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Mersin province water projections and water information and management system: Erdemli district model

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ABSTRACT

Mersin is one of the most important cities of the Middle East and Mediterranean Region as well as Turkey thanks to its intensive sectorial and commercial activities along with developing population. These progresses necessitate many urban needs such as drinking water, irrigation water, wastewater treatment, infrastructure planning for sewage-drinking water networks. In this study; medium and long term investments by 2050 (2015 + 35 years) for Erdemli, which is the third largest district of Mersin, are suggested and Water Information and Management System (WIMS) is formed in order to monitor all the activities and needs aforementioned above from a single center. WIMS can be considered as functional software thanks to being suitable for development, being modular software which can minimize the operating and investment costs, provide information in a short period of time and prepare electronic output of information transferred to the computer through the online database system. So far, 26606 data entries have been made in order to bring the functionality to the software. The WIMS software provided Mersin Water and Sewerage Administration with the ability to manage all data from a single center and monitor the current status of urban centers and rural settlements related to drinking water and wastewater.

1. Introduction

Water is one of the most important element for life. It is basically limited resource, contrary to what is believed. Though two-thirds of our world is covered with water, the amount of water that can be used by both living things and human population is extremely limited. Especially, in country and regional development projects; the role of water and land resources in the promotion and development initiative is inevitable.

There are serious discrepancies between places where water is found on the earth and areas where water is in demand. There are similar situations in our country and Mersin [1].

In non-water-rich countries such as Turkey, the best way to improve the water supply is managing and maintaining in optimal way. Along with the increasing population, public and private sector institutions need to use developing technology in order to use water more efficiently which has become the most important resource in the world [1, 2].

In the efficient evaluation of water resources; the economic situation of the countries, rapid population growth and urbanization, sectorial developments, water demands and projections related to all of them are done well and laws, regulations and regulations are applied correctly. However, the disadvantages encountered are more prevalent in metropolitan cities where rapid urbanization and sectorial activities are intensive. These problems are experienced more intensely in fast developing cities like Mersin. Drinking water and wastewater needs varies depending on urban centers and rural areas [1, 2].

With the Law No. 6360 entering into force at the end of March 30, 2014 Local Elections, the General Directorates of Metropolitan Municipalities, Water and Sewerage Administrations, expanded to the provincial boundaries of service area, will include new service areas; the drinking water and the wastewater in provinces, districts and rural areas should identify the current service conditions and

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deficiencies of their infrastructures [2]. In the direction of feasibility studies to be made for short, medium and long term investment needs should be determined for future years and plans should be established for realizing those plans. In this context, software's such as "Water Information Management System" which will enable related institutions to do their work more quickly and systematically are preferred.

By the law aforementioned above, the borders of the Metropolitan Municipality were extended to the provincial borders. Intensive sectorial activities, as well as Mersin in Turkey with growing population and commercial activity in the Middle East and the Mediterranean region is one of the most important centers. All these intensive activities; drinking water, irrigation water, wastewater treatment, infrastructure planning (sewage-drinking water networks) and so on as well as many urban needs.

In this study, short, medium and long term investments were determined for Erdemli which is the third largest city of Mersin and 2050 target year, and Water Information Management System (WIMS), in which all these activities can be monitored online from a single center, has been prepared. For this purpose, analysis of the existing infrastructure situation of the district center, coastal area and rural areas related to drinking water and wastewater, determination of problems, determination of possible problems, examination of investments directed to the region, calculation of population projections of continuous- as well as many other field researches.

2. Material and Method

The study has started in 2015 and is projected for 35 years through year 2050. In this context; current situation analysis of water resources of Erdemli, Mersin is done. Data on drinking water and wastewater infrastructure have been collected and evaluated. Population, drinking water and wastewater formation projections are calculated. According to these results; basin-based economic and sustainable projects have been established and alternative proposals for solving problems have been introduced by 2050 target years [2]. The geographical coordinates of drinking water reservoirs located in the district, WTPs, promotion centers and other important places were determined by GPS device and so the satellite map drawings are carried out. All these studies were prepared with the software program which was designed to cover the data, and WIMS which can be continuously monitored and updated is created on this basis.

The data used in the study is obtained by collaboration of Faculty of Engineering Department of Environmental Engineering, Mersin University, Mersin Metropolitan Municipality General Directorate of Water (MESKİ) and Sewerage Administration, State Hydraulic Works (DSİ) 6th Regional Directorate, State Water Works Mersin 67. Branch Directorate, Turkey Statistical Institute Regional Directorate of Adana, Mersin Provincial Directorate of Environment and Urban Planning, Erdemli Municipality and neighborhood headmen.

2.1 Erdemli

Erdemli has 1 municipality and 71 districts, the district map is given in Figure 1. From these neighborhoods, 23 are in the district center and the coastal zone between Çeşmeli-Kızkalesi and 48 are rural areas [5, 6]. Sectorial activities in the district; agriculture, tourism, service sectors and agriculture and animal husbandry activities are mostly performed in rural areas [8].

Figure 1. Map of Erdemli [7]

The main water sources of the province are Alata Stream, Lemas Stream, Kargıcak Stream, Kocahasanlı Stream Stream, Gökgübet Stream, Arpaçbahşiş Stream, Tömük Stream, Gilindires Stream, Karakız Stream, Karacaoğlan Stream, Sarıyer Stream, Dedekavak Stream, Madenler Stream, Kodoman Stream and Evliya Stream [2]. Water content of these rivers and streams is variable. Especially in summer months, most of the streams are not watered. The construction of Aksifat and Sorgun Dam is continuing to meet the water needs of the district [9].

2.2 Calculation of population projections

Estimated population values of 71 localities in Erdemli for the years 2015-2020-2030-2040-2050; population projections are calculated by five different methods (Iller Bank, Arithmetic Population Increase, Geometric Increase, Exponential Method and Compound Interest Methods) and is given in Table 1 [2, 14]. Turkey Statistical Institute of Population (TUİK) projection calculation population data are used [10, 11, 13].

Table 1. Erdemli District population projections [2 - 4].

Year	Iller Bank (person)	Arithmetic Increase (person)	Geometric Increase (person)	Exponential Method (person)	Compound interest (person)
2015	135181	132939	135705	135705	135677
2020	147154	132947	150428	150428	150239
2030	175467	132961	184839	184839	184221
2040	211039	132976	227121	227121	225888
2050	256080	132991	279076	279076	276981

2.3 Drinking Water and Wastewater Formation Calculations

According to the population projections calculated for Erdemli, the projections of drinking water demand and wastewater formation are calculated and given in Table 2-3. The settlement areas where drinking water and wastewater problems are most experienced are shown in Figure 4.

Table 2. Continuous population projections, drinking water demand and wastewater amount of Erdemli [2, 3].

Year	Continuous Population (person)	Water Demand (m^3/d)	Amount of Wastewater (m^3/d)
2015	135181	27071	21657
2020	147154	29619	23695
2030	175467	35453	28363
2040	211039	42514	34012
2050	256080	51229	40983

Table 3. Estimated drinking water demand and wastewater formation due to summer population projections in Erdemli [2, 3].

Year	Summer Population (person)	Water Demand (m^3/d)	Amount of Wastewater Formation (m^3/d)
2015	300159	60032	48025
2020	325735	65147	52118
2030	387355	77471	61977
2040	470322	94064	75252
2050	593300	118660	94928

The calculations of drinking water projections are based on the assumption that water consumption is 200 L / person-day and 80% of the water used is converted to wastewater (160 L / person-day) [14].

2.4 Creating satellite map drawings for the data

In Erdemli, transportation to the location of drinking water reservoirs, especially in winter, is very difficult. For this reason, locations of potable water reservoirs, promotion centers, WTP's and discharge points are processed on the internet based interactive satellite map in order to easily access information such as deposits, coordination, distance to the settlement units and network [2, 4].

In this direction; 129 drinking water reservoirs, 4 wastewater treatment plants and 5 promotion center coordinates in Erdemli are determined by Magellan eXplorist 610 handheld GPS device. Coordinates; NetCad 5.2 and Corel Draw X6 are processed on the satellite map using computer programs. Schematic drawings of facilities, warehouses and promotion centers were made using the AutoCAD 2016 program. Facility and warehouse locations are processed on Google Earth program with html web coding on online satellite map and satellite map is used interactively.

Figure 3 shows the schematic drawing of Erdemli Aksıfat water source and drinking water tanks connected to this source as Figure 4 shows the locations of drinking water warehouses processed on the satellite map. Also the area where Erdemli Municipality WTP is marked on the satellite map indicated in Figure 5 [2, 3, 4, 15-19].

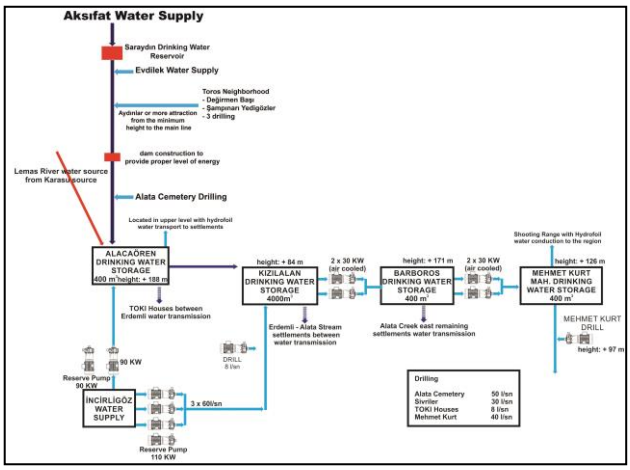

Figure 3. Schematic drawing showing Aksıfat water supply and drinking water reservoirs [2]

2.5 Design of Water Information Management System Software (WIMS)

Water Information Management System software is created by making approximately 26606 data entries for Erdemli, including continuous and seasonal population projections, water demand and wastewater formation projections, warehouse-center for interactive satellite mapping-WTP drawings and visuals, pump maintenance-repair, identification and schematic information [2, 4].

The WIMS software program is designed within the scope of the study; The C language is encoded in the C# interface. With the MySQL database connection, all collected data is easily accessible. The aim of the designed software program is to make the user interface simple, easy and understandable [4].

When the software program and the system are designed and coded, the data security is kept on the front panel and the user information is processed in encrypted form in the database. It is also aimed to ensure that each user's login time and IP address are registered and that the system operates at maximum security level [4].

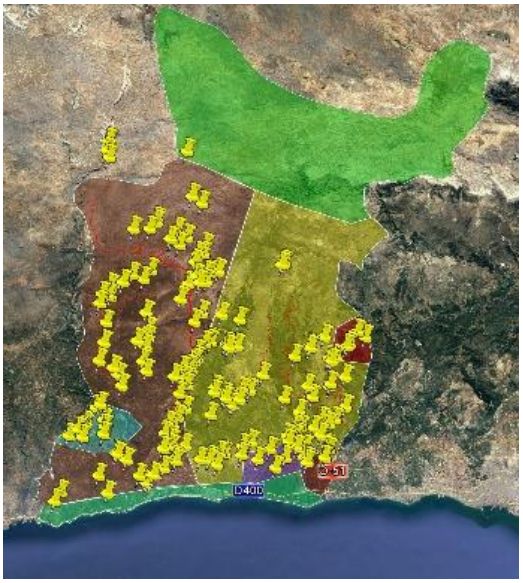

Figure 4. Demonstration of locations of drinking water tanks on satellite map [2, 4]

The WIMS software aims to manage all data from a single center, to monitor the current status of urban centers and rural settlements related to drinking water and wastewater, and to provide detailed management and control capability from a single center [4]. In addition, designed software can be developed in modular manner and so can reduce the software, business and investment costs to minimum, uploaded information in a short period of time to provide transportation and computerized information is the main advantages of obtaining electronic output [4]. The user interface general view of the WIMS software program designed in this context is given in Figure 6.

Figure 5. Display of Erdemli Municipality WTP on satellite map [3].

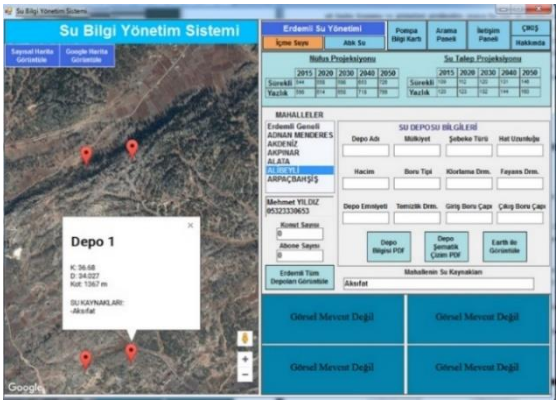

Figure 6. Water Information Management System user interface image [4].

3. Results and Discussion

When population projections for the 2015 TUİK population are compared to the population projections for the 2050 target year, it is expected to increase by about 90% for the permanent population and about 80% for the summer population [2].

It is predicted that Erdemli drinking water projections calculated for 2015 and 2050 will increase by about 80% of the demand and wastewater formation. The water resources in the district seem to be sufficient when compared to the projections calculated according to the year 2050. In the treatment of wastewater, the existing facilities need to be upgraded, revised and adapted to new treatment technologies [2, 3, 17].

Potential hazards for water resources; wastewater and sewage network projects of Kayacı, Sorgun, Koramşalı, Fakılı, Çamlı, Karahıdırlı, Karayakup, Sinap, Çiftepınar and Pınarbaşı neighborhoods should be done. This will not contaminate the source of drinking water and reduce chlorination costs [2].

In the summer months when the water demand is very high, there are water problems in Aydınlar - Sarıkaya, Arslanlı, Hacıalanı and Esenpınar districts, which are considered to be particularly springy. This is because the water is unplanned and used in the water. Development plans of residential areas can be solved by making drinking and wastewater projects and recording and using water [19].

Since water consumption in the rural areas decreases in winter, Aksıfat Drinking Water Supply can be integrated with Erdemli Drinking Water Network between October and June (about 9 months) for better quality and economical water usage. The corresponding connection is given by

Figure 2. Settlements where drinking water and wastewater problems are most experienced in Erdemli District [2,4]

Figure 2 [2].

It is necessary to revise the insufficient drinking water reservoirs in the district. Automatic disinfection should be done by installing the storage chlorine automatic device. All these operations can easily be performed with the WIMS program designed for the study [2, 4].

Efforts should be made to reduce the rate of loss-fugitives. Subscriber registration system should be continuously updated. The number of subscribers should be compared with water consumption and water collection, and the cause of water leaks should be investigated by determining the difference between the two. There are water shortages during the summer months when there is a lot of water demand, especially in areas where water is unplanned and is considered as a springboard due to illegal use in the water. For this reason, it is extremely important to record and control the use of water [12-19].

4. Conclusions

Waste water generated in the rural areas where there is not enough infrastructure system may cause danger to water resources in the district. For this reason, wastewater problems (zoning plans, sewerage network, package treatment facilities, etc.) of these areas must be resolved permanently and economically [2, 3]

In Erdemli, the distance between the rural and the district centers is far away each other, the topography is rough and the transportation is quite difficult during the winter months. In the case of possible problems with these remote areas, technical service centers to be able to serve 24/7, and mobile support teams who can work continuously on their control, should be placed in central locations in the countryside. Any faults that may occur on this site will be eliminated in a short period of time to prevent water loss and infrastructure problems [2, 3].

Universities, non-governmental organizations, written and visual press should give information about saving of water, importance of water and irrigation techniques to the people of urban centers and rural areas [2, 3].

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Nomenclature

WIMS : Water Information Management System
WTP : Wastewater treatment plant
GPS : Global Positioning System
MySQL : Structured Query Language

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