DOKUZ EYLÜL UNIVERSITY

GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES

IMPLEMENTATION OF A GIS BASED SYSTEM FOR WATER FACILITIES IN CESME

by

Selçuk DÜNDAR

March, 2013

İZMİR

IMPLEMENTATION OF A GIS BASED SYSTEM FOR WATER FACILITIES IN CESME

A Thesis Submitted to the
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M.Sc THESIS EXAMINATION RESULT FORM

We have read the thesis entitled **"IMPLEMENTATION OF A GIS BASED SYSTEM FOR WATER FACILITIES IN CESME"** completed by **SELÇUK DÜNDAR** under supervision of **ASSIST. PROF. DR. SEVGİ TOKGÖZ GÜNEŞ** and we certify that in our opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Science.

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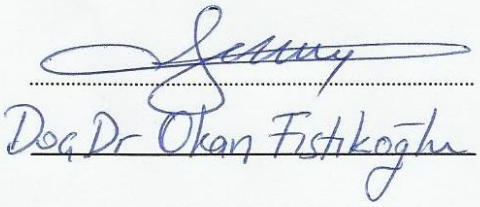

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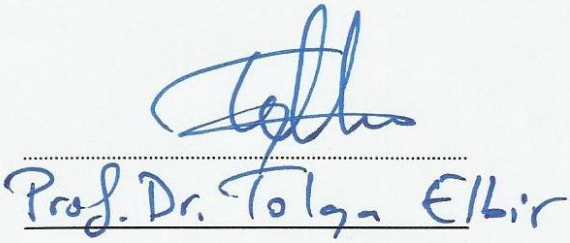

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Selçuk DÜNDAR

IMPLEMENTATION OF A GIS BASED SYSTEM FOR WATER FACILITIES IN CESME

ABSTRACT

This study was conducted in Cesme, Izmir district which is one of the most important tourism center in Turkey. Applications are proposed in order to improve the efficiency and serving quality of water operator company which is active in Cesme and its surroundings. For this aim, geographical information systems was implemented for supporting water operator company much demanded transactions.

While implementing the GIS system, satellite view was ordered, plot – parcel and street – avenue informations were obtained, a proper database and a CAD softwares were selected, field studies were carried out in order to detect the locations of the existing water subscribers. The obtained informations were integrated to the GIS system and querying is improved which goes slowly on the project layouts such as monitoring plot – parcel information. Each subscriber's supply mainline was determined, thereby affected subscriber information maps during the mainline breakdowns were created. Reliable leak – leakage calculations were made with the support of location based water meter reading values of subscribers.

In conclusion the necessary applications such as monitoring network equipments, monitoring regional water usage, estimating new settlements plot – parcel water demand, detecting affected subscriber during the water shortage, subscriber supply mainline detection, subscriber location control, plot – parcel location control, street – avenue location control and regional leak – leakage calculation were provided to the water operator company by using the GIS system.

Keywords: Water, network management, leak-leakage, geographical information systems, infrastructure.

ÇEŞME SU HİZMETLERİ İÇİN CBS SİSTEMİ UYGULANMASI

ÖZ

Bu çalışma Türkiye'nin önemli turizm merkezlerinden biri olan İzmir'in Çeşme ilçesinde yapılmıştır. Çeşme ve civar bölgelerde su hizmeti veren işletmeci firmanın verimliliğini ve hizmet kalitesini arttırmak için coğrafi bilgi sistemleri (CBS) kullanılarak en çok ihtiyaç duyulan işlemler için çözümler üretilmiştir.

Coğrafi bilgi sistemini uygulayabilmek için, uydu görüntüsü temin edilmiştir, ada – parsel, cadde – sokak bilgileri temin edilmiş, uygun bir veritabanı ve CAD yazılımı seçilmiş ve mevcut abonelerin yerlerinin tespit edilmesi için saha çalışmaları yapılmıştır. Elde edilen bilgiler CBS sistemine entegre edilerek, mevcut durumda abonelerin yerlerinin coğrafi olarak tespit edilmesi, şebeke ekipmanlarının ofis ortamında kontrol edilmesi, ada – parsel bilgileri ile sorgulama yapılması gibi proje paftaları üzerinden çok yavaş olarak yapılan işlemler hızlandırılmıştır. Her abonenin hangi isale hattı ile beslendiği sisteme işlenmiş, her isale hattının kapsama alanı belirlenmiştir, bu sayede isale hatları ile ilgili arızalarda etkilenecek abonelerin haritaları oluşturulmuştur. Abonelerin konum bazlı toplam sayaç okuma değerlerine ulaşılarak daha güvenilir kayıp – kaçak hesapları yapılmıştır.

Sonuç olarak CBS uygulamaları sayesinde şebeke ekipmanlarını bilgisayar ortamında kontrol etme, bölgesel su kullanımını izleme, yerleşime açılacak ada – parseller için yaklaşık su ihtiyacı tahmini yapma, su kesintilerinden etkilenecek aboneleri tespit etme, ilgili aboneyi besleyen isale hattı tespiti, abone yer tespiti, ada – parsel yer tespiti, sokak – cadde yer tespiti, bölgesel kayıp – kaçak hesabı uygulamaları gibi işletmenin ihtiyaç duyduğu uygulamalar bölgeye kazandırılmıştır.

Anahtar sözcükler: Su, şebeke yönetimi, kayıp–kaçak, coğrafi bilgi sistemleri, altyapı.

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CHAPTER ONE
INTRODUCTION

1.1 Introduction

Fast growing world location based studies have increased in recent years with the support of Geographical Information Systems (GIS). The GIS systems have been used in so many various utilities, such as gas, electricity, cable tv and public transportation facilities . Infrastructure and water sectors are also have already been started to follow up GIS applications benefits.

1.1.1 GIS

GIS is a computer technology that combines geographic data and other types of informations such as names, classifications, addresses and similars for generating visual thematical maps, reports and queries. GIS is a managerial tool for engineers and decision makers. It creates practical methods for large field operation such as gas networks, water networks and other similar municipal activities. Evaluation of GIS softwares accelerate the work and support these kind of operations.

GIS also has increased the importance of geography in engineering. GIS technology developments occurs great savings in time and effort. The evaluation of geographic data in the digital media, minimizes the error rates and allow to synthesize the results more clearly (Bayar, 2005).

Usually in GIS studies graphical and attribute data are used simultaneously for integrating data from different sources of information, management, planning and analysis that contribute to the solution of problems, exchange information and standardization of maps with the statements that the combination of computer supported systems. Digital maps with the help of databases for querying and using statistical analysis, allows the classification of demanded information.

Shortly GIS support which is available on the earth but difficult for mapping and analyzing of the data used to make all kinds of computer-based simulations and calculations (İnan & İzgi, 2005).

General aims of GIS;

- Accelerates the flow of information,
- Increase business efficiency,
- Provides effective and accurate analysis,
- Updating data practical and easy,
- Saving manpower and time,
- Planning support for future investments,
- Flex and adjustable for alternative requirements.

1.1.2 Fundamentals of GIS

An GIS system includes data, tools, database, satellite views and rasters for processing those datas according to proper demands. Satellite views, raster and datas are must be in digital form about selected specific duties. Generalization and synthesis give information and the representation of geographical informations. GIS studies demands suitable databases and these databases and other demanded information must be always updated for dependable results. GIS studies also demand investments and integration with other departments of study appliers.

In shortly fundamentals of GIS;

- GIS is a database based information system,
- GIS data and maps must be updated,
- GIS must allow the integration of various data sources,
- GIS needs long term investments and a stable management,
- GIS needs well trained an experienced staff.

1.2 GIS for Infrastructures

Today management activities, constitutes the most fundamental step for planning. Every operation demands a specific plan which is related to activities. GIS is one of the beneficial method used for infrastructure planning.

In today's world management of urban and infrastructure planning is getting more importance. In order to use city GIS systems fully and reasonably, provide information services for urban planning management and decision-making, raise the management level of urban and infrastructure planning administration departments. For improving these activities scientists and engineer are developing use of GIS systems for planning management information system and use the advanced technology fully to carry on the planning's scientific management and the decision making. The superiority of GIS technology in planning studies consist in its data synthesis, the geography simulation and analysis ability. Therefore using the GIS systems thought to establish the urban and infrastructure planning management information system has become an necessary choice for the planning activities.

1.3 GIS and Local Governments

GIS is an indispensable tool for local governments field operations such as, mapping, cadastres, zoning, city and regional planning, technical infrastructure, services, landscape planning and management, urban management, urban construction, licenses, scientific inspections and crisis management applications. (E-Belediye Taslak Rapor, n.d)

Uçar and Doğan (1998) state same indication for local governments and their GIS applications in their study years ago. According to their study they have already noticed main GIS application topics in local government applications for public services, urban development, infrastructure services, security, management, financing, education and social services. And finally they noticed Turkey is benefiting from this technology evolving at an accelerating rate in recent years (Uçar and Doğan, 1998). Figure 1.1 shows usage ratio for each operation in local governments with computer support and as seen % 43 Infrastructure Management ratio can support Uçar & Doğan study.

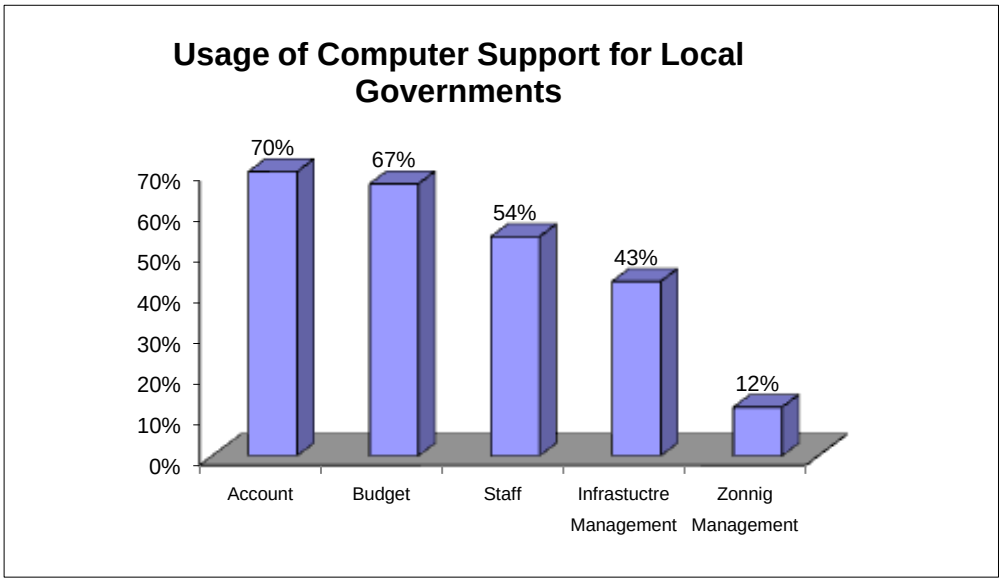

Figure 1.1 Usage of computer support for local governments. (Altıntaş, 2003)

1.4 Literature Review

The aim of this literature review is to provide a general overview of GIS applications for water infrastructure facilities in today knowledge relation between my thesis.

The city of Los Angeles applied a GIS study which is as called Navigate LA. Study performed for managing city and municipal infrastructure network with the support of management and maintenance of the GIS functions. 6500 miles of infrastructure network system is applied to 250 different layers. Aim of the study is to make inquiries for necessary demand, access to all information required to perform any change offers. This study is a wide ranged application rather than my study, it includes several city information, not only water facilities (Bensghir & Akay, 2006).

Coastal region of the state of California have been used GIS application since 2001, benefiting from municipal services supported with GIS. This study is not for water facilities management but similar applications to my thesis are studied, such as development of urban information, ownerships about houses, zoning density, land use, roads, streets, avenues, and it is possible to obtain maps of the necessary information needed (Bensghir & Akay, 2006)

Uçaner & Kaya (2011) studied about city information systems at Altindag Municipality. Their aim is getting graphical results with population. Study subject is different than my thesis but they also used very similar stages for creating their study as my study. For example they were implemented districts, avenues, streets, buildings and created thematical maps similar as my study. Their study is integrated with government address record system, this is the significant difference than my study.

Morova (2010) studied about GIS based drinking water systems at Isparta. His aim is creating a infrastructure information system for drinking network. Study is similar to my study, it consists similar stages and queries. Morova study commonly is about creating GIS system for supporting water facilities management and my study is

commonly about implementation of GIS to water networks for improving water operation efficiency.

Akbulut, Kurt and Ekinci (2011) studied about design of water distribution network with GIS systems. They created a module for hydraulic analyzes which is integrated with GIS components. My study does not contain any hydraulic analyzes because study area water network is already constructed, water operator company does not demand this kind of applications.

Panagopoulos and others (2012) studied about mapping urban water demands for Mytilene Island (Midilli). Their study has some similarities and also some differences to my study. They created some themetical maps similar as my study, but their difference is content of these thematical maps. For example their thematical maps are about sewerage network coverage, population density, distance from water supply network, in my study I created thematical maps for water shortage affected subscribers.

Motiee and others (2007) studied about estimating physical unaccounted water with GIS applications. Unaccounted water same issue which is presented as leak and leakage ratio in my study. In my study my aim is calculation of leak and leakage ratio and defining most critical losses in supply zone coverages, their aim is creating simulation models for estimating leaks.

Nas and Berktay (2001) studied for creating ground water hardness thematical map for Konya City with support of GIS applications. Creating thematical map methods are similar to my study water shortage affected subscriber application. In my study area water operator company distributes same water to each subscriber, this means

all subscribers consume same quality water and creating a hardness thematical map is not necessary.

1.5 Aim of the Study

Study area water company operates water facilities on a large field. Operation in large field affects negatively customer response for demanded actions. This study aims are speeding up reaching necessary points and decision making support from offices.

In this study my aim is creating solutions for each nine problems with the support of GIS applications in Cesme and Alacati regions. These solutions will improve water operation facilities efficiency, customer satisfaction and also affect favorably water sources.

Subjected these nine activities are;

- Monitoring network equipments,
- Monitoring regional water usage,
- Estimating future water demands,
- Determining water shortage affected subscriber,
- Monitoring supply source information,
- Monitoring subscriber location information,
- Monitoring plot & parcel information,
- Monitoring avenue and street information,
- Analyzing leak and leakage ratio.

1.6 Organization of the Thesis

This thesis includes three main chapters and is organized as follows;

In Chapter 1, there is a general information about GIS, fundamentals of GIS, literature review and aim of the study.

In Chapter 2, material and method for solving our problems are explained.

In Chapter 3, conclusions about study is explained, result and recommendations are stated and shortcomings are discussed.

CHAPTER TWO
MATERIAL & METHODS

To create a GIS study in a specific area a variety of infrastructure equipment, and field studies are demanded. In this study, one server computer and one client computer were used for computer analysis. Satellite image of study region Cesme peninsula was provided. Field studies were carried out to determine the locations of existing water subscribers.

Necessary data for the study plots - parcels, districts and streets, information were provided from local municipalities. CAD and database programs were selected accordance to the requirements. Collected site and equipment information were transferred to the computer media. Useful GIS applications were planned in water facilities management for water operator company demands.

2.1 Characteristics of Study Area

The towns of Cesme and Alacati are popular summer vacational destination which is located at the west side of the Aegean Region in Turkey, with longitude between 26˚32' - 26˚13' East, latitude between 38˚22' - 38˚13' North. Satellite view of Cesme and Alacati settlements is shown in Figure 2.1.

Study area of Cesme and Alacati have one number of water dam (Kutlu Aktas Water Dam) which is located longitude 26˚ 24' 65" East, latitude 38˚ 17' 22" North and shown in Figure 2.2. Also settlements have one union of water wells (Ildır Wells) which is located longitude 26˚ 30' 17" East, latitude 38˚ 22' 59" North and shown in Figure 2.3. Both water sources were located in Alacati Municipality borders.

Both towns are popular for local and foreign tourist visitors, summer season periods especially june, july and august water consumptions increase rapidly. Water operator company firstly try to produce water from dam, however during the summer season when dam production is not enough to supply peak consumption, water network supports with water wells production.

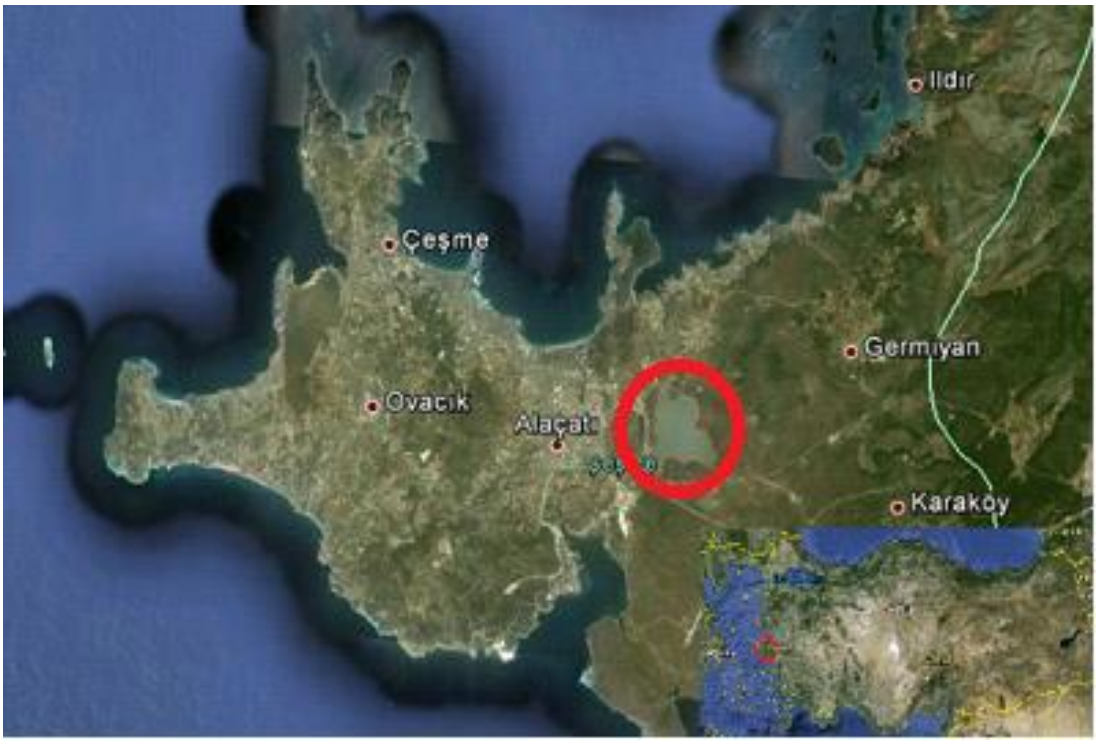

Figure 2.1 Location of Cesme and Alacati, longitude 26˚32' - 26˚13' East, latitude 38˚22' - 38˚13' North. Red circled point show water dam location which is shown with a closer view in Figure 2.2.

Figure 2.2 Location of Kutlu Aktas Water Dam Longitude 26˚ 24' 65" East, Latitude 38˚ 17' 22" North.

Figure 2.3 Location of Ildır Water Wells Longitude 26˚ 30' 17" East, Latitude 38˚ 22' 59" North.

2.2 Stages of The Study

Firstly seven main stages completed in order to implement GIS functions to study. These main seven stages are shown in Table 2.1

Table 2.1 Important main stages for creating GIS study.

No	Stages
1	Provide digital satellite view for study location.
2	To provide information about existing plot and parcels from local municipalities.
3	Making field studies to determine the existing water subscribers location.
4	Selecting a computer aided design (CAD) program to be used for demands.
5	Selecting a database system program to be used for demands.
6	Transferring the collected data to a computer system.
7	Determination of useful applications for water infrastructure management.

2.2.1 Satellite View

Satellite view is the most important objects for geographical information systems. All kinds of transactions will be processed on the digital satellite view. Due to this reason, providing satellite image is too important.

Satellite view provided from Nik System Istanbul satellite view brokerage company. This company gets images from US Quickbird Satellite according to order. Specifications of this satellite view are shown in Table 2.2. Satellite view which is used for our study is showed in Figure 2.4.

Table 2.2 General specifications of satellite view.

1	Real File Format	Tiff
2	Compressed File Format	ECW
3	File Size	210 mb
4	Date	July 2009

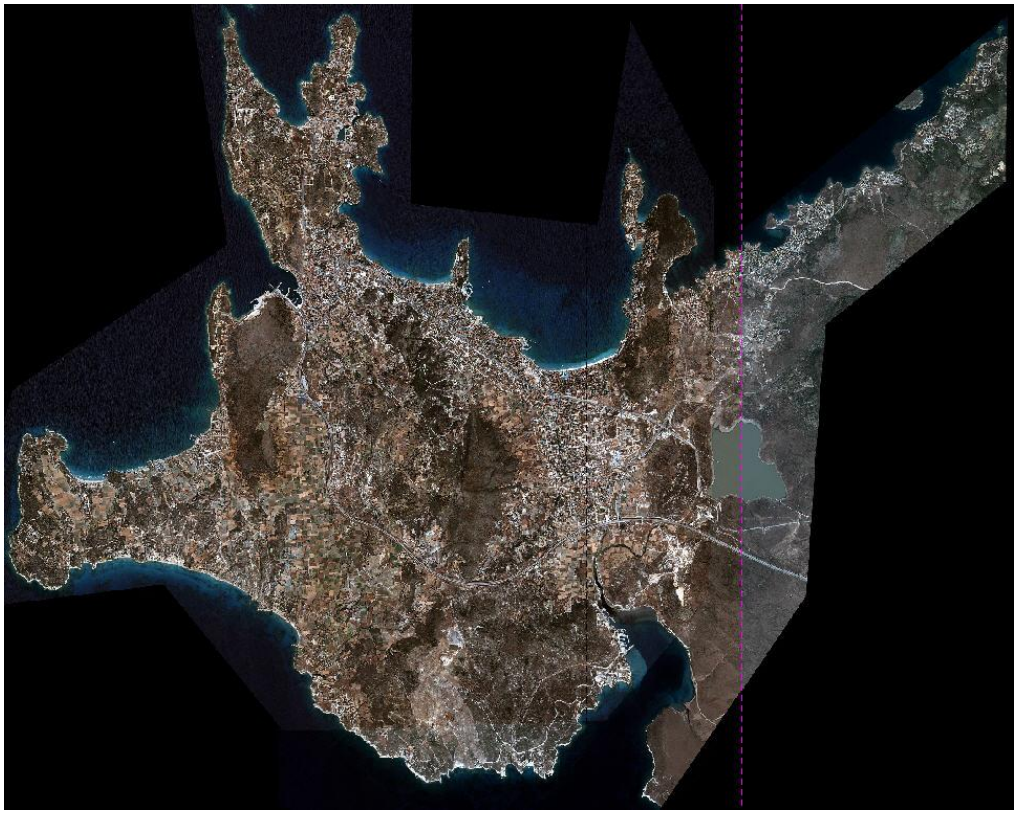

Figure 2.4 Cesme Peninsula Satellite View.

2.2.2 Plots and Parcels

Plots and parcel data are not a compulsorily required information when creating GIS studies. However most of the local governments units operates with plot and parcel informations in Turkey. For this reason plot and parcel informations are essential parts of this kind of GIS study related with municipal activities. Against this

issue whole plot, parcel and street information are taken from Cesme and Alacati Municipalities.

All collected plot and parcel information were added in a layer and connected to database. Sample of this plot and parcel applications are showed in Figure 2.5.

Figure 2.5 Sample of plot and parcels. Yellow lines show plot and parcel borders, also these border lines are connected to database.

2.2.3 Field Studies

Before installing the GIS system current location of subscribers must be known in the districts of study area. The field studies were conducted to determine subscriber geographical location with subscribers numbers. Field studies of all districts completed by 8 staff, on-site detection on the printed-out maps were made.

Cesme has 20 different residential districts (16 Eylul, Altınkum, Altinyunus, Ardic, Cakabey, Celal Bayar, Ciftlik, Cumhuriyet, Dalyan, Fahrettinpasa, Ilica,

Inonu, Musalla, Ovacik, Reisdere, Sakarya, Sehit Mehmet, Sifne, Universite, Yali). Alacati has 6 different residential districts (Fevzicakmak, Hacimemis, Ildir, Ismetpasa, Menderes, Yenimecidiye). Field studies were conducted in all these districts. Location of districts are shown in Figure 2.6 with red colored letters. Real name of letters are shown in Table 2.3.

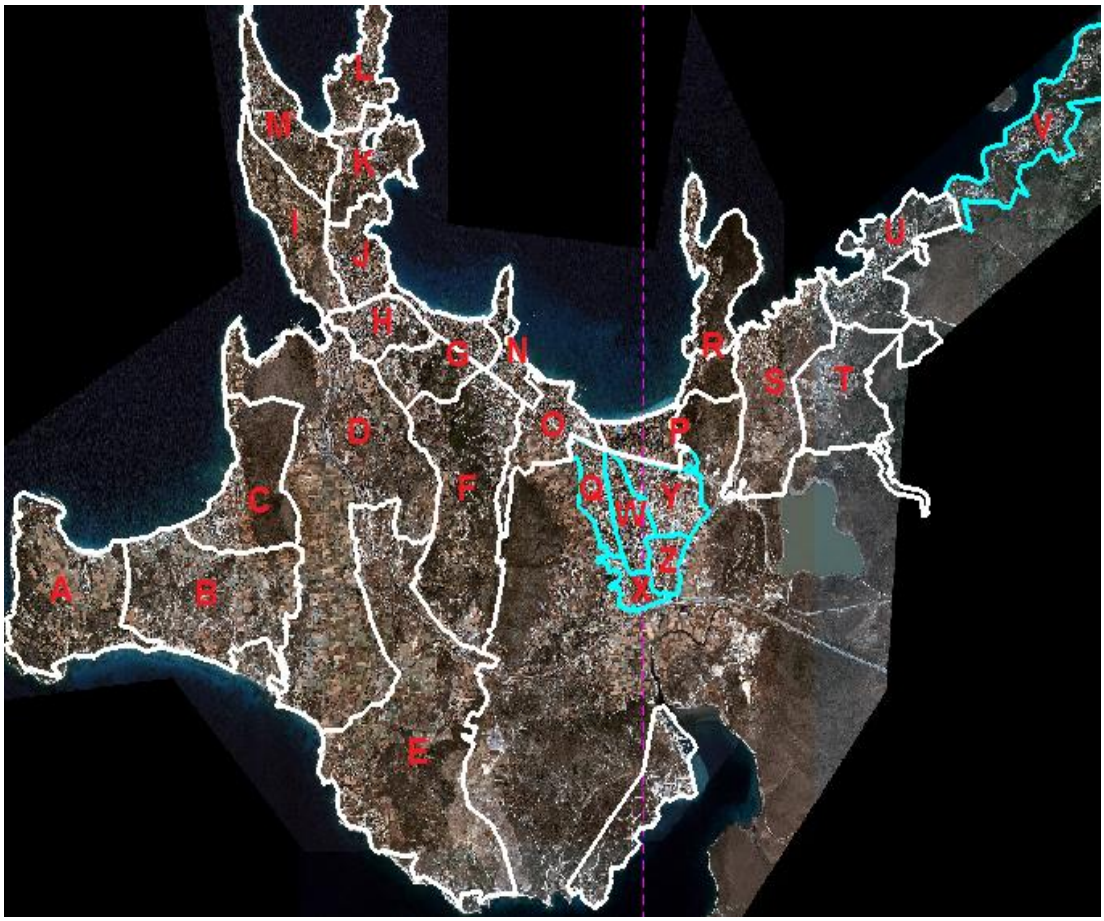

Figure 2.6 Borders and location of each district. Red colored letter's explanations are shown in Table 2.3.

Table 2.3 Name of each district which is shown with red colored letters in Figure 2.6.

Letter On Figure	Name of District		Letter On Figure	Name of District
A	Sehit Mehmet		N	Altınyunus
B	Altinkum		O	Ilica
C	Ciftlik		P	Celal Bayar
D	Musalla		Q	Fevzicakmak
E	Ovacik		R	Ardic
F	Cakabey		S	Sifne
G	Fahrettinpasa		T	Reisdere
H	Inonu		U	Yali
I	16 Eylul		V	Ildir
J	Sakarya		W	Menderes
K	Dalyan		X	Hacimemis
L	Universite		Y	Ismetpasa
M	Cumhuriyet		Z	Yenimecidiye

2.2.4 CAD Program Selection

CAD is an electronic tool that enables you to make quick and accurate drawings with the use of a computer. Meaning of CAD is Computer Aided Design. In this study for drawings a CAD software is demanded.

Because of the economical issues and water company rules was decided to use Microstation 8.5 CAD software. This software has ability to connect databases. GIS projects demands a CAD program to make queries and various drawing. Although this program is a regular CAD software which has database connectivity feature. It provides a connection link between database and CAD drawing objects. That is the most important difference than other regular CAD softwares. A view from Microstation 8.5 is showed in Figure 2.7.

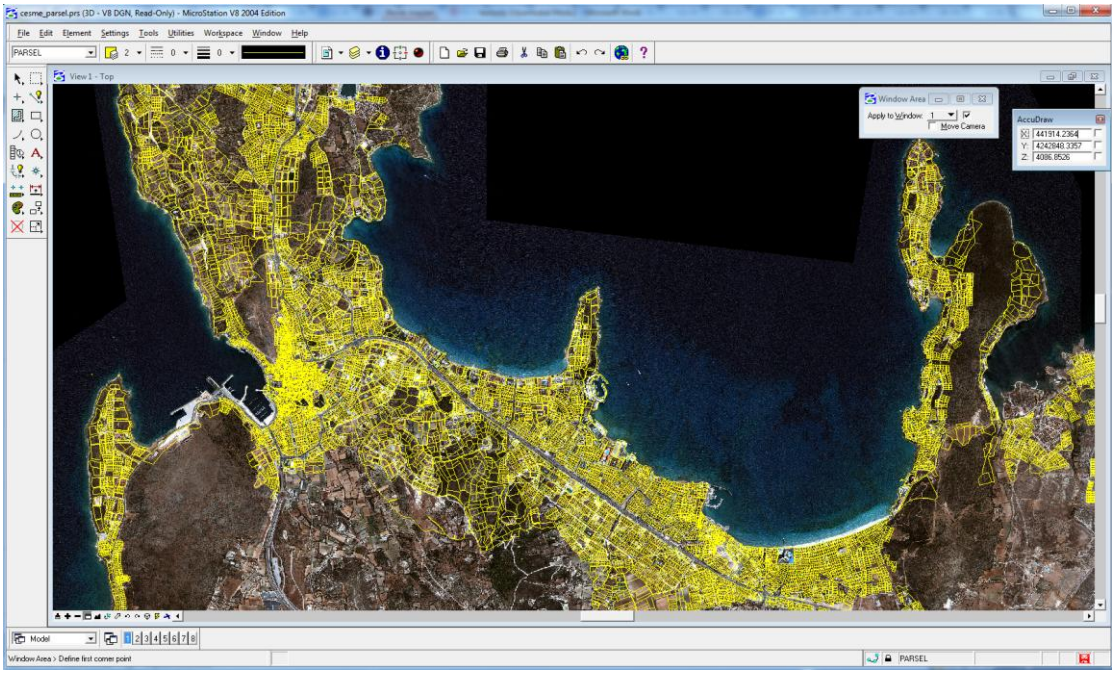

Figure 2.7 A View from Microstation 8.5.

2.2.5 Database System

Water operator company has Oracle 10g product, and software is already installed for billing facilities. Because of easiness Oracle 10g software was used in this study. This database is not a spatial database, it is a regular relational database.

2.2.6 Collected Field Data

Satellite view, plot - parcel data, the existing water and wastewater network information and the subscriber's location from field studies must be shown on CAD software, these CAD drawings are connected to database by features of Microstation CAD program. This step completed more than one year with two staffs.

2.2.7 Applications for Water Infrastructure Management

There are several methods and instruction for the management of the water networks. The aims of GIS applications are supporting water operator company administrative and managerial requirements for water networks faster and more efficiently. Therefore in this study useful applications were planned for improving water company operation efficiency and these applications were presented in Implementation of GIS Applications title. Difference of these applications are specially applied for water operator company demands.

2.3 Implementation of GIS Applications

The water company currently operates facilities without GIS support. In this part current situation is described and for each activity implementation methods are explained for improving operation with the support of GIS applications.

Activities which is also committed in aim of the study are;

- Monitoring network equipments,
- Monitoring regional water usage,
- Estimating future water demands,
- Determining water shortage affected subscriber,
- Monitoring supply source information,
- Monitoring subscriber location information,
- Monitoring plot and parcel information,
- Monitoring avenue and street information,
- Analyzing leak and leakage ratio.

2.3.1 Monitoring Network Equipments

The water operator company currently can not check network equipments from computer media, they still check printed out huge numbers of project layouts. This old method is so slow and not dependable.

Monitoring pipe diameter and length from computer is exactly quick and dependable method rather than printed out large sized project layouts. So in this study approximately 600 km water network were drawn with Microstation and attached all information about the pipes to database. Drawn pipes were showed in Figure 2.8. For this application each pipe type was described such as steel, ductile or pvc and length of the pipes calculated by using measurement tool of software.

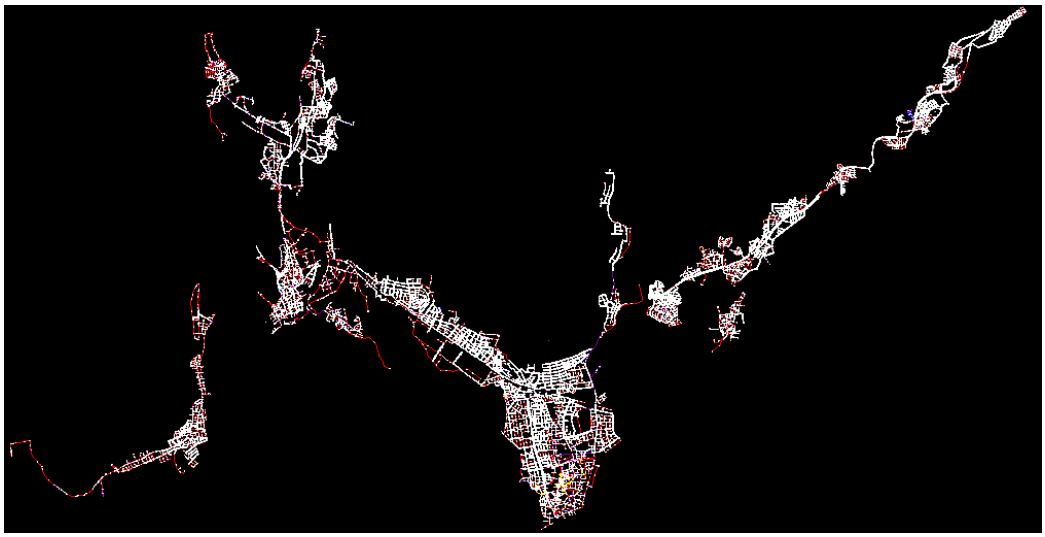

Figure 2.8 Digitally drawn water distribution network in study area.

Support of this application field team can check pipe length and pipe type without reaching site. Field team can decide before reaching site what they demand for field operation. As seen on Figure 2.9 pipe information can check by clicking related pipe.

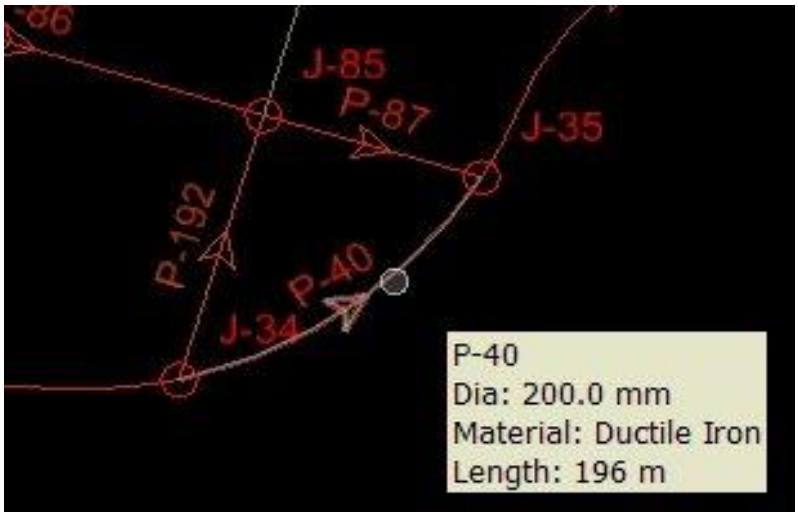

Figure 2.9 Information about selected pipe.

As seen on Figure 2.9 pipe code P-40 specifications were shown on the screen by clicking related pipe. In this figure, pipe type ductile iron, pipe diameter 200 mm and length of the pipe 196 m were shown.

2.3.2 Monitoring Regional Water Usage

The water company currently keeps records with Microsoft Excel Software. Records show only simple calculation of past period and not flexible for further changes for improving usage analysis. Also Excel software capability is weak for updating isolated supply zone coverage changes.

For improving this operation all records started to keep in database. With the support of SQL Developer staff can get so many different type water usage report from database, for example annual, seasonal, monthly, etc A sample list of annual usage list was shown in Table 2.4.

Table 2.4 2010 annual water usage for districts.

Description	jan 2010	feb 2010	march 2010	april 2010	may 2010	june 2010	juLY 2010	august 2010	sep 2010	oct 2010	nov 2010	dec 2010
Treatment Plant	300,425	264,470	311,645	365,930	468,684	526,906	571,091	579,339	445,432	393,845	352,268	347,867
Ildır Pumping Station	16,516	15,323	14,134	13,278	17,891	90,834	253,604	251,997	139,611	37,630	18,367	23,247
Total	316,941	279,793	325,779	379,208	486,575	617,740	824,695	831,336	585,043	431,475	370,635	371,114
Baskent	12,203	10,041	10,204	9,982	13,998	17,887	25,284	23,083	13,087	10,148	7,552	6,149
Egem Sahil	107	0	0	20	830	1,451	3,188	2,785	1,019	0	43	0
İmbat Sitesi	1,248	1,204	1,398	1,665	3,286	3,443	4,818	4,021	2,224	427	1,369	380
Germiyan	4,169	5,473	5,959	7,844	11,134	13,856	21,690	21,950	11,919	7,293	4,490	4,462
Reisdere	3,138	3,140	3,734	3,806	4,490	4,641	5,700	5,777	4,963	3,915	3,939	3,532
Alaçati 400	53,270	42,060	48,998	60,676	79,331	96,182	127,585	132,614	96,339	64,474	53,330	52,892
Balambaka	51,747	39,514	46,327	53,034	66,566	80,358	108,306	114,221	85,797	59,753	49,918	50,423
Fevzi Çakmak	2,937	3,061	3,131	3,857	5,571	7,234	10,739	10,545	6,355	4,040	3,479	3,266
Yeni Garaj	3,354	2,358	2,278	3,101	7,067	63,480	11,176	11,096	7,132	4,151	1,629	1,686
Agrilya	2,294	2,456	2,703	6,899	11,429	16,106	20,165	20,900	11,531	5,801	4,105	2,021
Pasalimanı	30,814	11,571	15,597	24,528	40,926	60,280	80,734	75,896	45,333	22,171	15,934	11,241
Ardıç	1,524	1,378	2,526	3,923	6,714	8,711	12,046	11,311	6,938	3,301	2,213	1,303
Gençlik Kampı	710	730	1,990	7,550	15,620	23,320	32,350	34,200	18,560	8,690	5,550	1,410
Ilica Est	0	24,891	30,968	41,001	60,899	93,180	127,294	122,415	87,840	61,594	54,996	57,373
Boyalık	9,946	8,467	11,155	18,003	30,413	51,138	78,383	77,673	43,096	17,130	15,589	13,587
Dalyan	55,228	51,639	62,849	72,968	91,792	101,921	144,061	147,077	103,525	72,429	66,183	68,529
Çeşme	52,499	45,198	52,142	52,355	61,754	64,621	82,675	83,054	67,151	63,339	56,003	56,691
Karadağ	3,663	3,310	3,819	4,339	5,720	9,869	13,192	10,574	6,047	4,541	3,686	3,595
Çiftlik	11,169	10,142	11,882	15,132	17,307	22,430	33,774	33,415	24,939	9,847	2,724	7,690
Fenerburnu	240	289	290	573	892	1,608	2,826	2,479	1,048	452	281	130
Belkent	2,917	2,303	3,062	3,919	1,992	5,825	8,464	7,943	5,436	4,212	4,036	4,029
Çeşme Tansaş	120	0	0	165	263	3,180	216	533	402	305	398	230
Total Çeşme Region	139,971	126,048	143,835	159,691	180,285	189,389	296,115	294,740	216,607	163,874	141,819	150,033

Table 2.4 created by support of SQL Developer with the query sentence (select * from SUPPLY_ZONE where MONTH between '012010' to '122010'), after proceeding this query Table 2.4 will seen on the screen. This kind of consumption analysis list can be used for future water and waste water projections for infrastructure projects.

2.3.3 Estimating Future Water Demands

The settlement areas in cities or towns can be monitored on satellite images with GIS systems for current conditions. Also these satellite images monitoring methods show us a way for future urbanization and infrastructure. Combined engineering and technology with satellite view easy to determine free plot and parcels. Free plot and parcel location must be receive from local municipalities zoning departments and combine on a CAD layer to satellite view. These methods easily support engineers for population density calculation. Calculated population for future settlements are important datas for future water demands. Over all these data will show a way for

dimension of water and waste water infrastructure projects for future infrastructure demands for planning and estimating.

The water company currently does not have any application, study and information about recently opened settlement zones. Defining these zones and calculation for estimated water demands with regular methods is difficult. Staff goes to field, measures area and decides water consumptions for these zones. These activities needs so much time and man power.

In this study for improving this demands applied a zone measurement application. Microstation area measurement tool was used for calculation area of selected plot and parcels. This feature operates with only capability of CAD programs, except features of database. Selected plots and parcels for sample study are shown in Figure 2.10 and calculation for selected plot and parcels are shown in Table 2.5

Figure 2.10 Sample plot and parcels at Alacati Town for area calculation, closer location to Izmir - Cesme Highway exits.

Table 2.5 Calculation of area for a sample plot and parcels at Alacati Town.

Parcel Numbers	Zone Area (m^2)	Zone Density	Max Floor	Base Area (m^2)	Max Construction Area (m^2)	Max Population	*Max Water Demand (Off Season) (m^2)	*Max Water Demand (On Season) (m^2)
1	472	20/40	2	94	189	9	0,94	1,89
2	436	20/40	2	87	174	9	0,87	1,74
3	455	20/40	2	91	182	9	0,91	1,82
4	483	20/40	2	97	193	10	0,97	1,93
5	474	20/40	2	95	190	9	0,95	1,90
6	462	20/40	2	92	185	9	0,92	1,85
7	459	20/40	2	92	184	9	0,92	1,84
8	453	20/40	2	91	181	9	0,91	1,81
9	464	20/40	2	93	186	9	0,93	1,86
10	470	20/40	2	94	188	9	0,94	1,88
11	478	20/40	2	96	191	10	0,96	1,91
12	452	20/40	2	90	181	9	0,90	1,81
13	445	20/40	2	89	178	9	0,89	1,78
14	454	20/40	2	91	182	9	0,91	1,82

*For calculation on season 200 lt/day/person, off season 100 lt/day/person accepted.

In Table 2.5 zone area column shows square meter areas of each parcel which is shown in Figure 2.10. Aim of this study is measuring square meter of area from office environment for possible future populations about related plot and parcels. Zone density and max floor number information provided from Alacati Municipality. Base area and max construction area is calculated by using zone area, zone density and maximum floor number. Maximum population, off season max water demand and on season max water demands are samples informations for this study.

2.3.4 Determining Water Shortage Affected Subscribers

The water company currently can not gives clear information during the water shortages to its subscribers. For a small shortage all districts take attention about shortages.

Support of the GIS system determination of the affected subscribers by various network problems is so easy and quick. A general list or thematic map output can be

created for affected subscribers such as pipe line maintenance, reservoir cleaning and network renewal activities.

In this study for solving company problems thematical maps created for affected customer during a network problem. Therefore for solving this problem a supply zone information column is added to database. Column that consist information for each subscriber connected to which supply mainline. Support of this column addition company can creates themetical maps. A sample for thematical map output is shown in Figure 2.11.

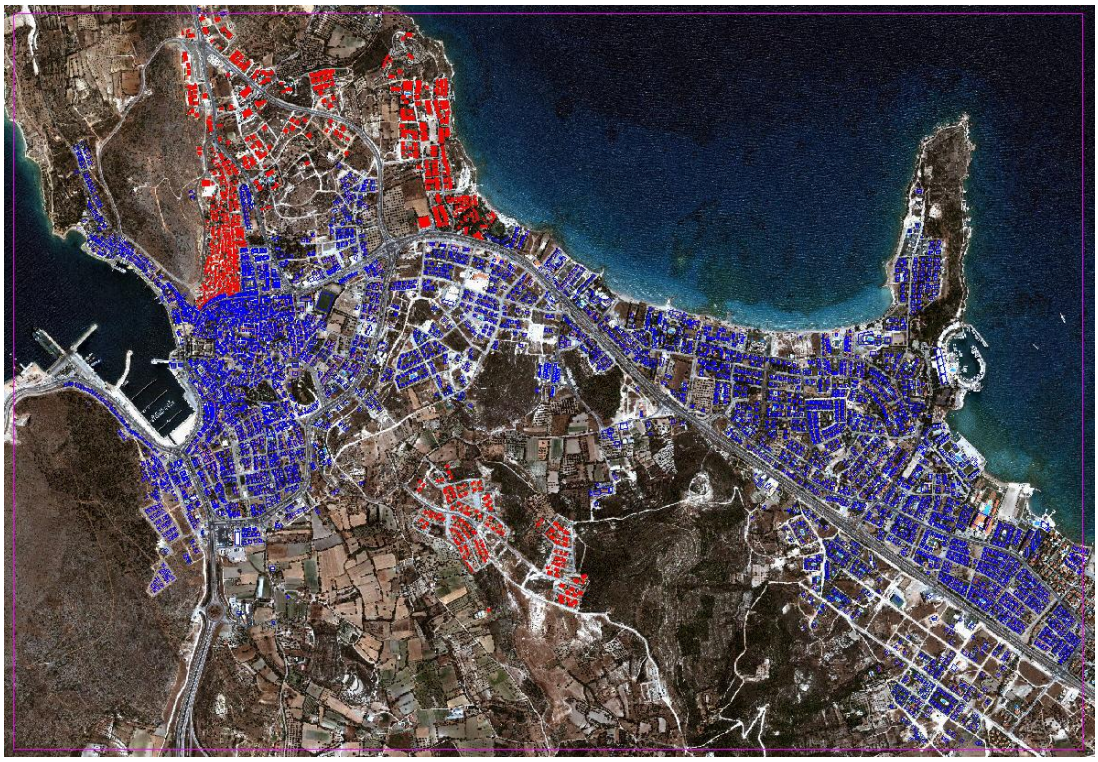

Figure 2.11 Affected subscribers thematic map output, during the maintenance works for DM42 and DC42 pipe lines. Red color shows affected water shortage subscribers, blue color shows not affected subscribers during the maintenance activities.

Figure 2.11 is created by Microstation SQL Query Builder with the query sentence (select * from SUBSCRIBER_LIST where SUPPLY_ZONE='DM42' or SUPPLY_ZONE='DC42'), after proceeding this query Figure 2.11 will seen on the screen.

These kind of application such as shown in Figure 2.11 gives detailed geographical informations about affected subscribers during the water shortages, maintenance, pipe burst or similar. Also this application creates a perspective for decision maker engineers and managers.

2.3.5 Monitoring Supply Source Control

The water company currently have weak information about each subscriber supply mainline information in Microsoft Excel Software. These information is not geographically and difficult to update during the supply source changes and water company can not response quickly to subscriber complaints. Also leak and leakage calculation can not calculate easily and results are not dependable because of missing geographical location information relation between isolated local flow meters.

In this study all subscribers were shown on the satellite view and attached their informations to database for solving this problem. When staff click a subscriber from satellite view, staff can see supply source name. For this application same database column is used, which is explained in water shortage affected subscribers application. A sample application is shown in Figure 2.12 for water supply source control.

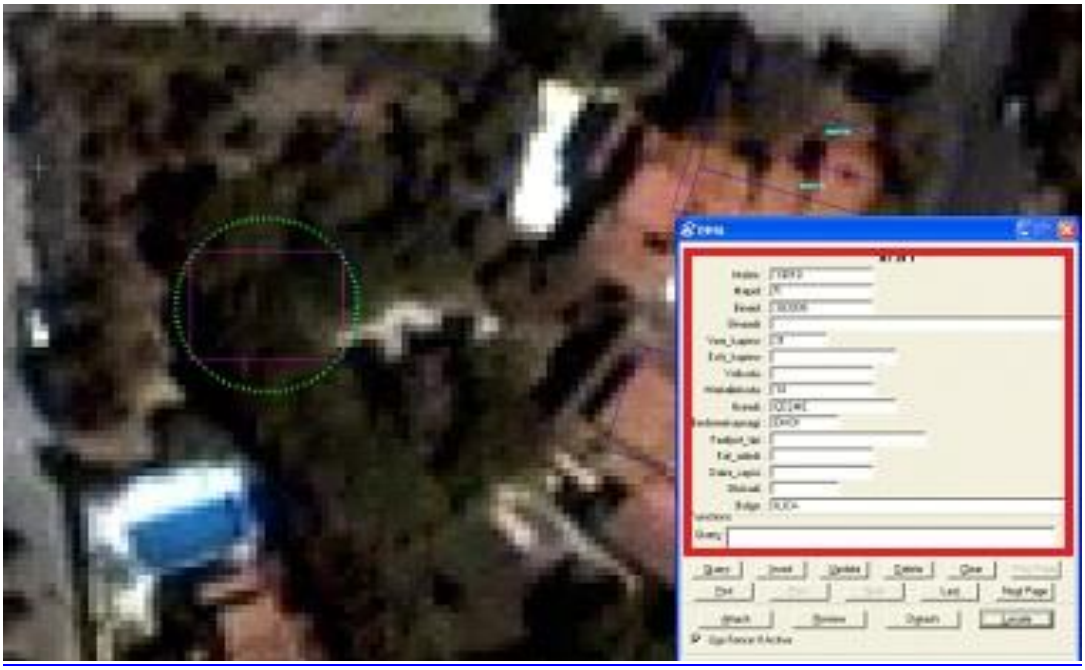

Figure 2.12 Randomly selected building is seen that supplies water from DM31 mainline.

Figure 2.12 created by Microstation query tool. This query tool shows information about selected buildings details from database.

2.3.6 Monitoring Subscriber Location

The water company currently has not any geographically record about subscriber locations. During the field operation, if field staff need to reach subscriber they are trying to search with address information and this address informations usually not clear and dependable.

All urban water networks companies always serving on wide areas with a lot of subscribers. During the complaints and breakdowns water operator company staff demands to reach to the these subscribers. However subscribers are always been difficult to find in a wide geographic area. Before GIS study in Cesme – Alacati settlements water operator company made a subscriber number based classification with numeric prefixes. Number based inefficient old classification is shown in Table 2.6.

Table 2.6 Subscribers Number Prefixes.

Subscriber Number Format	Location
1XXXXXXX	Boyalık
2XXXXXXX	Dalyan
3XXXXXXX	Alacati - Ildır
4XXXXXXX	Reisdere
5XXXXXXX	Ilıca - Pasalimani
6XXXXXXX	Not in Use
7XXXXXXX	Ciftlikkoy
8XXXXXXX	Cesme Center

As seen on Table 2.6 water operator company was coded main locations by a prefix number. For example if a subscriber number was 20004714, that is mean subscriber located in Dalyan region. A water operator company gets a lot of request and complaint which need a geographic location on site intervention. In such cases, the subscriber number that was only enough to understand in Dalyan, but this information was not sufficient.

Staff needs to reach some subscribers real location in field various time for so many different issues. But without clear location information staff try to find by phone talk, by address and some similar regular methods. In this study for solving this problem, each customer number is attached with blue colored CAD figures which is drawn on satellite view for solving this problem in this study. Support of this application staff can check subscriber location before leaving office for understanding real location of demanded subscribers.

This application also speeds up reaching the demanded location arrival time and reduce fuel consumption of motor vehicles. Field teams do not search address informations, easily find the target points. A sample application is shown in Figure 2.13 for monitoring subscriber location.

Figure 2.13 The subscriber number 50000350 location have been identified on the satellite view.

Figure 2.13 created by Microstation Query tool. 50000350 numbered subscriber number randomly selected for query, GIS application shows subscribers real geographical location.

2.3.7 Monitoring Plot and Parcel

The water company currently had huge numbers of printed out plot and parcel information drawings. These drawings usually were not updated on time and very difficult to check while some information demanded.

Cadastral operations such as land registrar's office and municipality duties usually performs with plot and parcel information. Therefore all parcels and plots information for Alacati and Cesme settlements must be implemented on GIS system interface. All plot and parcel borders were received from Cesme and Alacati Municipalities, than located as a layer file on the satellite view and all shapes attached to database with numerical information of each plot and parcel.

Support of this application staff can check, which subscriber located in which plot and parcel, or a specific demanded plot and parcel location where it is. A sample application is shown in Figure 2.14.

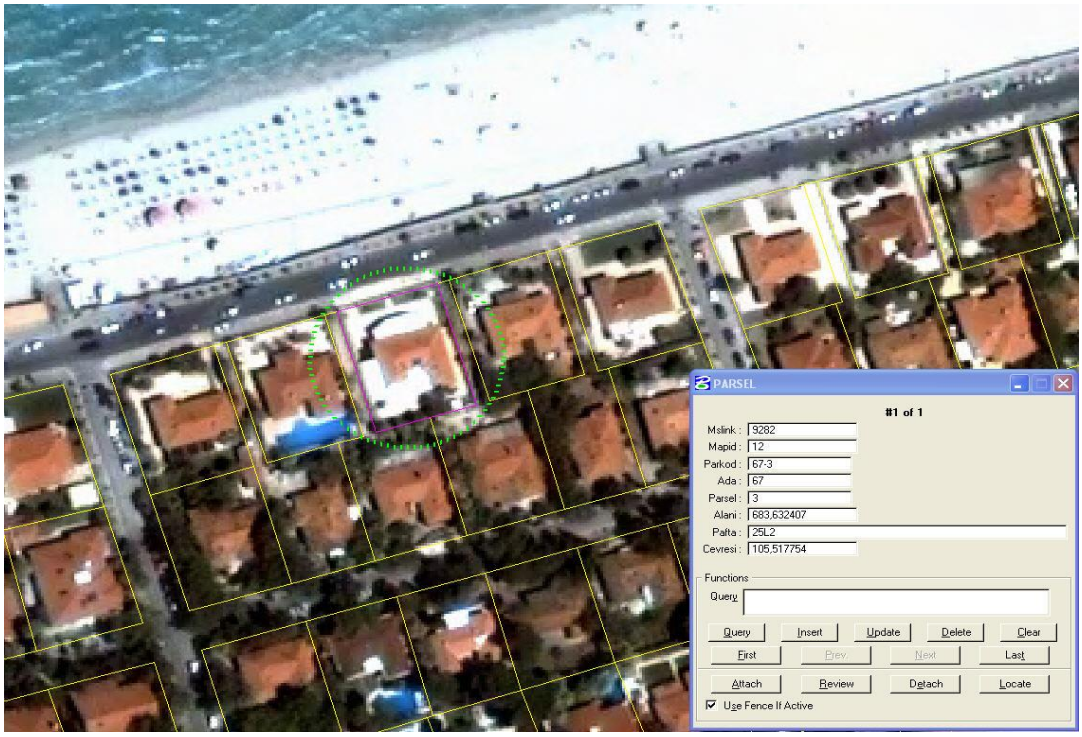

Figure 2.14 Plot number 67 and parcel number 3 location have been identified on the satellite view.

Figure 2.14 created by using Microstation Query tool. Plot number 67 and parcel number 3 numbered area randomly selected for query, GIS application shows these plot and parcel real geographical location.

2.3.8 Monitoring Avenue and Street

The water company currently has no records and information about avenues and streets. In case of need they are getting information from online maps softwares, but these method is usually contains not updated information.

Address information is important for more productive and effective operation in field operation therefore street and avenue information must be know correctly. Implementation of avenue and street are similar to other applications. Street and

avenue information received from Cesme and Alacati Municipalities, than all of them drawn on the satellite view, street name and number inserted to database. CAD drawings and database information attached to each other.

Support of this application staff can check a street name or avenue name information by clicking on selected street or avenue on the satellite view also staff can search by name or number on satellite view. A sample application is shown in Figure 2.15.

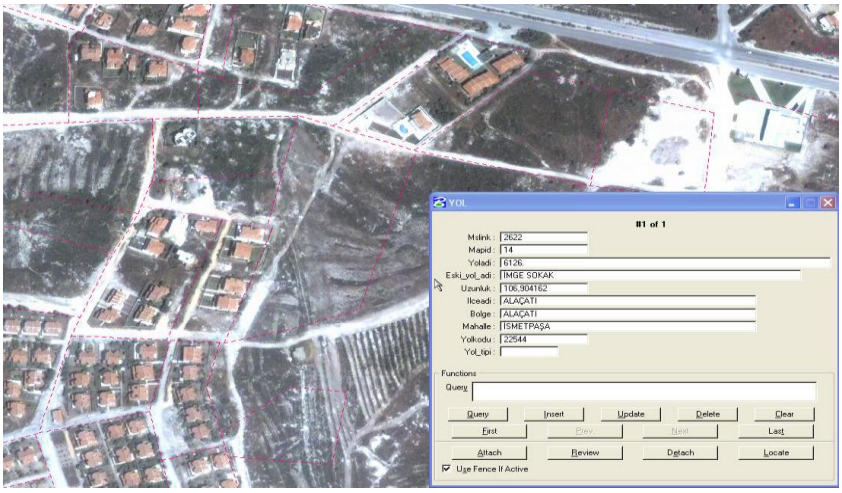

Figure 2.15 Street 6126 location have been identified on the satellite view.

Figure 2.15 created by using Microstation Query tool. 6126 numbered street randomly selected for query, GIS application shows streets real geographical location.

2.3.9 Analyzing Leak and Leakage Control

The water company currently can not get clear consumption total in each isolated distribution zones. Water company needs clear information and easy calculation for subscribers total water consumptions for comparing isolated supply zones flow meter.

Leak and leakage problems is one of the most important problems in all water networks. Treatments plants and all other similar water production units consume energy, chemicals, manpower, untreated raw water and also each equipment has a lifetime related to capacity. Leak and leakage problems affect all budgets and engineering calculations negatively. Water network operator companies aim must be operate water networks beneficially, productive, efficient and effective for strong cost results.

Leak and leakage is a comprehensive subject in water network management. In this study especially tried to solve calculation of common leak and leakage ratio for physical and commercial leak and leakage in each isolated districts. Important factors of the ratio for leak and leakage were shown in Figure 2.16.

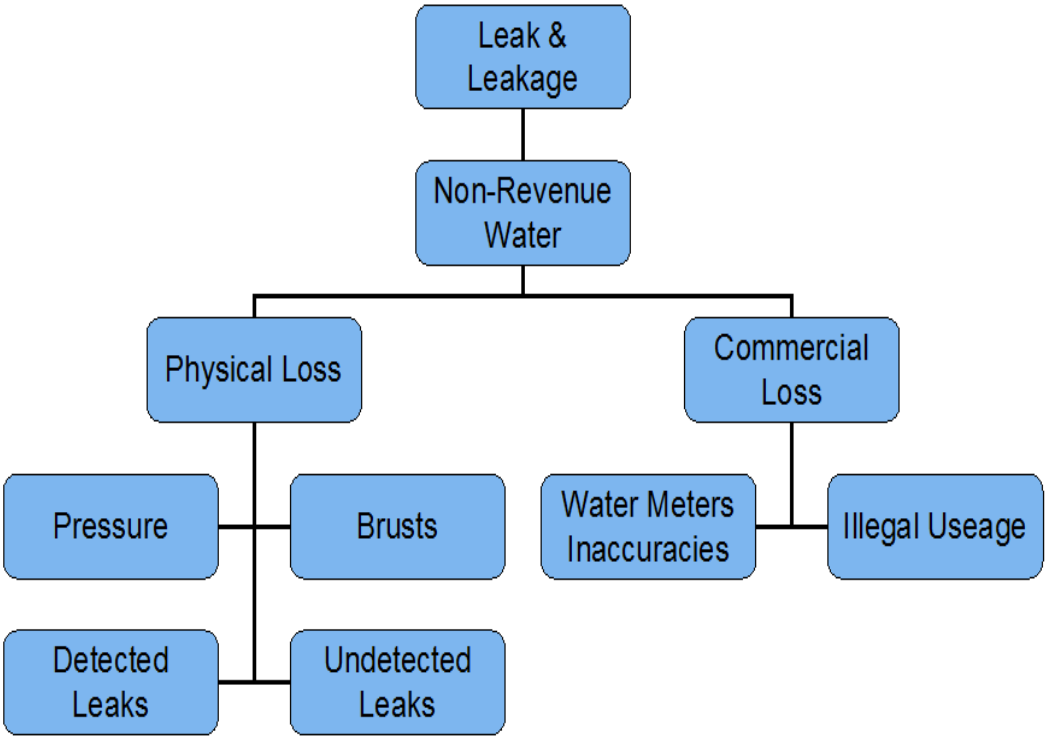

Figure 2.16 Factors of leak and leakage.

Water company must analyze relation between each isolated supply zones water distribution and subscriber water meter billing consumptions. Without GIS system they can not determine each subscriber related with which isolated supply zones. For solving this problem each isolated zone borders are drawn in CAD program, than subscriber in each isolated supply zone coverage described and added to database with a syntax such as DM10, DM32, DM35 and similars. This operation applied for getting easy consumption calculation from SQL Developer interface. Detailed coverages and names of isolated supply zones are shown in Figure 2.17. Relation between isolated supply zones borders and subscribers are shown in Figure 2.18.

Figure 2.17 Coverages of each isolated distribution zones. Light blue colored lines shows each isolated supply zones borders. Explanation of red colored letters listed in Table 2.7.

Table 2.7 Details of each isolated distribution zones.

Letter on Figure	Short Name	District Name
A	DM45	Ciftlik
B	DC44	Fenerburnu
D	DM42	Dalyan
F	DM43	Cesme Merkez
H	DC41	Mavikent
H	DC42	Belkent
I	DM41	Boyalik
K	DM32	Ilica
L	DM31	Pasalimani
M	DM13	Germiyan
N	DM14	Reisdere
O	DM12	Baskent
P	DM35	Balambaka
R	DM33	Alacati
S	DM34	Degirmendag
T	DC32	Agrilya

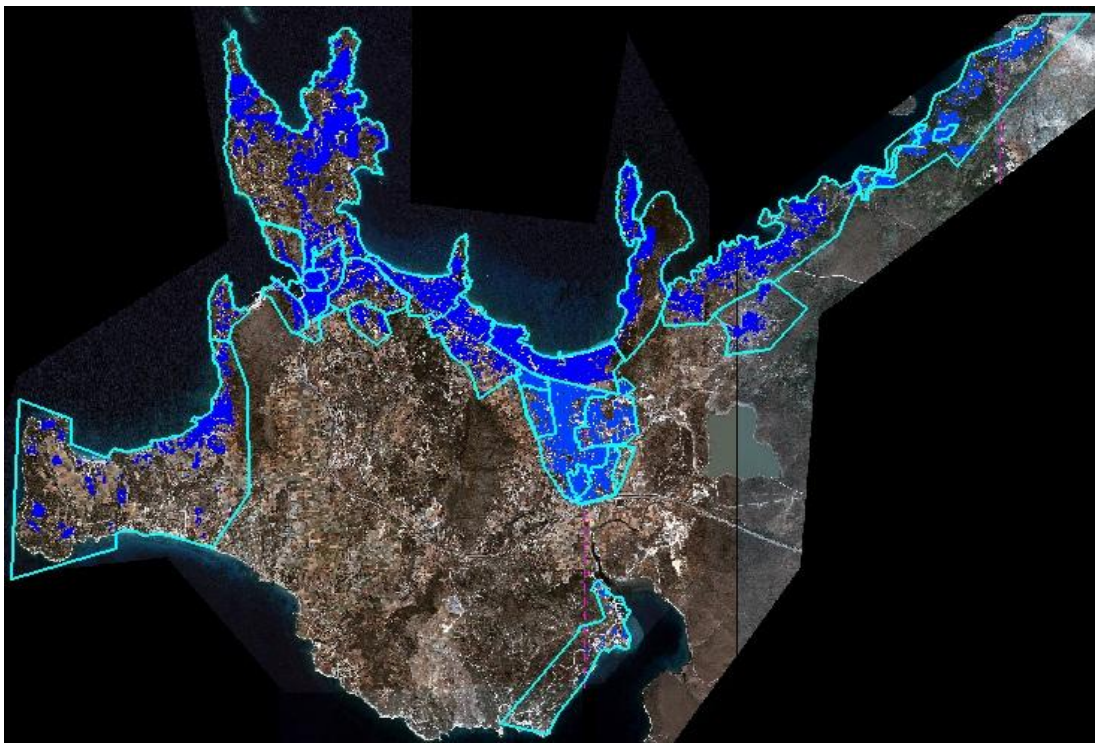

Figure 2.18 Dark blue colored points show each customer locations, choosing with one distribution border GIS system can calculate whole consumptions under the coverage off distributions zone edges. Results can be taken monthly, seasonal or annual.

Support of these applications Table 2.8 can create easily for inspect situation of leak and leakage ratio. Furthermore this application will help company to update subscriber supply zone information if they change network coverage.

Table 2.8 Calculation of 2010 annual leak and leakage ratios for all distribution zones in Alacati and Cesme. Negative value of No 5, DM30 shows water meter faults.

No	Source Name	Distribution Zone	Metered Consumptions (m^3)	Distrubited Volumes (m^3)	Diffrence (m^3)	Leak and Leakage Ratio (%)
1	DM34	Degirmendag	30354	80786	50432	62
2	DM33	Alacati DN250	187275	389209	201934	52
3	DC32	Agrilya	89843	106409	16566	16
4	DM35	Balambaka	315184	805964	490780	61
5	DM30	Alacati DN400	912373	907751	-4622	-1
6	DC41	Mavikent	71781	122559	50778	41
7	DC42	Belkent	22266	54138	31872	59
8	DC43	Karadag	47592	72355	24763	34
9	DM41	Boyalik	270047	374580	104533	28
10	DM42	Dalyan	420969	1038201	617232	59
11	DM43	Cesme Merkez	438367	737482	299115	41
12	DC44	Fenerburnu	10910	11107	197	2
13	DM45	Ciftlik	112176	190736	78560	41
14	DM40	Cesme Toplam	2026514	2538078	511564	20
15	DM31	Pasalimani	233039	435025	201986	46
16	DM32	Ilica	313387	783243	469856	60
17	DM12	Baskent	45647	159618	113971	71
18	DM13	Germiyan	58750	120239	61489	51
19	DM14	Reisdere	27953	50775	22822	45
20	DM30+DM40	Mainline	2938887	3445829	506942	15
21	Total		2665186	5367727	2702541	50

Table 2.8 created by using of SQL Developer with the two different query sentences. First query is (select sum from SUBSCRIBER_CONSUMPTION where MONTH between '012010' to '122010' group by 'SUPPLY_ZONE') this query shows subscriber water meters total reading value. Second query is (select sum from 'SUPPLY_ZONE' where MONTH between '012010' to '122010') this query shows supplied water to isolated supply zone. Comparison chart completed with Microsoft Excel support.

CHAPTER THREE

RESULTS AND CONCLUSIONS

3.1 Results

In this study implementation of general GIS applications for water networks are presented. Especially best suitable GIS application decided for water network facilities. These applications explained and examined in material method chapter.

3.1.1 Monitoring Network Equipments

Support of this application water operator company can easily check water network pipe type, pipe diameter and location of equipments. Staff can use digital CAD files when they need information about water network, they do not use any printed out papers.

3.1.2 Monitoring Regional Water Usage

Support of this application water operator company can get reports from each districts water usage with so many different alternative options such as monthly, seasonally and annually.

3.1.3 Estimating Future Water Demands

Support of this application water operator company can estimate population by using measurement tool of GIS programs and this feature support technical staff for deciding pipe diameters and lenght.

3.1.4 Determining Water Shortage Affected Subscribers

Support of this application water operator company can create thematical geographically maps during a mainline or reservoir breakdown – maintenance. This feature is important for announcing water shortage to subscriber.

3.1.5 Monitoring Supply Source

Support of this application water operator company staff can check which subscriber connected to which mainline quickly during the complaints.

3.1.6 Monitoring Subscriber Location

Support of this application water operator company staff can check which subscriber located in which location without using any address information before reaching to subscriber during breakdown time.

3.1.7 Monitoring Plot and Parcel

Support of this application water operator company staff can check which subscriber located in which plot and parcel. When a new subscriber connected to network GIS system operator can add new subscriber to GIS system using land registery sheets plot and parcel information, so for new subscriber water operator company does not need periodical studies for determining new subscriber geographical locations.

3.1.8 Monitoring Avenue and Street

Support of this application water operator company staff can check which avenue and street located where it is, and staff can check which subscriber closer to which avenue or street.

3.1.9 Analyzing Leak and Leakage Control

Support of this application water operator company staff can calculate each supply zone water subscriber water meter total reading results monthly, seasonal or annual and with this total water readings value staff can create so many different alternative reports for obtaining more troubled locations about leak and leakages.

In shortly;

Implementation of GIS application for water networks are support positively to reduce operational cost in water network facilities. GIS applications give engineers a chance for monitoring and counting data with the power of wide applicability for water network facilities.

Before the GIS application, water operator company staff were trying different ways for monitoring leak & leakage waters such as night volumes informations. This method does not have location information and difficult to combine with regional water flow meters data. However after the implementation of GIS applications staff started to monitoring their each demands geographically.

3.2 Conclusion

Most of the GIS studies in water network management usually do not include subscribers consumption and location data. But subscriber consumption and location is the basic and the most important data for improving GIS studies effectivity. For better results all water operator companies must use GIS application for their network facilities with subscriber consumption and location information.

In this study valve simulations are not presented only water shortage affected subscribers during whole mainline and reservoir problems presented. But determining of water shortage affected subscriber in a smaller geographical area valve simulation is necessary. For solving this problem valve simulation may perform in future works.

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