizyona ihtiyaç duyacakları tespit edilmiştir.

Anahtar kelimeler: *İçme suyu arıtımı, su kalitesi, mevzuat, işletme sorunları, revizyon ihtiyacı*

Introduction

It is estimated that over 1.1 billion people do not have access to safe water (UNICEF Handbook on Water Quality, 2008). Keeping in mind that water scarcity is often a problem of water quality as well as quality is important (Bauer, 2004). One of the major challenges humanity is facing is related to the uncertainties in spatial and temporal variations in quality and quantity of water resources (Schwarzenbach et al., 2010). The increase in population, agricultural and industrial activities leads to the introduction of a wide variety of chemicals to the environment, and hence result in significant deterioration in water quality. Contamination of drinking water resources by anthropogenic chemicals is a problem particularly experienced in industrialized countries (Benner et. al., 2013). As a result, degradation trends in drinking water quality lead to adverse health impacts (Delpla et. al., 2009).

Water treatment technologies have evolved over the past few centuries to protect public health from pathogens and chemicals (Ray and Jain, 2011). The goal of all water treatment technologies is to remove turbidity as well as chemical and pathogenic contaminants from water sources in the most affordable and expedient manner possible. A typical water treatment plant treats lake or river water (turbid surface water with organics) and processes the raw water using various unit processes, including screening, aeration, coagulation, flocculation, sedimentation or settling, filtration, hardness treatment, disinfection, and fluoridation (Spellman and Drinan, 2012).

Drinking Water Quality in Turkey is regulated by Regulation Concerning Water Intended for Human Consumption by Ministry of Health (2005), which is compatible to the EU Drinking Water Directive (1998). However, a complete inventory of the surface water resources used for drinking water supply and drinking water treatment plants are not available. Also, the problems being experienced at the drinking water treatment plants in terms of water quality and operation are not recorded.

This work aims to make a complete inventory of the drinking water treatment plants in Turkey. Doing this, also the treatment process selections were researched and included in the inventory. Site-visits were conducted to selected drinking water treatment plants for determination of the problems experienced by the operators, and possible revision needs that is required at the plants.

Method

An inventory work has been undertaken all around Turkey to deteminate the surface water resources and drinking water treatment plants. A total of 193 drinking water treatment plants were site-visited and evaluated in terms of process, operational issues and treated water quality. A site-visit report was issued for each drinking water treatment plant site-visited. The reports included information on the water resource of the plant, water quality, existance of an on-site laboratory and analysis capability, the process and equipment used, occupational health and security issues and energy efficiency. Revision needs were determined for each drinking water treatment plant site-visited in terms of both increasing treated water quality and EU harmonisation process. Also, a study was conducted to determine the costs to adopt necessary revisions at the drinking water treatment plants.

An identity card (ID card) was prepared to include general information on the plant, process details, all the supporting documents to be supplied by the operators and operational issues detected during site-visits. These ID cards were filled with relevant information during site-visits where site-visits were conducted. For plants that were not visited, the ID cards were sent to the plant operators for their contributions and collected back once ready.

A GIS based drinking water information system, namely ISBIS (İçme Suyu Bilgi Sistemi in Turkish) was developed, which uses the information on the ID cards as input. Only using the information on the ID cards, seven different reports can be generated using ISBIS, which are per capita consumption, per capita production, day vs. year ratio, banded population, deployable yield, source yield vs. production, and banded capacity. ISBIS also includes information on surface water resources used for drinking water supply. All data is available as a map, where all the coordinates for water resources and drinking water treatment plants are marked. Also, water quality data is available for both the resources and drinking water treatment plant inlet and outlet. Reports regarding water quality can be generated through using ISBIS.

Results and Discussions

The work carried out in terms of inventory of the drinking water treatment plants in Turkey revealed that there are 489 plants. Among these, 397 are in operation while the other 92 are out of operation. Out of 489, 229 drinking water treatment plants were large scale, 158 of which are in operation and all site-visited. The other 260 were package treatment plants and 239 were in operation, while the rest were inactive. Site visits were conducted to 35 of these package plants.

The process distribution of the treatment plants are given in Table 1. Also the number of drinking water treatment plants in operation and the ones that were site-visited are listed. According to the data given, most of the large scale plants do conventional treatment, while the selected process is advanced treatment for only 12 active large scale plants. On the other hand, most of the package treatment plants are employed for arsenic removal, while similar to large scale plants, the number of conventional treatment systems are also high. Table 1 is visualized in Figure 1 to make the comparison clear.

Table 1

Drinking Water Treatment Plants' Process Distribution and Counts

Type	Process	Count	In operation	Site-visited
Large scale	Physical treatment	28	28	28
Large scale	Conventional treatment	187	118	118
Large scale	Advanced treatment	14	12	12
Package*	Conventional treatment	109	90	20
Package	As removal	115	113	15
Package	As(1), Fe(2) and Mn(3) removal	2	2	-
Package	Fe and Mn removal	29	29	-
Package	Br removal(4)	1	1	-
Package	Softening	4	4	-

Note. **Package drinking water treatment plants are those with treatment capacity below 4000 m^3/day.*

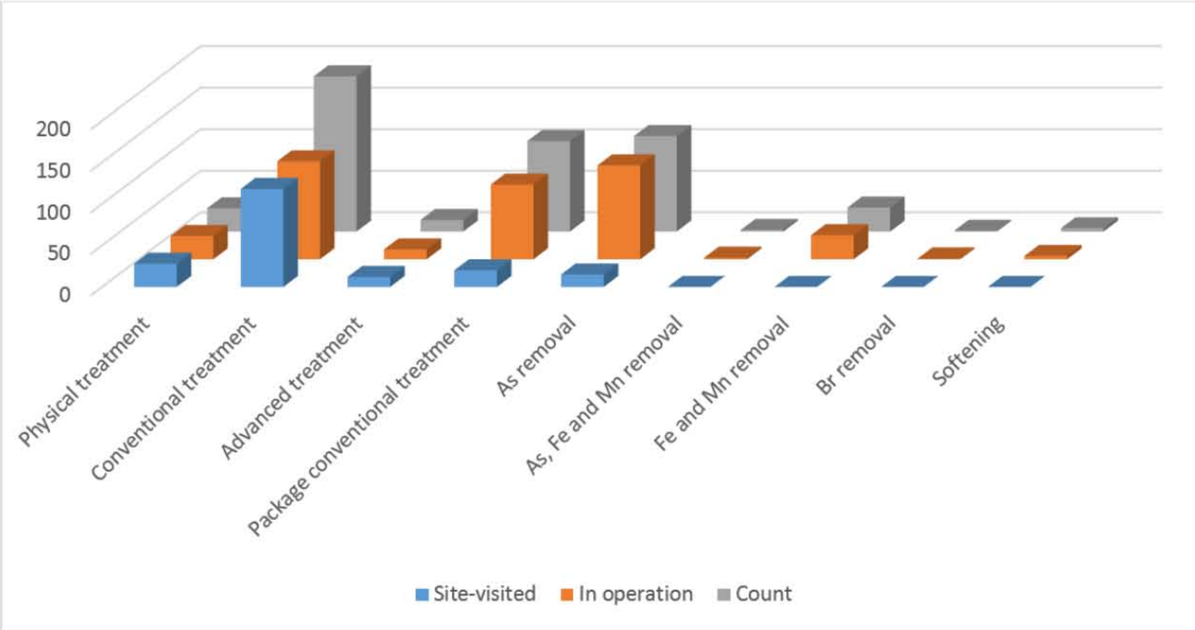

Figure 1. Process distribution and counts of drinking water treatment plants in Turkey (prepared by author).

Figure 2 shows the distribution of large scale drinking water treatment plants among Turkey. As expected, the plants are mostly located where the population is higher and where the water needs to be treated prior to supply. Table 2 shows how the site-visited drinking water treatment plants distributed among the 25 water basins of Turkey. According to the information given, most of the large scale drinking water treatment plants are located in Marmara Basin, where more than 20% of the total population of Turkey is living. On the other hand, there are no large scale plants located in Antalya, Batı Akdeniz and Burdur Basins.

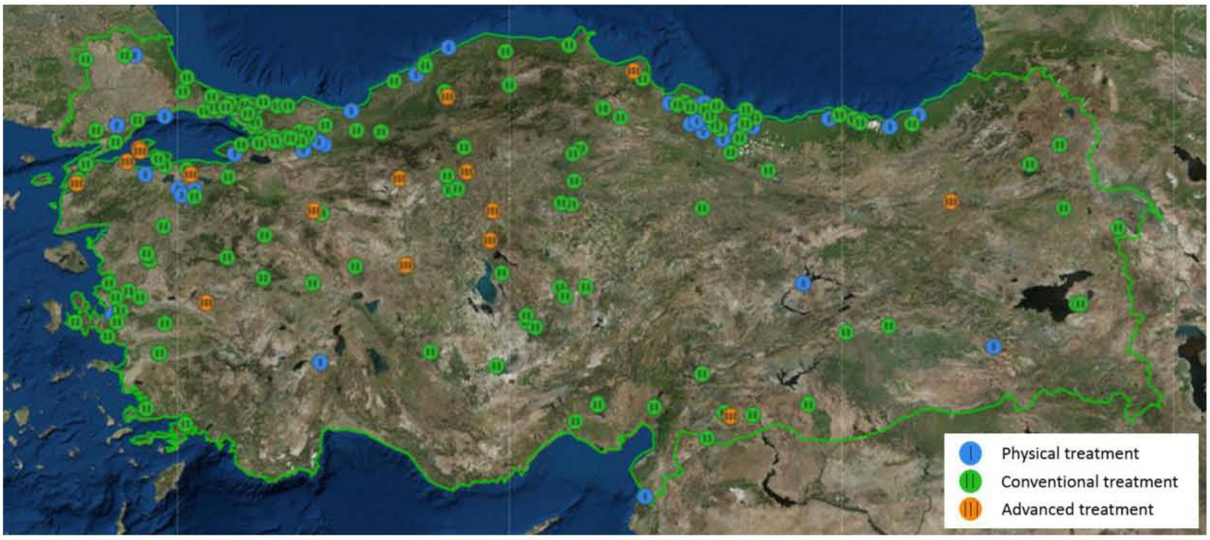

Figure 2. Distribution of large scale drinking water treatment plants among Turkey (prepared by author).

Table 2

Distribution of Site-Visited Drinking Water Treatment Plants Among Water Basins of Turkey

No	Basin	Physical treatment	Conventional treatment	Advanced treatment	Package treatment	Total
1	Akarçay	0	1	0	0	1
2	Antalya	0	0	0	0	0
3	Aras	0	2	0	0	2
4	Asi	0	0	0	0	0
5	Batı Akdeniz	0	4	0	0	4
6	Batı Karadeniz	3	3	1	4	11
7	Burdur	0	0	0	0	0
8	Büyük Menderes	0	2	0	0	2
9	Ceyhan	0	1	0	0	1
10	Çoruh	0	1	0	0	1
11	Doğu Akdeniz	1	3	0	0	4
12	Doğu Karadeniz	6	17	0	2	25
13	Fırat – Dicle	1	9	1	1	12
14	Gediz	0	1	1	4	6
15	Kızılırmak	1	6	4	3	14
16	Konya Kapalı	0	2	0	3	5
17	Kuzey Ege	0	1	0	0	1
18	Küçük Menderes	0	5	0	3	5
19	Marmara	5	29	2	5	41
20	Meriç Ergene	1	3	0	0	4
21	Sakarya	0	14	3	3	20
22	Seyhan	0	1	0	0	1
23	Susurluk	5	5	0	3	13
24	Van Gölü	0	0	0	2	2
25	Yeşilırmak	5	8	0	2	15
	TOPLAM	28	118	12	35	193

The evaluation carried out at the site-visited drinking water treatment plants revealed that there are several major problems regarding the raw water quality, the process selection at the plants and operation. First, the water intake structures were not selected appropriately. Some dams supplying water to drinking water treatment plants were constructed to supply water for irrigational purposes, and the water intake structure was constructed to take water from one level only. On the other hand, these structures should be constructed to take water from different levels, depending on the water level at the dams and water quality at different levels depending on trophic status.

Secondly, process selection of drinking water treatment plants were not done considering the water quality at the water resource. The main reason for this is lack of data regarding water quality at the dams and other water resources. Prior to process selection, long term monitoring should be done at the water resources and the changes in water quality should be followed carefully. The monitoring should be done at least for five years. Different locations and levels of water should be included in the sampling work. Seasonally, cyanobacteria, cyanotoxin and other toxins should be included in the monitoring. If taste and odor problems are being observed, the source of this should be defined. Especially, total organic carbon, turbidity and microbiological parameters should be taken into consideration while treatment process selection is done.

The site-visits revealed that the incoming flow cannot be distributed equally to independent treatment lines, resulting in different and deteriorated water quality at the outflow. Also, the incoming flow is changing in a wide range and suddenly, as mentioned by the operators. Operational conditions are not changed according to inlet water flow and quality. At some treatment plants, inflow water quality is not determined, hence there is no valve to do sampling.

General approach followed in Turkey is to drain the sedimentation tanks occasionally and to clean the sludge accumulated manually. However, mechanical equipment should be employed for this, and the sludge cleaning process should be done periodically and automatically.

Algae formations and solid matter accumulation in aeration and oxidation tanks were observed at many of the site-visited drinking water treatment plants. As mentioned by the operators, manganese and iron peaks are observed frequently and it was observed that the operators are not capable of handling these situations.

Powdered and/or granular activated carbon is used at some drinking water treatment plants. However, it was understood that there was no selection criteria while selecting these activated carbons, resulting in low removal rates for targeted pollutants. Not every type of activated carbon solves the target problems. While selecting the one that is to be used, the target pollutants and the water chemistry should be taken into consideration for successful treatment. Also, the steps to dose powdered activated carbon should be determined. Dosage also needs to be adjusted, as overdosing may result in detection of powdered activated carbon in the drinking water to be supplied. Regeneration need of granular activated carbon is not considered and many of the treatment plants have not done regeneration even once. The granular activated carbon filters' inflow and outflow and head losses are not tracked.

In terms of coagulation and flocculation process, Jar-Test is the most important step of successful removal of pollutants. However, these tests are carried out at only a limited number of drinking water treatment plants. Accordingly, chemicals are dosed without knowing the needs. pH adjustment is not done considering the dosages, or not done at all. Acid and base dosages are done without automation. Different dosages are applied at independent treatment lines. Sometimes, coagulant dosage is done at steps different than it was designed in the project. Operators are not changing operation conditions for changing raw water turbidity. Other than issues on chemical usage, it was observed that sometimes the fast-mixers are not employed even if they are available at the plant. Also, flocculation pedals are corroded at many of the plants.

In clarifiers and sedimentations tanks, the belt cleaners were not in operation, or they were broken. Lamella plates were deformed where they were employed. There are dead zones or short circuiting at the basin effluent of some of the plants. The solid concentrations were not analyzed, water is pumped out of the tanks instead of sludge and at some plants rise of upflow sludge blanket were observed due to problems regarding opeation.

There are many problems observed regarding the problems in filtration step. First, backwash frequency is not optimized considering the effluent turbidity levels, but only according to the head losses. Second, minimization of loss of water and energy efficiency during filtration are not emphasised. One of the main concerns of filtration, microbiological removal in terms of Giardia, Cryptosporidium and viruses, are not analyzed at the inflow or outflow of the filtration process. There are automated filtration systems at some plants, however these automation systems are not used and filtration and backwash are done manually. Moreover, at many of the plants, the sand employed in filtration systems has never been changed and in use for over 25 years, causing many problems including microbiological odor. Sometimes backwash is done without using blowers, or the plant do not have any blowers for this job at all. At many of the water treatment plants, wastebackwash water is recycled within the treatment plant (i.e. by directing the flow to the beginning of the treatment plant) which causes the increase in microbiological pollutants.

Moreover, contact time parameter should be taken into consideration when disinfection is done. Disinfection activity should be monitored at plants which do not have a contact tank. Chlorine need of raw water at different temperatures should be determined and dosage should be done considering residual chlorine concentrations. Excess dosing should be avoided. pH during disinfection should be monitored as forms of HOCl and OCl have different chemical features. Pre-chlorination and $FeCl_3$ dosages should be optimized according to water chemistry and arsenic concentrations in water.

Disinfection by-products should be taken into consideration while designing the drinking water treatment plants. Total organic carbon concentrations should be the primary concern while designing chlorination and applying disinfection. Dosage should not be done only according to the microbiological parameters, but also total organic carbon. Chlorine management should be done together with disinfection by-product formation potential.

UV disinfection, ozonation, advanced oxidation or membrane processes should be considered instead of chlorination, where there is high pathogenic potential in raw water resources. If UV disinfection is selected, turbidity should be monitored to have high removal rates. Where ozonation is applied, gas phase ozone measurement should be included in design of off-gas line. Air space in ozone contact tank should be designed considering minimization of off-gas escape. Also, the liquid phase ozone analyzers should be place at the effluent of contact tank.

It was also observed that the treated water storage tanks were not cleaned frequently, causing water quality deterioration after treatment. Some of these tanks lack an appropriate entrance so that it can be cleaned. At some, there is no online chlorine measurement system, so the residual chlorine concentration is not known.

All these problems observed at the treatment plants cause treated water quality to deteriorate and supply of unhealthy drinking water for public use. Out of 193 drinking water treatment plants site-visited, 124 need structural revisions to be able to treat water sufficiently prior to supply. 13 of these plants require a revision at their water intake structures, while 30 of those need a revision at their aeration steps. Conventional treatment units should be revised at 57 drinking water treatment plants. Finally, 84 of those plants site-visited need to have an activated carbon filtration system to be able to treat micropollutants, which possibly will be a concern in the near future as awareness has been raising about these chemicals, harmful for humans at very low concentrations.

Operational refinements at 29 of site-visited drinking water treatment plants will be sufficient enough to meet the drinking water standards. However, 37 plants should be taken out of operation, demolished, and constructed again, as the problems observed at these plants cannot be solved through minor revisions. Revision needs of drinking water treatment plants are summarized in Table 3.

Table 3
Revision Needs in Site-Visited Drinking Water Treatment Plants

Revision need	Count
Structural revision	124
Water intake structure	13
Aeration unit	30
Conventional treatment units	57
Activated carbon unit addition	84
Reconstruction	37
Operational revision	29

Conclusions

The study undertaken has shown that there are 489 drinking water treatment plants. Among these, 397 are in operation while the other 92 are out of operation. 158 of those in operation are large scale plants, while the rest are small plants. All the large scale plants in operation are site-visited, while 35 out of the small ones are also included in the work.

This work has revealed the problems observed at especially large scale drinking water treatment plants in Turkey. The quality of surface water resources are regulated by Ministry of Agriculture and Forestry with By-law on quality of surface water to be obtained or planned to be obtained as drinking water (2012), which is under development to include the groundwater resources as well. While these changes are being made, there is high potential that the micropollutants will be included in the standards with limits, as these chemicals are very harmful to human health at very low concentrations. If the regulation on water resources is changed and includes the micropollutants, most of the drinking water treatment plants in Turkey will not be able to treat these chemicals, as many of the existing drinking water treatment plants are constructed as conventional treatment systems, while advanced treatment techniques need to be used for micropollutant removal.

Moreover, the existing drinking water treatment plants need some revisions to be able to meet the current drinking water standards. During site-visits undertaken within this work, it was observed that many of the plants are in need of structural changes, while some other plants need to have operational changes to supply healthy drinking water to the consumers.

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References

Bauer, C. (2004). *Marketing water, marketing reform: lessons from the Chilean experience*. Washington D.C: RFF Press.

Benner, J., Helbling, D.E., Kohler, H.P.E., Wittebol, J., Kaiser, E.; Prasse, C., … Boon, N. (2013). Is biological treatment a viable alternative for micropollutant removal in drinking water treatment processes? *Water Research, 47 (16)*, 5955-5976.

Delpla, I., Jung, A.V., Baures, E., Clement, M., & Thomas, O. (2009). Impacts of climate change on surface water quality in relation to drinking water production. *Environment International, 35 (8),* 1225-1233.

European Union. *Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption.* Official Journal of the European Community 1998. L330/32 –L330/54.

Ray, C., & Jain, R. (Eds). (2011). *Drinking water treatment.* New York: Springer.

Schwarzenbach, R.P., Egli, T., Hofstetter, T.B., Gunten, U., & Wehrli, B. (2010). Global water pollution and human health. *Annual Review of Environment and Resources, 35*, 109-136.

Spellman, F.R., & Drinan, J.E. (2012). *The drinking water handbook.* Washington D.C: Taylor & Francis. Retrieved from. https://www.routledgehandbooks.com/doi/10.1201/b12305-4

Turkish Republic Official Gazette. (2012). By-law on quality of surface water to be obtained or planned to be obtained as drinking water. Official gazette dated 29/06/2012 and numbered 28338. Retrieved from http://www.resmigazete.gov.tr/eskiler/2012/06/20120629-9.htm

Turkish Republic Official Gazette. (2013). Regulation Concerning Water Intended for Human Consumption. Official gazette dated 07/03/2013 and numbered 28580. Retrieved from http://www.mevzuat.gov.tr/Metin.Aspx?MevzuatKod=7.5.7510&MevzuatIliski=0

United Nations Children Fund. (2008). *UNICEF handbook on water quality*. New York: UNICEF. Retrieved from http://www.unicef.org/wash/files/WQ_Handbook_final_signed_16_ April_2008.pdf

Extended Turkish Abstract
(Genişletilmiş Türkçe Özet)

Türkiye'deki İçme Suyu Arıtma Tesisleri Envanteri ve Revizyon İhtiyaçlarının Belirlenmesi

Dünyada 1.1 milyar insanın temiz su kaynaklarına erişimi bulunmamaktadır. Günümüzde suyun miktarı kadar kalitesinin de önem taşıdığı anlaşılmıştır. Hem insan eli ile yapılan faaliyetler hem de doğal döngüler sonucunda temiz su kaynaklarının kirliliğinde artış gözlenmektedir. Dolayısı ile insanların su kaynaklarına erişimi de gün geçtikçe kısıtlanmaktadır.

Bu sebeple geçtiğimiz yüzyılda içme suyu arıtımı önem kazanmaya başlamıştır. Tüm içme suyu arıtma tekniklerinin temel amacı, su içinde bulunan patojenlerin ve kimyasal kirleticilerin gideriminin en elverişli ve en ucuz şekilde sağlanmasıdır. Yerüstü içme suyu kaynaklarından su sağlayan tipik bir içme suyu arıtma tesisinde ızgara, havalandırma, koagülasyon, flokülasyon, son çökeltim, filtrasyon, sertlik giderimi ve dezenfeksiyon adımları bulunmaktadır.

Yapılan envanter çalışmasında Türkiye genelinde yerüstü su kaynaklarından su temin eden toplam 489 içme suyu arıtma tesisi tespit edilmiştir. Bu tesislerin her biri için tesis kimlik kartları oluşturulmuştur. Tesislerden 92'sinin mevcut durumda çalıştırılmamakta olduğu belirlenmiştir. 489 tesisten 229'unun büyük kapasiteli tesisler olduğu ve bunlardan 158'sinin mevcut durumda işletilmekte olduğu görülmüştür. Kalan 260 içme suyu arıtma tesisi küçük kapasiteli olup bunların 239'u çalıştırılmaktadır. Büyük kapasiteli ve işletmede olan tüm tesislere ve seçilen 35 küçük kapasiteli tesise saha ziyareti düzenlenmiştir.

Saha ziyaretleri sırasında tesislerin durumları incelenmiş, tesislerde yaşanan problemlerle ilgili tesis operatörlerinden bilgi alınmıştır. Saha ziyaretleri sonrasında tesislerdeki işletme ve yapısal sorunlara odaklanan saha ziyaret raporları düzenlenmiştir. Ziyaret edilen 193 tesiste yapılan gözlemlerde hem işletmede yapılabilecek iyileştirmeler hem de yapıların iyileştirilmesi ile ilgili notlar alınmıştır. Gözlemlere göre, Türkiye'de içme suyu arıtma tesislerinde hem yapısal, hem de işletme odaklı dikkate alınması gereken birçok husus bulunmaktadır.

Yapılan incelemeler sonucunda oluşturulan tesis kimlik kartları ve saha ziyaret raporlarının tamamı, oluşturulan Coğrafi Bilgi Sistemi (CBS) tabanlı İçme Suyu Bilgi Sistemi (İSBİS)'ne yüklenmiştir. Tesis kimlik kartlarındaki bilgileri girdi olarak kullanan İSBİS, kişi başına su tüketimi, kişi başına su üretimi, günlük su üretiminin yıllık üretime oranı, nüfusa göre arıtma tesisi sayıları, su kaynağının kullanılabilir su kapasitesi, su kaynağı kapasitesinin su üretimine oranı ve üretim miktarına göre tesis sayısı olmak üzere yedi farklı rapor üretebilmektedir. Tüm veri harita olarak erişilebilir olup tüm yerüstü su kaynakları ve tesisler koordinatları ile gösterilmektedir.

Bunlardan ilki su sağlanan su alma yapılarının içme suyu temini maksadıyla yapılandırılmamış olmasıdır. İçme suyu temin edilen bazı kaynaklar, aslında tarımsal sulama maksadıyla yapılmış, ancak artan su talebini karşılamak üzere sonradan içme suyu teminine başlamıştır. Bu sebeple su alma yapıları tek seviyeden su alacak şekilde yapılandırılmış olup değişken seviyelerden su alımına müsaade etmemektedir. Bununla ilgili olarak mevcut su alma yapılarının yüzer tipte su alma yapıları ile değiştirilmesi gerektiği belirlenmiştir.

İçme suyu arıtma tesislerinin proses seçimleri kaynaktaki su kalitesi göz önünde bulundurulmadan yapılmıştır. Bunun temel sebebi içme suyu kaynaklarında su kalitesi izleme çalışmalarının çok sınırlı olmasıdır. Bir tesisin projesinin en az 5 yıllık sürekli izleme sonuçlarına dayanılarak yapılması gerekmektedir. Veri eksikliği sebebi ile içme suyu arıtma tesisindeki proses seçimi, çıkışta ihtiyaç duyulan su kalitesinin sağlanması için yetersiz kalabilmektedir.

Saha ziyaretleri sırasında gözlenen bir diğer durum ise suyun tesis içindeki bağımsız hatlara eşit debilerde dağıtılamamasıdır. Tesis içinde meydana gelen çökmeler bu soruna yol açabildiği gibi, tesisin inşaatı sırasında gerçekleşen aksaklıkların da bu tip problemlere sebep olduğu tespit edilmiştir. Tesis operatörleri genellikle bunun yol açtığı sorunların farkında değildir. Bu sebeple her iki hatta giren debiler farklı olmasına rağmen dozlanan kimyasallar ve diğer işletme koşullarının iki hatta aynı olması, iki ayrı hattan çıkan suyun kalitelerinin farklı olmasına yol açmaktadır.

Kimyasal dozlamaları mevcut durumda herhangi bir bilimsel metot kullanılarak yapılmamakta olup tesislerin tamamında Jar-test yapılması önerilmektedir. Dozlanan kimyasalların dozaj ayarının tesise gelen su kalitesine göre ayarlanması, su arıtımı açısından büyük önem teşkil etmektedir. Dozajların manuel olarak değil, pompalarla yapılması önem taşımaktadır.

Dezenfeksiyon uygulamaları genellikle klorlama ile yapılmakta olup klor dozajı tesise gelen suda bulunan organik madde konsantrasyonuna göre ayarlanmamaktadır. Bu da dezenfeksiyon sırasında dezenfeksiyon yan ürünlerinin oluşumuna sebep olup halk sağlığı açısından tehlike arz etmektedir. Dezenfeksiyon yan ürünleri oluştuktan sonra giderimleri için ileri teknikler gerekmekte olup bu yan ürünlerin oluşumunun engellenmesi en iyi çözümdür. Bu sebeple klorla dezenfeksiyon yapılan durumlarda, dozlanan klor konsantrasyonunun doğru şekilde ayarlanması büyük önem taşımaktadır.

Tesisler, mikrokirletici giderimi yapabilecek proses konfigürasyonuna sahip değildir. Mikrokirleticilerle ilgili farkındalık son yıllarda artmış olup, küçük konsantrasyonlarda bile insan sağlığına zararlı olan bu kimyasalların mevzuatlara dahil edilmesi söz konusu olacaktır. Mikrokirletici giderimi konvansiyonel sistemlerle sağlanamamakta olup iyi giderim verimlerinin elde edilebilmesi için ileri arıtma tekniklerinin uygulanması gerekmektedir. Mevzuatlarda mikrokirleticilere yer verildiği takdirde tesislerin birçoğunun uygun arıtma gerçekleştirebilecek proses seçimi bulunmamaktadır. Bu sebeple özellikle su temin ettiği yerüstü su kaynaklarında mikrokirletici tespit edilen birçok tesiste aktif karbon filtrasyonu yapılması önerilmiştir.

Sonuç olarak 29 tesisin işletme koşullarında iyileştirme yapılarak standartlara uygun su arıtılabileceği belirlenmiştir. 37 tesisin ise büyük revizyon ihtiyaçları tespit edilmiş olup bu tesislerin yenisinin yapılması önerilmiştir.