PLANNING of ELECTRICITY DISTRIBUTION SYSTEMS BASED on GEOGRAPHICAL INFORMATION SYSTEMS (GIS)

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By
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ABSTRACT

**PLANNING of ELECTRICITY DISTRIBUTION SYSTEMS
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This thesis represents a GIS (Geographic Information System) application in planning of electricity distribution systems. Problems in the planning and operating stages of the electricity distribution network are investigated and analyzed. The electricity distribution network is considered to integrate with GIS technology. The electricity distribution network model for the city is established with GIS and GPS (Global Positioning System) support. The digital map of the electricity distribution network is produced by MapInfo® and then end-user software tools are developed by using MapBasic® software's. To facilitate an electrical analysis, calculation tools (Voltage Drop Analysis - Power Loss Analysis), printing and a lot of reporting tools (find-subscriber, find-transformer, etc.) are developed. By the application, the current electricity distribution network of Gaziantep is transferred to a digital environment and it is used for the planning and operating of the network. In this study, each stage of the application is explained and shown with examples.

Keywords: Electricity Distribution Systems, Electricity Distribution Planning,
GIS (Geographic Information Systems)

ÖZ

ELEKTRİK DAĞITIM SİSTEMLERİNİN COĞRAFİ BİLGİ SİSTEMLERİ (CBS) TABANLI PLANLAMASI

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Bu tez, elektrik dağıtım sistemlerinin planlamasında CBS (Coğrafi Bilgi Sistemleri) tabanlı bir uygulamayı göstermektedir. Elektrik dağıtım şebekesinin planlama ve işletme aşamalarında karşılaşılan problemler incelenmiş ve analiz edilmiştir. Elektrik dağıtım şebekesinin CBS teknolojisiyle entegre edilmesi düşünülmüştür. CBS ve KKS (Küresel Konumlama Sistemi) desteğiyle şehir için elektrik dağıtım şebeke modeli kurulmuştur. Elektrik dağıtım şebekesinin MapInfo® ile sayısal haritası üretilmiş ve sonra MapBasic® ile son kullanıcıya yönelik araçlar geliştirilmiştir. Elektriksel analizi kolaylaştırmak için, hesaplama araçları (Gerilim Düşümü Analizi-Güç Kaybı Analizi), çıktı ve birçok raporlama aracı (abone-bul, trafo-bul vb.) geliştirilmiştir. Bu uygulama ile Gaziantep'in mevcut elektrik dağıtım şebekesi sayısal ortama aktarılarak, şebekenin planlama ve işletmesinde faydalanılmıştır. Bu çalışmada, uygulamanın her safhası açıklanmış ve örnekleriyle gösterilmiştir.

Anahtar Kelimeler: Elektrik Dağıtım Sistemleri, Elektrik Dağıtım Planlaması, CBS (Coğrafi Bilgi Sistemleri)

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LIST OF SYMBOLS/ABREVIATIONS

P = kW	Power
N = kVA	Apparent Power
I = A	Current
L = km	Length of Line
R_0 = Ω / km	Resistance of Conductor at 20°C
X_L = Ω / km	Inductive Reactance
U = kV	Line Voltage
f = Hz	Frequency
r = mm	Conductor Radius
d = cm	Geometric Mean Distance
λ = **(H.km/phase)**	Inductance
Cosφ = **0.8**	
K:	Coefficient
C:	Coefficient
ΔU:	Absolute Voltage Drop
%e	Percentage Voltage Drop
ΔP	Power Loss
%P	Percentage Power Loss

GIS	Geographic Information System
GPS	Global Positioning System
UIS	Urban Information System
SCADA	Supervisory Control and Data Acquisition
TEDAŞ	Turkish Electricity Distribution Company/ Turkish single authority for electricity distribution around the country

CHAPTER I

INTRODUCTION

1.1. Introduction

There is a trend, which has been dominant over last 50 years on electrical distribution systems planning: the movement of the population from villages to metropolitan areas. The number of families in rural areas has continuously declined during this century, this population flow into larger urban areas [1]. So the migration from the suburbs to the urban and near-urban areas caused a vitally important problem for electricity distribution system planners. Rapid developing cities and their energy needs have gradually made electricity distribution systems as more complicated structures. While such a complicated structure is managed, it is important that service quality giving to the consumers is increased, that the current systems are more effectively used, and that very appropriate decisions are made [2].

Because of unforeseen rapid increase in population of our country, some infrastructural problems in urbanization appear. One of those problems is planning of electricity distribution. Mostly electrical distribution systems are overlapped but not synchronized and not even regularly updated. The major problem is lack of data: the quantity, quality and accuracy of data. Therefore, distribution network cannot be used optimally because electrical calculations such as voltage drop, power loss cannot be done. In some districts while transformers may break down due to an overloading, in some districts transformers are set up where they could be sufficient even for the next ten years. This situation causes source extravagance for an electricity distribution company and poor-qualified service for the consumers [3]. As there are difficulties mentioned above, the observation of the network becomes more complex and necessary statistical data cannot be gathered.

This chapter briefly introduces the electricity distribution problem and the electricity distribution network of Gaziantep. And the aim of thesis is explained.

1.2. Electricity Distribution

Large amounts of power are generated at power plants and sent to a network of high-voltage (380, 154 kV) transmission lines. These transmission lines supply power to medium voltage (e.g. 30 or 15 kV) distribution networks (distribution primary system), which supply power to still lower voltage (0.4 kV) distribution networks (distribution secondary system). Both distribution network lines supply power to customers directly. Thus, the total network is a complex grid of interconnected lines. This network has the function of transmitting power from the points of generation to the points of consumption.

An electric power distribution system delivers power to the customers via a set of distribution substations. While transmission and subtransmission lines are configured in a meshed network, distribution feeders are configured radially in almost all cases. This radial configuration simplifies overcurrent protection of the feeder. To help restore power to customers following a fault, most feeders are provided with tie circuits to neighboring feeders from either the same or the different substations. A number of switching operations are needed to restore power using these ties. Loads vary with time of day, day of the week, and season. Each type of load (residential, commercial, industrial) has a different time profile, and each feeder serves a different mix of loads [4]. Therefore, the load pattern on each feeder varies constantly and with a different variation on each feeder. This creates an opportunity that loses be constantly keep at a minimum level by reconfiguring the feeders during the day.

1.3. Electricity Distribution Planning

Distribution system planning starts at the customer level. The demand type, load factor and other customer load characteristics dictate the type of distribution system required. Distribution system planners must determine the load magnitude and its geographic location. A distribution substation must be placed and sized in such a way as to serve the load at maximum cost effectiveness by both minimizing feeder losses and construction costs, while considering the constraints of service reliability.

When feeders are newly expanded in a distribution system, allocation of new feeders, new routes that connect from the new feeders to substations and tie-line routes to other feeders, must be determined so as to minimize installation costs of new facilities under such constraints as load-balancing, current capacity, voltage drop and geographical installation restrictions [5]. However, it is difficult for planners to find the optimal feeder expansion plan among various candidates. The problem of the expansion planning has been how to minimize a new facility installation cost under the constraints: 1) line and transformer capacity, 2) voltage drop at each load point, 3) demand/supply balance, and 4) radial configuration of the system. When an expansion of power distribution feeders is planned in urban areas, the following items must be taken into account: 1) geographical installation restriction, 2) feeder load balance, 3) availability of interconnection between new feeders and existing feeders in order to obtain reliability of power supply, 4) constraints of current capacity, voltage drop and radial system structure, and 5) minimization of new facility installation cost. It is difficult to find a space to install a new feeder in urban areas because existing feeders are so dense. Furthermore, tie lines that connect the expanded new feeder to the existing feeders must be newly installed to ascertain the reliability of the power supply in a fault [5].

Design process of electricity distribution network can be divided into three independent parts. These parts are load forecasting, design of secondary and primary substations. Load forecasting means load growth of a geographical area served by substation. Load growth is very much depended on the community and its development. It is important to determine load magnitude, its geographic location and customer load characteristics. Economic indicators, demographic data and official land use plans all serve as raw input to the forecast procedure. The forecasted load, load density and load growth may require a substation expansion or a new substation construction [1]. In the system expansion plan the present system configuration, capacity and forecasted loads can play major roles. The distance from the load centers and from the existing subtransmission lines as well as other limitations, such as availability of land, its cost and land use regulations are vitally important. There are some factors, which influence the load forecast, such as geographical factors, city plans, industrial plans, load density, population growth.

Design of secondary system (low voltage distribution network) consists of optimal substation allocation, transformer sizing, and secondary circuitry routing and sizing.

Design of primary system (medium voltage distribution network) also consists of optimal substation allocation, and primary circuitry routing and sizing.

Once the loads are assigned to the substations are determined, then the remaining factors affecting primary voltage selection, feeder route selection, numbers of feeders, conductor size selection, and total cost (the cost of equipment + labor and money) need to be considered. The distribution system is particularly important to an electrical utility for two reasons: its proximity to the ultimate customer and its high investment cost [1, 6]. The objective of distribution system planning is to ensure that the growing demand for electricity, with growing rates and high load densities, can be satisfied in an optimum way, mainly to achieve minimum of total cost of the distribution system expansion.

1.4. Electricity Distribution Network in Gaziantep

Gaziantep is the sixth largest city in the TURKEY with more than one million inhabitants. After the formation of the Republic, electricity was provided to 105 settlements between 1923 and 1933, and the electricity consumption per person was 10 Kw/h in 1923. Gaziantep was among the first cities receiving electricity and an Italian company built the first power station in 1932. Electricity was generated at this station by using wood and coal at first and diesel fuel later. It was used to provide lighting for homes and businesses first and later to industries. Electricity network of Gaziantep was laid out by this Italian company in the 1930s and then between 1970 and 1975 it was partially improved and distributed by the Provinces Bank. Although the power cable network was renovated after 1990 and was added on to with delegation and deposit systems using a new master plan for the city, it was not enough for the fast growing city.

The amount of increase in electric consumption was about 1139 million Kw/h between 1995 and 2000. Nowadays, the average monthly energy sold in Gaziantep is 320 million kWh. A small amount is provided by 4 auto-producer power stations in 57.5 MVA installed capacity in Gaziantep Organized Industrial Zone for the purpose of meeting the energy needs of their own plants and partners. Of the energy that is sold in Gaziantep 65% goes to industry, 17% to dwellings, 6% to commercial buildings, 5% to official buildings and 7% to other customers. There are currently a total of 390,000 electricity customers and of these customers 81% are dwellings, 13% commercial and offices, 3% factories and 3% others.

In Gaziantep there are; Gaziantep I TM: 154/31.5 kV, 2x50 MVA, Gaziantep II TM: 154/31.5 kV, 2x100 MVA; 380/31.5 kV, 1x100 MVA, Gaziantep III TM: 154/31.5 kV, 2x100 MVA, Gaziantep IV TM: 154/31.5 kV, 1x50 MVA, 1x100 MVA. İslahiye and Nurdağı townships' energy received 2x25 MVA Fevzipaşa TM, Araban township center and villages with Yavuzeli township village's energy received 1x50 MVA PS5 and 1x5 MVA PS4B TM; in Nizip and Karkamış townships, energy is received in 4 feeders 2x50 MVA from Birecik TM. There are about 7000 distribution transformers (30(15)/0.4 kV) including those owned individually for miscellaneous power and potential with 1.380 MVA installed capacity and 500 MW transferred power.

Gaziantep electricity network consists of 5 secondary substations 30/15 kV, and more then 5200 km of cables and overhead (aerial) lines. The electric utility TEDAS GAZIANTEP as a part of the national power company TEDAS is responsible for distribution of electric energy at medium and low voltage level, covering the urban area and seven townships of Gaziantep. TEDAS GAZIANTEP serves more then 390,000 customers spreading over the area of about 6216 sq. km. Eventually, as mentioned above the electricity network of Gaziantep is a quite large one.

1.5. Aim of the Thesis

Aim of the thesis is to present an application of electricity distribution planning based on GIS for Gaziantep. This application is proposed to use as a decision support system in management of electricity distribution network.

Gaziantep is a rapidly growing city, receiving intensive migration from the rural settlements of the area. In recent years, this growth has assumed the form of uncontrolled expansion, which is not supported by adequate urban planning work. It has been become almost impossible to obtain information from electricity network of the city and appreciation information to consider correctly about the problems. One of the important problems was used to be getting the correct data while doing the technical calculations in the electricity distribution planning. Since the information on current maps is constantly changing, the maps need to modified or completely redrawn to keep current situation. This is a very expensive and labor-time consuming process. In addition, one department may produce a given map and another department may use it, but whose latest version of the map may no longer be up-to-date. This can lead to costly errors and lost time for all involved. It was possible to do various mathematical calculations by appreciating conductor type and transformer power sizing, but this would not be realistic. Because in planning of electricity distribution for a city, it must be considered some factors such as the population, the widen direction of the settlement places, the existing situation of trading and industry, and the widen direction of the city. The load growth of the geographical area served by a utility company is the most important factor influencing the expansion of the distribution system. Hence, the thesis aims to integrate GIS into electricity distribution planning for Gaziantep.

For this purpose, the model of electricity distribution network will be established for Gaziantep with GIS and GPS support by using MapInfo®. In the current system, calculations are not so reliable. To facilitate some electrical analysis such as voltage drop, power loss and reporting, etc. some end-user software tools will be developed by using MapBasic® on the GIS system. Thanks to those modules time consuming calculations take as less time as seconds. Now, expansion scenarios for the new additions to the distribution network can be developed in less time and better decisions can be made for planning.

Briefly, an application will be developed, which is a modern information system and a tool that manages everyday tasks related to operating, maintaining, planning, design and actual expansion of the city's electricity network.

1.6. Organization of the Thesis

In the first chapter, we introduce to electricity distribution problem. In this chapter, importance of the problem for especially our country is mentioned. Chapter II contains literature survey about the role of GIS in electricity distribution planning.

Chapter III explores GIS technology. In this chapter, it is mentioned that what GIS can do, how it work and what its components is. Chapter IV step-by-step presents the application of electricity distribution planning based on GIS for Gaziantep. Some conclusions, discussion and future work is presented in the last chapter.

CHAPTER II

LITERATURE SURVEY

2.1. Introduction

In this chapter a survey is done from literature related to role of GIS in electricity distribution planning. We also survey about real GIS applications in electricity distribution planning. However, we could not found any real applications in our country which is also limited in the literature.

2.2. Electricity Distribution Planning

The other problem of distribution system planning is to find the optimum location of the substation, the optimum feeder configuration to connect the loads to the substation and the optimum branch conductor sizes. Many approaches to solve optimally the distribution system planning have been proposed [7-13]. These approaches are based on mathematical programming techniques such as branch and bound technique and mixed integer programming method. Other some approaches to solve heuristically the problem have been proposed [14-16]. These approaches are based on artificial intelligence, especially expert systems. On the other hand, better heuristic approaches have been proposed by some researchers [17-19]. These approaches are based on load flow algorithm. Especially, the heuristic approach proposed by [18] does not require prior knowledge of candidate substation location and can automatically select location of a substation, the optimal feeder configuration and the optimal sizes of branch conductors while satisfying constraints such as current capacity, voltage drop and heuristic rules.

In those former studies mostly, small, simplified problems had been taken into account. But optimization of electricity distribution system planning could not be integrated with GIS. But in real an electricity distribution system contains many geographical restrictions. For distribution systems planning or feeder expansion in the urban area it is very difficult to find the space for substation and feeder. In addition to this, finding the optimal candidate location itself will not suffice to solve the problem, heuristic rules need to be incorporated for a feasible optimal distribution system planning. Solving the exact problem by using classical optimization technique is not possible because of the combinatorial nature of the problem.

2.3. Role of GIS in Electricity Distribution Planning

In order to control dynamically changing structure of residences a dynamical planning is required. GIS is the most suitable tool for collecting the data needed for electrical distribution plans in a short and actual way. GIS can prevent the inefficiency and extension of voltage drop limits as a system which can update the current electrical distribution maps and monitor the whole network [20]. GIS can not only supply a digital map but because it can built up a relational database whenever there exists a click on the map complete data belonging to that point is called and presented to the user and analysis can be made coinciding with the purpose. This property of GIS made the calculation of electrical data and preparation of reports possible and made it vital for the planning of electrical distribution [2]. Most of the electrical network/equipment has a geographical location and the full benefit of any network improvement can be had only if the work is carried out in the geographical context. Business processes such as network planning, repair operations and maintenance connection and reconnection has also to be based around the network model. Even while doing something as relatively simple as adding a new service connection; it is vital to know that users of the system are not affected by this addition. GIS in conjunction with system analysis tools helps to do just this [21].

Electric utilities have a need to keep a comprehensive and accurate inventory of their physical assets, both as a part of normal service provision (extending the network, undertaking maintenance, etc.) and as a part of their obligation to inform third parties about their facilities. The complexity of an electrical distribution power system is a good reason for introducing new information technology -GIS- that carries out complex power system analyses (e.g., fault analysis, optimization of networks, load forecasting) in acceptable amount of time. By using modern GIS, in conjunction with its own in-house developed software, in less time and more accurately, the utility engineer is able to design and to analyze electrical distribution network. The distinguishes an electrical utility information system from an other information system - such as those used in banking, stock control, or payroll systems - is needed to record geographical information in the database. Electrical utility companies need two types of geographical information: details on the location of facilities, and information on the spatial interrelations between them. The integration of geographically referenced database, analytical tools and in-house developed software tools will allow the system to be designed more economically and to be operated much closer to its limits resulting in more efficient, low-cost power distribution systems [6, 22].

The planning and the design of the electrical supply system are daily tasks for engineers in the electric utilities. The goal of power distribution system planning is to satisfy the growing and changing system load demand during the planning period within operational constraints and with minimal costs. The planning process comprises several phases, and one of the most important is the optimization of the electric distribution network. The network optimization is considered a hard combinatorial optimization problem due to a number of limitations (network voltage level, network structure, amounts and locations of loads, routes and types of feeders, voltage drops, etc.). An additional complexity is imposed by the geographically referenced data. In this process it is important to have on time accurate relevant (related) data and information on the electric distribution system and its assets, and possibly to have data from other utilities. Computerization and development of various geographic information systems have opened new horizons for all decision-making processes as well as for manipulation and dissemination of information [23].

For efficient and reliable operation of a distribution system, a reliable and well knit communication network is required to facilitate project coordination of the maintenance and fault activities of the distribution system. GIS when integrated with real time SCADA (Supervisory Control and Data Acquisition) can help in sending the right signals to the communication network. GIS environment hosts a wealth of presentation techniques that enable fast and accurate interpretation of results from power flow results to short circuit analysis [21].

GIS database provides the source of sufficiently accurate data on medium-voltage distribution network assets. Its spatial data model comprises topological information on network elements (connectivity, sharing, adjacency, proximity, overlapping, etc.), providing the foundation for spatial analyses and reasoning. The accurate positions and lengths of the existing cables and all their segments in the cable route between two substations are defined. The exact locations of existing and proposed locations of future-planned substations, as a result of load growth analyses and predictions, are known. The possible routes for new cables in keeping with urban zoning plans, ecological and aesthetic constraints are also known from database spatial queries and graphic presentation of observed geographic area. The knowledge of precise cable lengths (i.e. segments of the cables between substations) and other corresponding attributes (e.g. the year the cable segment was laid down, construction type, material, cross section, operating voltage) for the existing cables and selected set of possible new cable routes enables the better electrical analyses and planning of the network. GIS mechanisms of spatial and non-spatial querying enable us to reach the relevant data and information for the process of optimization and planning the distribution network. The same mechanisms are applied to analyses of interim or final planning results. The GIS is also used as graphical editor for displaying and taking interactive actions during the whole planning procedure. Layers of information are contained in map representations. For example; the first layer corresponds to the distribution network coverage. The second layer corresponds to the land background containing roads, landmarks, buildings, rivers, railway crossings etc. The next layer could contain information on the equipment poles, conductors, transformers etc.[21, 23].

GIS, as its basic feature, provides to the users precise geographical location of an object. This feature of GIS is definitely useful to the electrical utilities. The objects for electrical utilities are their assets in the form of equipment and supply cables that are installed in the field. Therefore, the utility would greatly benefit if it could locate its assets precisely and also get as much information about them as possible by using the GIS technology [24]. GIS, to yield this important benefit, would normally require that, the utility should place its assets correctly on the accurate and reliable geographical maps of its service area. To process the information associated these assets correctly, and prepare required reports, it is necessary that the utility includes, as much information as possible, in the form of attributes of the objects that are placed on the maps.

In the era of restructuring and modernization of electric utilities, the application of GIS technology in the power industry is growing and covering several technical and management activities. The integration of GIS with existing power analysis tools is tremendously improving planning and operation of the system. As modern technologies arise, power utilities are seeking new methods to improve system reliability, power quality and customer satisfaction [25]. High quality of the power can only be achieved if the system losses are at their minimum level and the voltage level is within an acceptable range.

GIS provide a real solution to the management of the data required for engineering analyses. In addition, it provides tools to support the planning of spatial components and means to interface to third party analysis tools [25]. Most GIS electric power studies and analysis applications were developed for electrical distribution systems analysis and design. GIS was used as a component of a full-featured distribution automation system [26]. Other applications tackled the problem of designing the electrical supply system for new residential development [27]. Other utilities have been also investing on process automation in order to provide their customers with high quality attendance [28-31]. GIS was also used to rebuild the design of the whole work procedures in electric utilities [32]. GIS and GPS are also integrated for mapping and analysis of electric distribution circuits [33].

GIS integrate common database operations such as query and statistical analysis with the unique visualization and geographic analysis benefits offered by maps. These abilities distinguish GIS from other information systems and make it valuable from explaining events, predicting outcomes and planning strategies for distribution system management. Nowadays not making so much projects regarding city planning brings huge economical losses along with. In order to stop the occurrence of those losses, long term designs must be made and information technology must be used. GIS brings those facilities to the users. GIS is an important tool in this area. In brief, GIS is necessary for making optimum decisions in planning, engineering and a healthy flow of administrative data for analysis of electrical distribution plans.

CHAPTER III

GEOGRAPHIC INFORMATION SYSTEM (GIS)

3.1. Introduction

At the beginning of the chapter, definitions of GIS are given. At the following sections GIS's capabilities, working methods, components, advantages and some application areas are given.

3.2. Definitions

GIS is a special-purpose digital database in which a common spatial coordinate system is the primary means of reference. A comprehensive GIS require

1. Data input, from maps, aerial photos, satellites, surveys and other sources
2. Data storage, retrieval and query
3. Data transformation, analysis and modeling, including spatial statistics
4. Data reporting, such as maps, reports and plans

There are observations about this definition:

First, GIS is related to other database applications, but with an important difference. A GIS database uses geo-references as the primary means of storing and accessing information. Second, GIS integrates technology. Whereas other technologies might be used only to analyze aerial photographs and satellite images, to create statistical models, or to draft maps, these capabilities are all offered together within a comprehensive GIS. Third, GIS, with its array of functions, should be viewed as a process rather than as merely software or hardware. GIS are for making decisions. The way in which data is entered, stored, and analyzed within a GIS must mirror the way information will be used for a specific research or decision-making task. To see GIS as merely a software or hardware system is to miss the crucial role it can play in a comprehensive decision-making process [34].

Geographic information is a significant subset of the information explosion that has occurred over the last two decades. In the broadest sense, geographic information is information that includes an ocational/spatial reference (street address, latitude/longitude, section/township) as part of the data records. The geographic component of information has become increasingly important as information technologies, such as GIS, have been developed to analyze and display information based on its location [35]. GIS is computer-based software that integrates the maps (spatial/graphical component) and database (tabular alphanumeric component) aspects of information. A GIS is designed for the collection, storage and analysis of phenomena where geographic location is an important characteristic or critical to the analysis.

A GIS is core information technology with capabilities to effectively collect, organize, access, and analyze geographic information. In its simplest form, GIS technology supports automated mapping the creation, update, and production of maps providing great advantages over manual mapping methods. But GIS is much more than a mapping tool. GIS software has the ability to store graphic representations of map features and to access diverse types of data and records that are geographically referenced [36]. It allows users to access, examine, and analyze geographically referenced information.

A GIS is a facility for preparing, presenting, and interpreting facts that pertain to the surface of the earth. This is a broad definition . . . a considerably narrower definition, however, is more often employed. In common, a GIS is a configuration of computer hardware and software specifically designed for the acquisition, maintenance, and use of cartographic data.[37].

A GIS is an information system that is designed to work with data referenced by spatial or geographic coordinates. In other words, a GIS is both a database system with specific capabilities for spatially-reference data, as well [as] a set of operations for working with data . . . In a sense, a GIS may be thought of as a higher-order map [38].

A GIS is an organized collection of computer hardware, software, geographic data, and personnel designed to efficiently capture, store, update, manipulate, analyze, and display all forms of geographically referenced information [39].

A GIS is a computer system capable of assembling, storing, manipulating, and displaying geographically referenced information, i.e. data identified according to their locations. Practitioners also regard the total GIS as including operating personnel and the data that go into the system. These definitions tell that GIS means different things for different groups of people. Different definitions of GIS emphasize different aspects of GIS. There are also arguments about what GIS should be called. In the United States, it's called geographic information systems; whereas in the United Kingdom and Europe it's called geographical information systems. In Canada, it's called geomatics [40].

3.3. What Can GIS Do?

GIS allows users to view, update, query, analyze, combine, and manipulate map data. It can take information from different map and tabular sources and register them to a desired base. It can manage large collections of natural resource and environmental data and the complex data sets needed for urban studies. It can overlay maps to eliminate or include areas based on multiple layers of tabular criteria. It can automatically generate buffers around features like sensitive land use types. Any analysis which uses map data can make use of GIS. Applications for GIS include resource assessment and management, habitat assessment, development planning, waste management site analysis, infrastructure and environmental impact analysis, and urban land records analysis [41]. GIS technology can be used for scientific investigations, resource management, and development planning. For example, a GIS might allow emergency planners to easily calculate emergency response times in the event of a natural disaster, or a GIS might be used to find wetlands that need protection from pollution [42].

In general, the most effective and efficient GIS is one that is integrated with the rest of an organization's information technology (hardware, software and databases) and one that is shared and/or coordinated across multiple agencies. The power of GIS is most apparent when the quantity of data involved is too large to be efficiently handled manually. There may be thousands of features to be considered, and hundreds of factors associated with each feature or location. This information may be stored on a multitude of maps, paper tabular files, computerized databases, and/or large lists of names and addresses. With GIS, all of this information can be brought into the same system and the interrelationships of the numerous features and their characteristics analyzed as they relate to a given problem [35].

3.3.1. Graphical display of data and its implications

One of the most powerful capabilities of a GIS is its ability to graphically display data or information related to public policy decisions. The capability to link tabular data to related maps or other graphic displays of the data is a powerful communication tool that turns raw data into useable information [35]. For example, one view in your project that displays a city's census tracts classified by population, and another view that shows just the outlines of these census tracts, as shown in Figure 3.1.

3.3.2. Neighborhood analysis

Another powerful capability of a GIS is the ability to identify and/or analyze phenomenon based on their physical proximity or being in the same neighborhood. The spatial or locational component of GIS enables the user to accomplish several types of analyses or applications that would be difficult without reference to location. Neighborhood function analyzes the relationship between an object and similar surrounding objects. A new map is created by computing the value assigned to a location as a function of the independent values surrounding that location. Neighborhood functions are particularly valuable in evaluating the character of a local area.

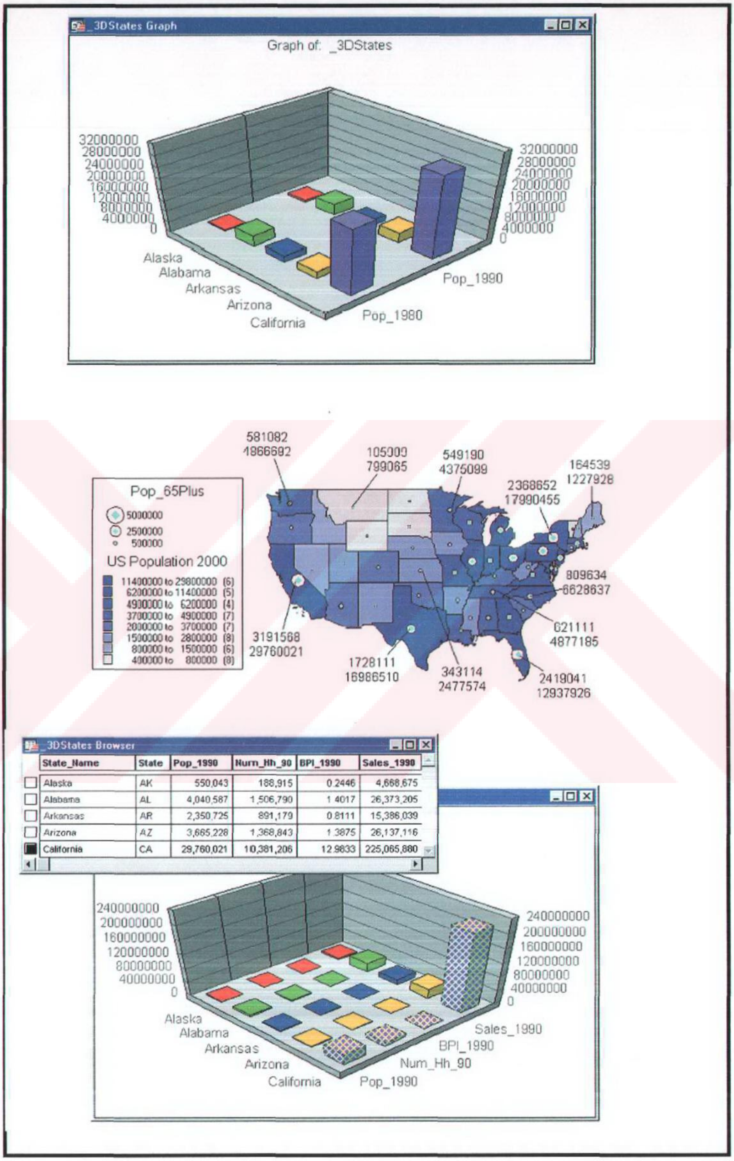


Figure 3.1 A view capabilities of GIS (from MapInfo® professional user guide)

3.3.3. Overlay analysis

Within a GIS, this locational or physical proximity information can also be used to overlay several different types of information and analyze their interaction as it relates to a given problem. In GIS, the different types of information relevant to a particular problem are organized into separate digital data layers. The overlay function creates composite maps by combining diverse data sets.

The overlay function can perform simple operations such as laying a road map over a map of local wetlands and adding map attributes of different value to determine averages and co-occurrences. This feature of GIS allows information on completely different types of features, from different information sources, to be brought together and analyzed for how they might interact and impact on a particular phenomenon of concern. A similar approach could be used with GIS for a wide variety of types of data layers and a wide variety of applications [35]. For example, one might map optimum sites for potential manufacturing plant development based on the interaction of data layers such as: streets and highways, railroads, utilities, zoning, vacant lots, distance to suppliers, location of trained workforce, etc. Figure 3.2 illustrates how this overlay technique might be applied to analyze the potential for soil erosion.

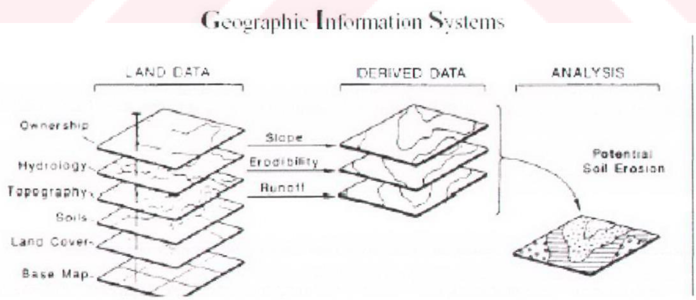


Figure 3.2 Illustration of overlay capabilities of GIS

3.3.4. Storing and retrieving maps

GIS allows these maps to be stored digitally and updated on an on-going basis. These digitally stored maps can be printed out to produce an up-to-date version upon request either by the department that maintains the map information or by another department that shares a common computer network. Specific attribute information about a given feature on a map, such as the traffic volume on a given road, can also be accessed via computer [35]. This fundamental capability of GIS can provide a great deal of increased efficiency, and eliminate unnecessary redundancy in many operations.

Essentially, any set of data that has a spatial extent and is referenced with a geographic identifier- such as an address, parcel ID, or latitude/longitude- can be utilized in a GIS to answer questions and solve problems. A GIS typically addresses questions and problems related to location proximity, conditions, trends and patterns. Additionally, a GIS can be used to perform analytical operations to support decision-making processes, such as site suitability analyses for future landfills or soil erosion potential within a specific region. A GIS can also answer "what if...?" questions based on different scenarios and situations. A GIS can be used to automate existing operations (e.g., map production and maintenance), as well as provide enhanced capability to analyze geographic information for decision-making purposes. One of the most powerful features of a GIS is its ability to simultaneously use multiple discrete spatial data sets to answer questions that were previously impossible to answer using conventional mapping methods. By inputting spatial information into a GIS, we can query data based on its location in the real world. When we link our spatially referenced data to an existing database and query based on a geographic identifier and attribute, we add another dimension to our query, giving us results impossible to achieve from a database alone. When used as a result of proper planning and attention to detail, a GIS allows the end user to make better decisions quicker, and provides planners, engineers and technicians with the ability to make sense out of data that may otherwise be overlooked [43]. A GIS combines the best of map-making with the best of database management, resulting in a powerful combination of visual and computational analysis.

3.4. How Does GIS Work?

GIS stores information about the world as a collection of thematic layers that can be linked together by geography. This simple but powerful and versatile concept has proven invaluable for solving many real-world problems from tracking delivery vehicles, to recording details of planning applications, to modeling global atmospheric circulation [44]. By default a theme represents all the features of a particular feature class that the data source is based on. It is useful to be able to restrict a theme to represent only a desired subset of the features displayed in a particular feature class. For example, you might have a data source that contains arcs for all the roads in your study area, but you want to create a theme that only represents the major highways. In this case, you would first add the theme to your view then set its theme properties to define a feature selection consisting of the major highways.

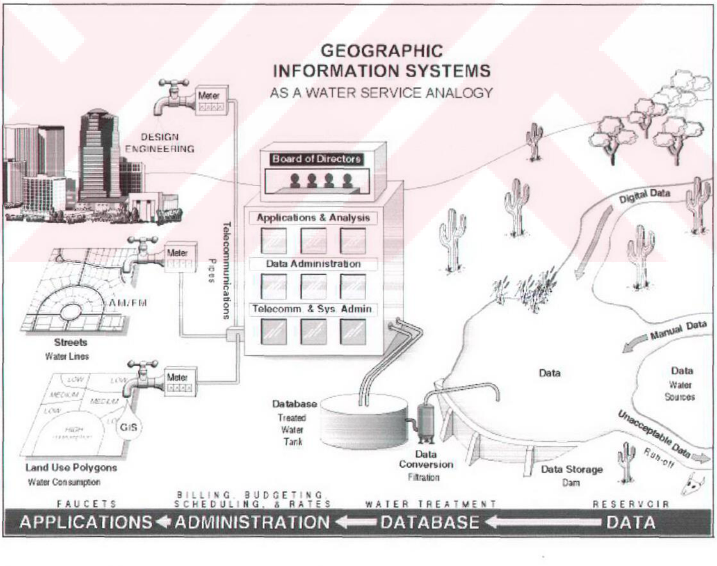


Figure 3.3 Illustrations of sources of GIS

3.4.1. Relating different sources

A GIS, which can use information from many different sources, in many different forms can help with such analyses, as shown in Figure 3.3. The primary requirement for the source data is that the locations for the variables are known. Location may be annotated by x, y, and z coordinates of longitude, latitude, and elevation, or by such systems. Any variable that can be located spatially can be fed into a GIS. Different kinds of data in map form can be entered into a GIS. A GIS can also convert existing digital information (which may not yet be mapped) into forms it can recognize and use.

3.4.2. Data capture

If the data to be used are not already in a digital format (something the computer can recognize), there are various techniques and technologies available to capture the visible features. The simplest, technologically, is digitizing, hand-tracing the paper map computer mouse. Electronic scanning devices may be employed to convert map lines and points to digits. In addition to being costly there are rarely completely automatic ways to do that. Much of what we can easily recognize reading a map is very confusing to a scanner. This method is very useful where the number and type of features are limited, and area contrasts are clear. Data capture -putting the information into the system- is the time-consuming component of GIS work. Identities of the objects on the map must be specified, as well as their spatial relationships. Editing of information that is automatically captured can also be difficult. Electronic scanners record blemishes on a map just as faithfully as they record the map features. Although increasing amounts of spatial information are captured in a digital format (for example, satellite imagery, and aerial photography) many organizations will have to convert large volumes of information from a paper format. An example would be a water utility that has to convert its water mains records (graphical and text based), to digital format. Some of these records might be up to one hundred years old. Data capture is achieved by manual or automated means and may involve integrating spatial data from a number of sources, with non-spatial information such as finance accounts, customer records etc. [42, 45].

3.4.3. Data integration

A GIS makes it possible to link, or integrate, information that is difficult to associate through any other means. Thus, a GIS can use combinations of mapped variables to build and analyze new variables. A GIS can be used to emphasize the spatial relationships among the objects being mapped. While a computer aided mapping system may represent a road simply as a line, a GIS may also recognize that road as the border between wetland and urban development, or as the link between Street A. and Lane B. [42].

3.4.4. Projection and registration

Map information in a GIS must be manipulated so that it registers, or fits, with information gathered from other maps. Before the digital data can be analyzed, they may have to undergo other manipulations - projection conversions, for example - that integrate them into a GIS. Projection is a fundamental component of mapmaking. A projection is a mathematical means of transferring information from the Earth's three-dimensional curved surface to a two-dimensional medium - paper or a computer screen. Different projections are used for different types of maps because each projection is particularly appropriate to certain uses. For example, a projection that accurately represents the shapes of the continents will distort their relative sizes. Since much of the information in a GIS comes from existing maps, GIS uses the processing power of the computer to transform digital information, gathered from sources with different projections to a common projection [42].

3.4.5. Data structures

A GIS must be able to convert data from one structure to another. Image data from a satellite that has been interpreted by a computer to produce a land use map can be "read into" the GIS in raster format. Raster data files consist of rows of uniform cells coded according to data values. An example would be land cover classification. Raster data files can be manipulated quickly by the computer, but they are often less detailed an may be less visually appealing than vector data files, which can approximate the appearance of more traditional hand drafted maps. Vector digital data have been captured as points, lines (a series of point coordinates), or areas (shapes bounded by lines). An example of data typically that is held in a vector file would be the property boundaries for a housing subdivision [42]. A GIS can perform data restructuring in order to convert data into different formats. For example, a GIS may be used to convert a satellite image map to a vector structure by generating lines around all cells with the same classification, while determining the cell spatial relationships, such as adjacency or inclusion. Thus a GIS can be used to analyze land use information in conjunction with property ownership information.

3.4.6. Data modeling

A GIS, however, can be used to depict two- and three-dimensional characteristics of the Earth's surface, subsurface, and atmosphere from information points. For example, a GIS can quickly generate a map with lines that indicate rainfall amounts. Such a map can be thought of as a rainfall contour map. Many sophisticated methods can estimate the characteristics of surfaces from a limited number of point measurements. A two-dimensional contour map created from the surface modeling of rainfall point measurements may be overlain and analyzed with any other map in a GIS covering the same area [42].

3.4.7. Data output

A critical component of a GIS is its ability to produce graphics on the screen or on paper that convey the results of analysis to the people who make decisions about resources. Wall maps and other graphics can be generated, allowing the viewer to visualize and thereby understand the results of analyses or simulations of potential events [42]. High quality output in various forms remains important for most GIS users. Communicating the results of GIS analysis is essential for the effective use of the technology. Output may take the form of a map; a table; a report or a digital file.

3.4.8. Graphic display techniques

A GIS can combine map types and display them in realistic three-dimensional perspective views that convey information more effectively and to wider audiences than traditional, two-dimensional maps. Traditional maps are abstractions of the real world, a sampling of important elements portrayed on a sheet of paper with symbols to represent physical objects. People who use maps must interpret these symbols. Topographic maps show the shape of land surface with contour lines. Graphic display techniques in GIS's make relationships among map elements visible, heightening one's ability to extract and analyze information as shown in Figure 3.4.

Figure 3.4 Graphic display techniques (from MapInfo® Professional User Guide)

3.5. Three Unique Concepts of GIS

3.5.1 Discrete thematic data layers

A map view is an interactive map that lets display, explore, query, and analyze geographic data. A view is actually a collection of themes. A theme represents a distinct set of geographic features in a particular geographic data source. A view defines the geographic data that will be used and how it will be displayed, but it does not contain the geographic data files themselves. Instead, a view references the sources of the data files. A view is dynamic, because it reflects the current status of the source data. If the source data changes, a view that uses this data will automatically reflect the change, the next time the view is drawn. It also means that the same data can be displayed on more than one view, as shown in Figure 3.5.

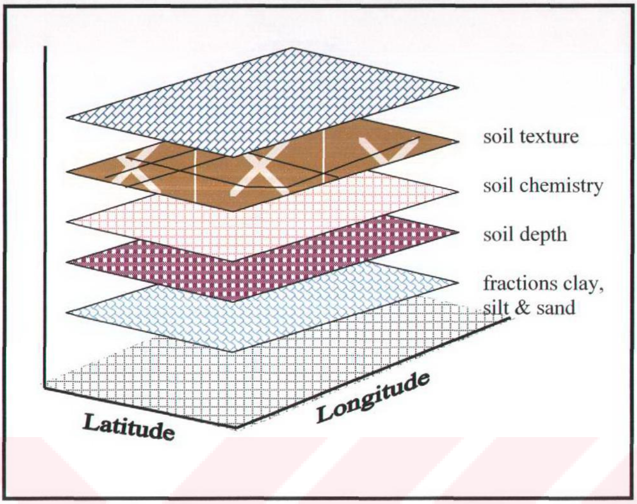


Figure 3.5 Environmental example

3.5.2. Georeferenced data

Once map data have been registered carefully within a common locational reference system, information displayed on the different layers can be compared and analyzed in combination. Single locations or areas can be separated from surrounding locations, by simply cutting all the layers of the desired location from the larger map [34]. Whether for one location or the entire region, GIS offers a means of searching for spatial patterns and processes, as shown in Figure 3.6.

3.5.3. Map algebra and data combination

Not all analyses will require using all of the map layers simultaneously. In some cases, a researcher will use information selectively to consider relationships between specific layers. Furthermore, information from two or more layers might be combined and then transformed into a new layer for use in subsequent analyses. This process of combining and transforming information from different layers is sometimes called map "algebra" in so far as it involves adding and subtracting information as shown in Figure 3.7 [34].

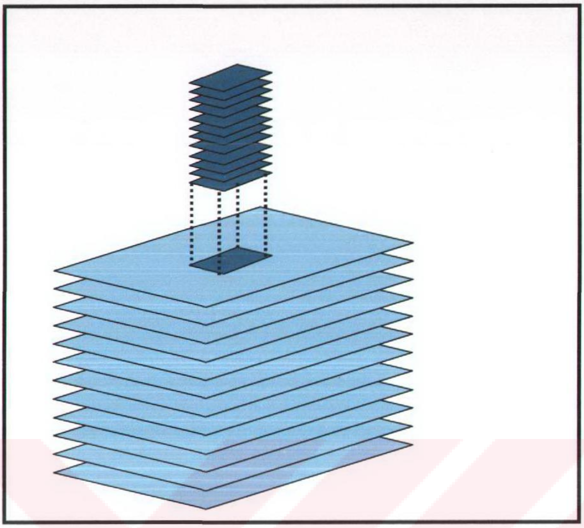


Figure 3.6 Layers of information collated for a single location

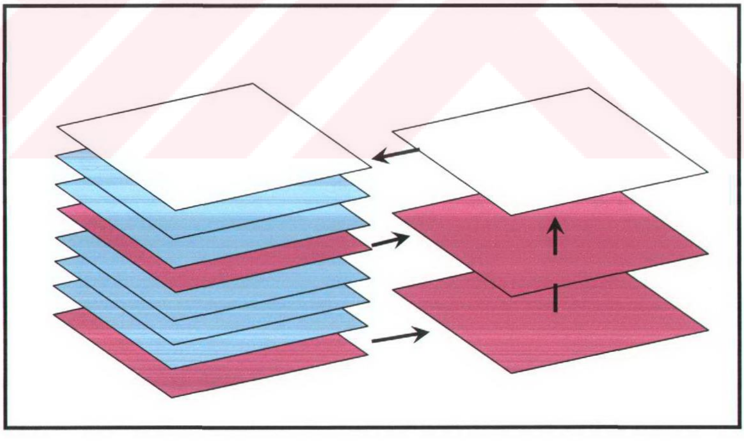


Figure 3.7 Selecting and transforming GIS data by layer

3.6. Components of GIS

GIS is a complex system and, as such, it requires more than just the hardware (computers, etc) and software (computer programs) to make it function. Two other types of components are necessary for any successful GIS: information or data in the proper form; and the agencies and trained people working together to make a GIS a success. Indeed, most GIS analysts would assert that the most challenging aspects of building a successful GIS are the development and maintenance the proper data and securing the cooperation of multiple agencies and retaining trained-experienced people [35].

As shown in Figure 3.8, GIS constitutes of five key components:

- Hardware
- Software
- Data
- People
- Method

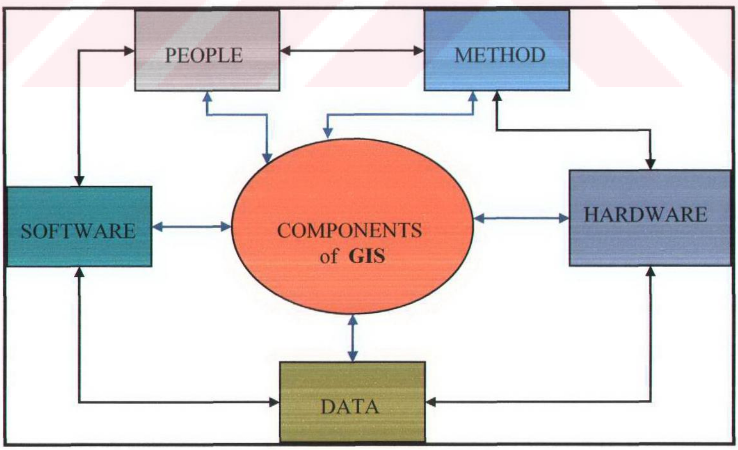


Figure 3.8 Components of GIS

3.6.1. Hardware

Hardware is the computer on which a GIS operates. It consists of the computer system on which the GIS software will run. The computer forms the backbone of the GIS hardware, which gets its input through a scanner or a digitizer board. The scanner converts a picture into a digital image for further processing. The output of scanner can be stored in many formats e.g. TIFF, BMP, JPG etc. A digitizer board is flat board used for vectorisation of a given map objects. Printers and plotters are the most common output devices for a GIS hardware setup. Another important hardware component is GPS (Global Positioning System) which is a satellite-based system that can be used to locate positions anywhere on the earth. A GPS receiver calculates its position by a technique called satellite ranging, which involves measuring the distance between the GPS receiver and the GPS satellites it is tracking. The range or distance is measured as elapsed transit time. The position of each satellite is known, and the satellites transmit their positions as part of the "messages" they send via radio waves. The GPS receiver on the ground is the unknown point, and must compute its position based on the information it receives from the satellites.

3.6.2. Software

GIS software's in use are MapInfo®, ARC/Info®, AutoCAD® Map, NetCAD® etc. The software available can be said to be application specific. MapInfo® may be a suitable option and it is easy to use and supports many GIS feature. If the user intends to carry out extensive analysis on GIS, ARC/Info® may be a preferred option. For the people using AutoCAD® and willing to step into GIS, AutoCAD® Map is good option. GIS software provides the functions and tools needed to store, analyze, and display geographic information.

Key software components are;

a) Tools for the input and manipulation of geographic information

b) A database management system (DBMS)

c) Tools that support geographic query, analysis, and visualization

d) A graphical user interface

3.6.3. Data

Geographic data and related tabular data can be collected in-house or purchased from a commercial data provider. The digital map forms the basic data input for GIS. Tabular data related to the map objects can also be attached to the digital data. A GIS will integrate spatial data with other data resources and can even use a DBMS, used by most organization to maintain their data, to manage spatial data.

3.6.4. People

GIS technology is of limited value without the people who manage the system and develop plans for applying it to real-world problems. GIS users range from technical specialists who design and maintain the system to those who use it to help them perform their everyday work. The people who use GIS can be broadly classified into two classes. The CAD/GIS operator, whose work is to vectorise the map objects. The use of this vectorised data to perform query, analysis or any other work is the responsibility of a GIS engineer/user.

3.6.5. Method

A successful GIS operates according to a well-designed plan and business rules, which are the models and operating practices unique to each organization. There are various techniques used for map creation and further usage for any project. The map creation can either be automated raster to vector creator or it can be manually vectorised using the scanned images. The source of these digital maps can be either map prepared by any survey agency or satellite imagery.

3.7. Advantages of GIS

A GIS is a computer-based tool for mapping and analyzing things that exist and events that happen on Earth. GIS technology integrates common database operations such as query and statistical analysis with the unique visualization and geographic analysis benefits offered by maps. These abilities distinguish GIS from other information systems and make it valuable to a wide range of public and private enterprises for explaining events, predicting outcomes, and planning strategies [44].

A GIS is an integration of computer hardware and software, which can create, manipulate, and analyze a geographically referenced database to produce new maps and tabular data. GIS includes the capabilities of computer aided design (CAD) and database management systems (DBMS), but is more than just a combination of those systems. In a GIS, a relationship between the graphic map data and the tabular database is maintained so that changes to the map are reflected in the database. GIS allows automatic determination of the relationships between maps, and can create new maps of those relationships.

The traditional method of preparing and analyzing environmental and planning maps has been to overlay thematic maps manually to choose areas of coinciding constraints and opportunities. Engineers managing infrastructure have compiled facilities data manually, drafting on large scale street map bases. The difficulties with the manual overlay method include registering maps which may be published at different scales or projections. The more layers of maps included in the analysis and the more complex they are, the more the likelihood of human error entering the analysis and the longer the process takes. The GIS can take maps from different sources and register them easily and is consistent in its analysis of multiple layers of map data. It is also faster than manual methods of analysis, allowing the flexibility to try alternate variables in analysis [34].

GIS integrates spatial and other kinds of information within one system: it offers a consistent framework for analyzing space. GIS makes connections between activities based on spatial proximity. GIS provides the mechanisms for undertaking the manipulation, analysis and display of geographic knowledge [45]. The availability of GIS has increased the importance and utility of the geographic component of the information that governments routinely collect and maintain. GIS adds a powerful package of tools to an organization's information technology capability because of its ability to integrate and analyze diverse types of information based on the physical location or proximity of the various features or characteristics [35].

Computational functions of a GIS system are following

a. Data Acquisition & Verification
b. Data Compilation
c. Data Storage
d. Data Update & Manipulation
e. Data Management & Exchange
f. Data Retrieval & Presentation
g. Analysis & Combination

And GIS as a set of interrelated subsystems:

a. Spatial and Attribute Data Base
b. Cartographic Display System
c. Map Digitizing System
d. Database Management System
e. Geographic Analysis System
f. Image Processing System
g. Statistical Analysis System
h. Decision Support System

3.8. Decision Making and GIS

Firstly, and most importantly, a GIS is an information system. A system is a group of connected entities and activities which interact for a common purpose. An information system is a set of processes, executed on raw data, to produce information, which will be useful in decision-making. The development of IT (information technology) tools to support decision-making has matured in the 1990s. GIS is one of many systems available to the decision maker. It is important to remember, however, that there is a problem with the declared aim of GIS to improve decision-making: How do you measure what is a good decision and what are the feedback mechanisms to put right a poor decision? This is a complex area, which needs addressing. GIS has focused on the technology and more recently, on the information, but not on how they are used to the best effect in decision- making.

Systems are established to monitor the information flow and decision making nodes in many organizations. These provide ways of informing people about the success or otherwise of decisions they make, of the knock-on effects, and help to determine remedial action where necessary.

Measuring the success of a GIS in the decision making process may prove to be difficult to quantify, and this difficulty has certainly been recognized in the literature concerning cost-benefit analysis of GIS. There is, however, recognition that just the graphics alone, including maps, can be very beneficial as an aid in making decisions. For example, the use of an ortho-corrected aerial photograph, overlaid with property polygons, by a planning committee could increase the understanding of, say, the limitations of potential sites for development [45]. An added problem, however, is that many people are not particularly spatially aware, having had little formal experience of using spatial information. Some individuals may even find it impossible to understand map-based information. Thus there is a need to consider improved methods of spatial data representation and aids to spatial data interpretation. Once again the use of multimedia technology and aerial photography could have a role to play in improving our spatial awareness.

3.9. GIS Applications

Some important application areas of GIS are following

- Landscape Ecology
- Geography
- Cartography
- Remote Sensing
- Photogrammetry
- Surveying
- Geodesy
- Statistics
- Operations Research
- Computer Science
- Mathematics

GIS usage by Industry:

Agriculture: Allows for site-specific analyses of physical, chemical and crop data that can determine the cause of yield variations.

Banking & Insurance: Allows banking institutions to target appropriate marketing and advertising resources to their customers based on their purchasing habits.

Defense & Intelligence: Allows defense agencies to present a wide variety of information onto one map, allowing for a more efficient level analysis of information. Also used to show troop dispositions, status, and routes of movement.

Electric and Gas Utilities: Allows Utility companies to maximize efficiency through direct knowledge of the location of current and potential clientele.

Environmental Conservation & Management: Allows environmental agencies to monitor environmental issues using existing spatial and attribute data. It also allows them to monitor potentially dangerous industries.

Federal Government: Allows federal agencies to become more efficient through the use of current geographical information.

Forestry: Allows foresters to monitor and make decisions about the resources in a certain area from a global viewpoint.

Health: Allows medical facilities to provide customers with a direct knowledge of health care locations ranging from nursing homes to pharmacies.

K-12 Education: Allows teachers to enhance the lessons of the classroom by providing useful maps, and representations that were previously not available with the "static" wall maps that are currently in use in many schools today.

Law Enforcement/Criminal Justice: Allows multiple sources to input information on criminal activity and emergency response that can be analyzed visually.

Libraries & Museums: Allows libraries and museums to manage and present information in a way that is easier to understand.

Logistics/Vehicle Management: Allows delivery of goods to be more efficient by knowing where the product is at all times. It also allows helps eliminating waste from the delivery process as a whole.

Petroleum: Allows data-basing of information such as recourse location, and pipeline/well configuration to be presented on a digital map.

Pipeline: Allows pipeline owners/operators to plan routes and construction paths, flow efficiencies, pipeline integrity and supply analysis.

Public Safety: Facilitates the planning of emergency responses, dispatch critical information to response vehicles, and predict a future event based on past events.

Real Estate: Allows the real estate industry to organize information about residential areas into a map that can be easily understood by themselves and clients.

Retail & Commercial Business: Allows business professionals to display sales trends and patterns based on geographic information from different sources.

State & Local Government: Allows state and local agencies to become more efficient through the use of current geographical information.

Telecommunications: Allows Telecommunications companies to maximize efficiency through direct knowledge of the location of current and potential clientele. It also allows them to display information about networking strategies.

Transportation: GIS allows for the tracking and routing of vehicles, inventory tracking, and infrastructure management.

Water & Wastewater: Allows water and sewer utilities to keep track of the locations and conditions of water mains, meters, valves, hydrants, and other maintenance facilities [46].

In all of these applications, the location of some features or characteristics in relation to other features is an important consideration. A GIS allows a user to associate this feature location information with other types of information that are important relative to the particular application.

Before GIS technology, only a few people had the skills necessary to use geographic information to help with decision-making and problem solving. Today, GIS is a multi-billion-dollar industry employing hundreds of thousands of people worldwide. GIS is taught in schools, colleges, and universities throughout the world. Professionals in many fields are increasingly aware of the advantages of thinking and working geographically. The future of GIS and the internet would have to be GIS in today's network information technology infrastructure. A network-oriented geographic information system would be used to fill the demand of providing GIS functionality on the Net by way of the World Wide Web.

CHAPTER IV

A GIS BASED APPLICATION FOR ELECTRICITY DISTRIBUTION NETWORK in GAZİANTEP

4.1. Introduction

In this chapter each stage of the application is explained and shown with examples.

One of the most frequently utilized capabilities of GIS is its ability to store, modify and retrieve maps digitally. Much of the routine work of the public foundations or companies involves maps, thousands of maps. The information on these maps is constantly changing, requiring the maps to be modified or completely redrawn to keep current. This is a very expensive and labor-time consuming process. In addition, one department may produce a given map and it may be used by another department, but whose latest version of the map may no longer be up-to-date. This can lead to costly errors and lost time for all involved. In order to eliminate this problem in 1999, TEDAŞ GAZİANTEP decided to transfer electricity distribution network to GIS medium. Steps of the application process are shown in Figure 4.1.

4.2. Production of the Digital Map of Gaziantep

GIS can use information from many different sources. In GIS, with suitable data standard, it is possible to transfer data from other GIS. Because it is more logical to update digitally obtained geographical data then to redigitized. In other words if the city development plan involving streets, districts and subdistrict had been digitally prepared by local authorities' beforehand, integration of electrical network with these plans in the form of layers would have been much easier and economical. But this had not been realized in the case of Gaziantep and thus TEDAŞ GAZİANTEP has pioneered this activity. Before digitizing process of electrical network, it had been necessary to set up Urban Information System. Many layers pertinent to the city had been formed. To serve this purpose MapInfo® software was used.

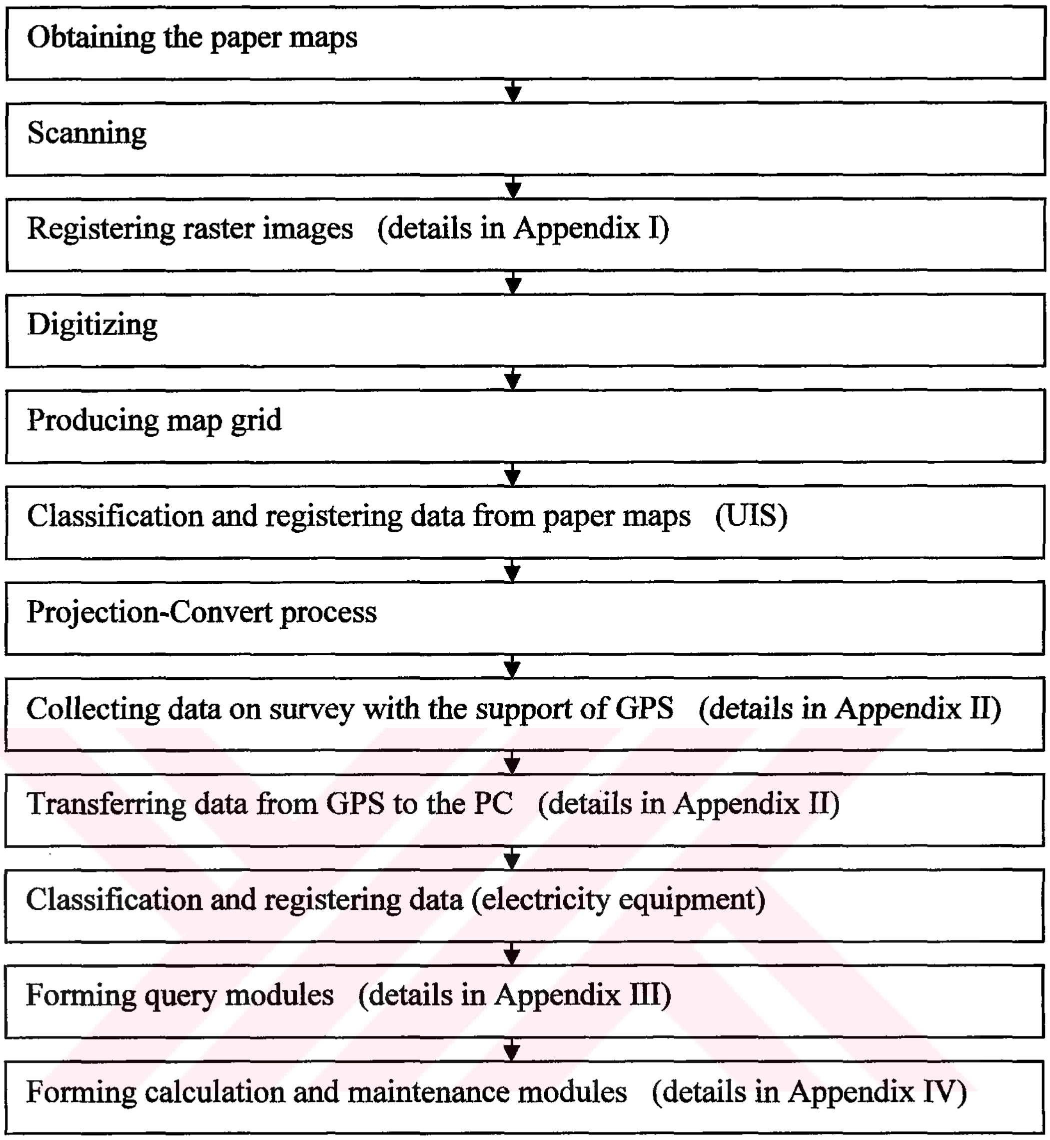


Figure 4.1 Steps of the application process

All utility planning activities related to the city should be based on the master development plan. For this purpose, the most suitable means are city development maps. These plans are usually prepared in 1/1000 scales. However the number of these maps varies from 100 to 500 for a medium sized city. If these maps are not digitized, tracing the network as whole unit by bringing all these maps together is almost impossible. When going to larger scales, the details and accuracy are lost.

As a first task, paper maps were compiled from the Greater Municipality of Gaziantep and subdistricts by TEDAŞ GAZİANTEP GIS department. All these maps were scanned. After that all the data on paper maps was scanned and digitized on the screen as shown in Figure 4.2. (Details in Appendix I)

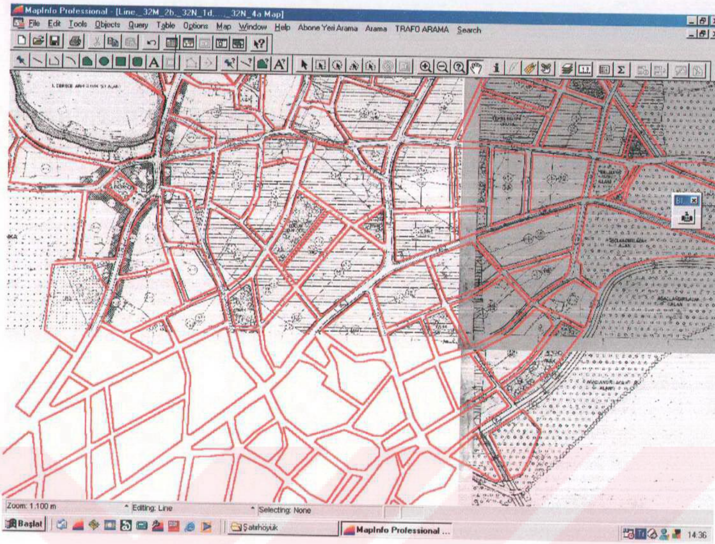


Figure 4.2 A sample of digitizing

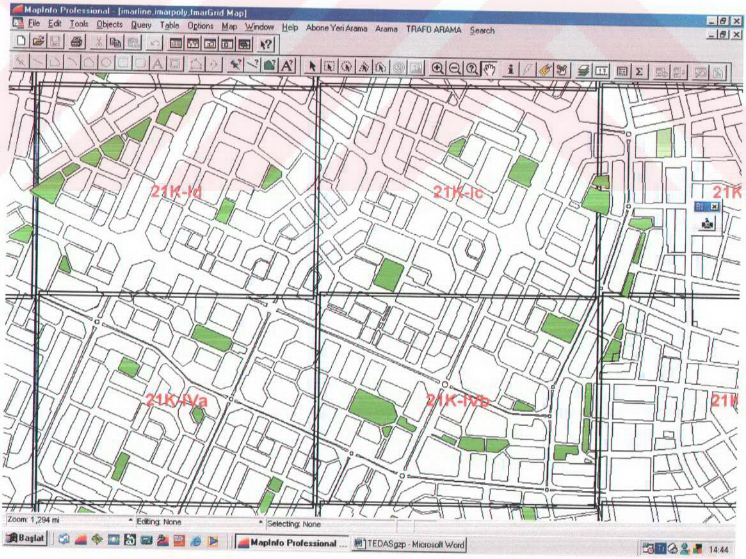


Figure 4.3 A view of Gaziantep City Development Grid

In addition, a city map grid was produced in order to facilitate utilizing these maps and subdistricts name were added to the Grid database. In this way, it has become easier to draw the maps and to enter database information on to the Grids, as shown in Figure 4.3.

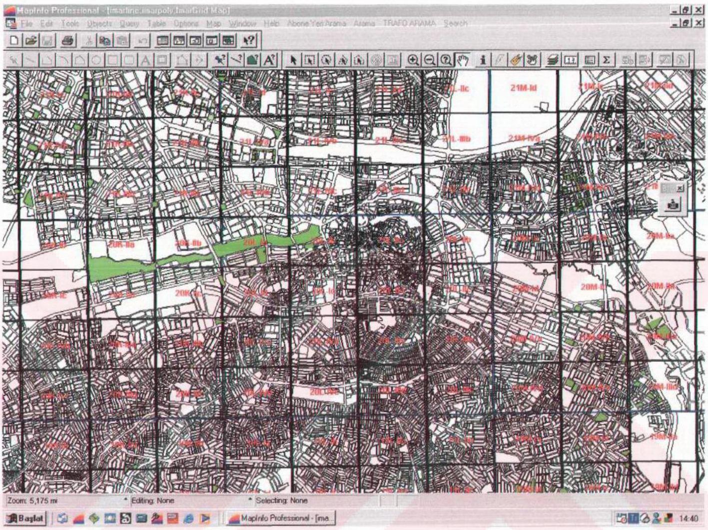


Figure 4.4 A view of digitized maps

By using GIS, all the development maps were integrated to one layer after been digitized. Consequently this has relieved burden of spending a lot of time seeking maps a lot of time seeking maps of the districts and reaching the development plan information of a particular district has become a matter of seconds. The number of 1/1000 scale maps digitized for the central part of Gaziantep city is about 500, as shown in Figure 4.4 and that of 1/25000 scale maps digitized for suburban areas is about 50. (Digitizing process is still in progress).

Small area or spatial, forecasting is the prediction of both the amounts and locations of future electric load growth in a manner suitable for distribution planning which really means with geographic resolution adequate for planning a new distribution network or extensions to the existing one. The procedure is based on dividing a utility service area into a number of sufficiently "small areas" and projecting the future load in each one. This is usually accomplished by dividing a utility service area into either a grid of uniformly sized rectangular "cells", or into "equipment oriented" areas corresponding to feeder or substation areas [47-50].

During digitizing phase, all the information on the maps were classified and registered in the related layers. For example, health institutes were registered on the hospital layer; streets and boulevards were registered on the street layer etc. Together with specific attributes (names of street, hospital), as shown in Figure 4.5.

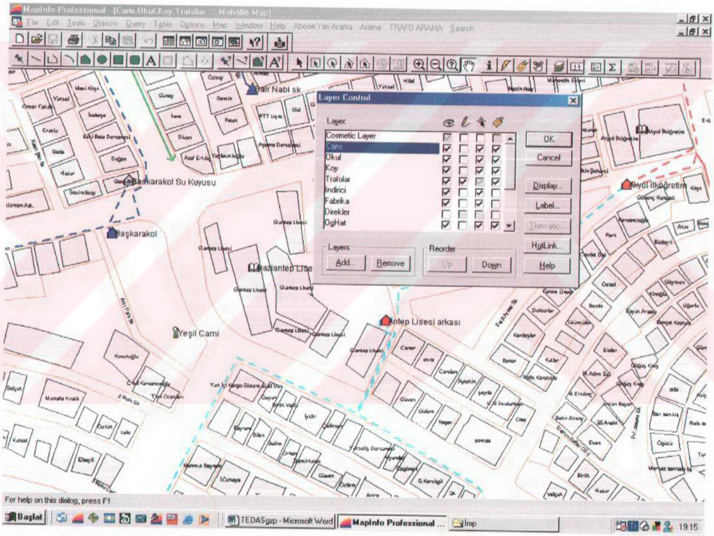


Figure 4.5 A view of Urban Information System of Gaziantep

The maps prepared with local coordinates were projection-converted to countries coordinate system with a tool which is supported by MapInfo® Turkey distributor firm.

With the accuracy of city development plan obtained with the support of GPS was cross-checked. GIS should not be confused with a related technology, GPS which uses satellite signals to determine one's position or location on the earth's surface. GPS receivers are frequently used in conjunction with a GIS to determine the location (or coordinates) of features so that these coordinate can then be entered into a GIS for display or analysis of those features. (Details in Appendix II)

After forming the Urban Information System, layers related to electricity network were formed. Primary substation, distribution substation, transformers, transformers on the poles, conductors were transferred to the GIS medium according to their current locations and layers. In this study, thirty layers are actively updated and located on the layers according to attributes as shown in Figure 4.6.

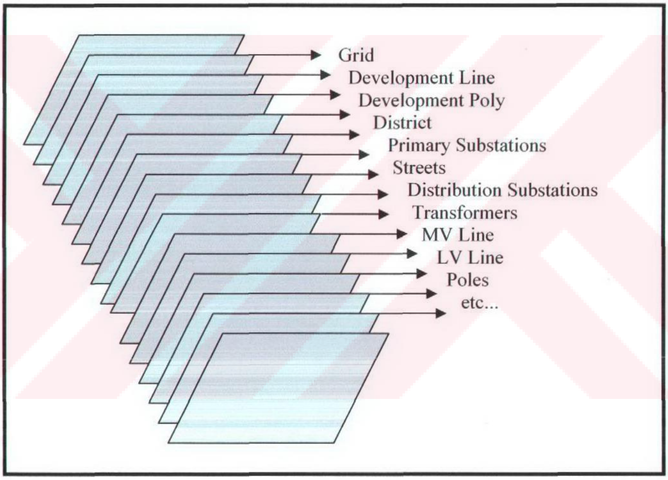


Figure 4.6 Formation of current layers

To carry out any operation on electricity network, a user may not need to deal with information not pertinent to a specific operation so the user can discard the information on other layers. The user can eliminate the information on the layer he doesn't need or recall the information only on the layer he needs. That is, depending on the nature of the task and the details needed the user can focus on a specific layer. (Transformers layer, poles layer, different voltage layers etc.)

The layers should be determined during the GIS establishment phase or should be revised according to the requirements in later phases. One of the most significant characteristics of GIS is that data are stored in layers and there is no restrictions concerning the number of layers. Thus, the new layers can be added into the system easily. The current layers are shown in Figure 4.7.

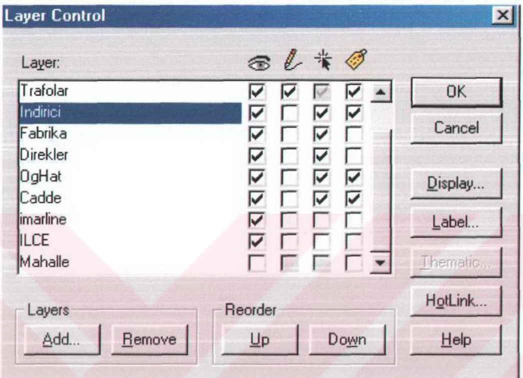


Figure 4.7 A view of created layers in MapInfo®

4.3. Layers and GIS Query Modules

Queries are set by the software operator and define a certain set of attributes. This option allows us to selection of features by defining a query based on their attributes. During studies need to conduct detailed search related to layers arose. To serve this purpose, search-find modules were written with the help of Mapbasic®. (Details in Appendix III)

Villages: A layer was formed by specifying the names and locations of 500 villages, as shown in Figure 4.8.

Districts: A layer was formed by specifying the names, boundaries of 169 districts, as shown in Figure 4.9.

Addresses: The names of 3800 streets were obtained from their actual site and were formed into a layer, as shown in Figure 4.10.

Hospitals: All the hospitals and health organizations were collected on a layer, as shown in Figure 4.11.

Mosques: 125 mosques were digitized with their names and a layer was formed, as shown in Figure 4.12.

Schools: 190 schools were collected on a layer, as shown in Figure 4.13.

Government Offices: All the government offices were classified and collected on a layer, as shown in Figure 4.14.

Police Stations: Police stations were also digitized and collected on a layer.

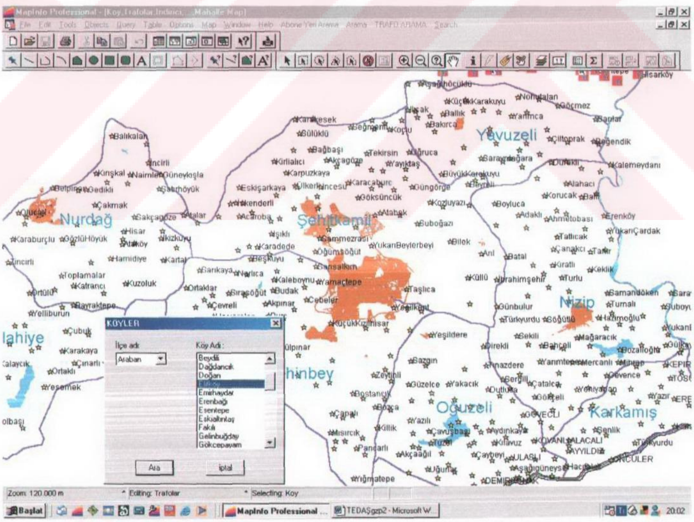


Figure 4.8 Villages

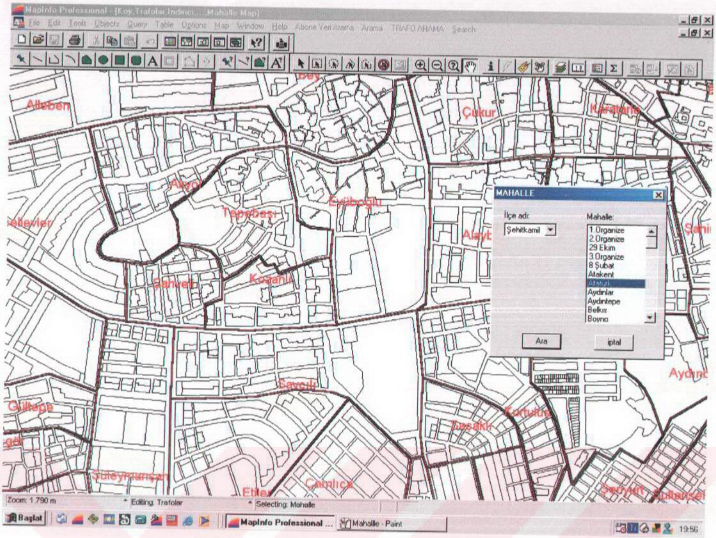


Figure 4.9 Districts

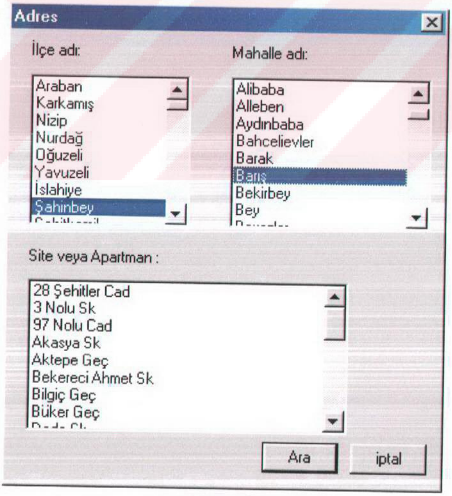


Figure 4.10 Addresses

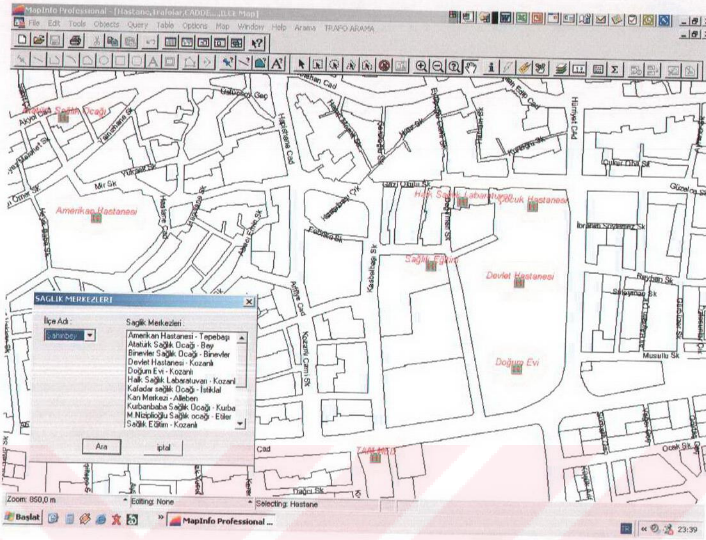


Figure 4.11 Hospitals

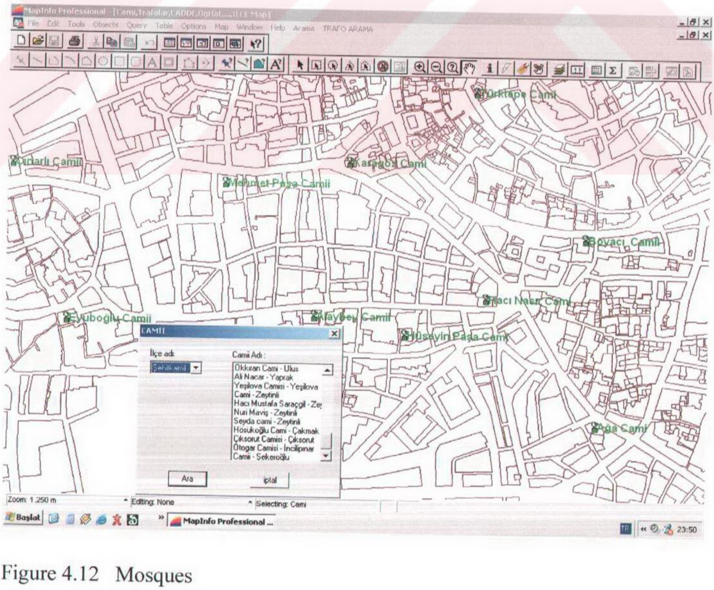


Figure 4.12 Mosques

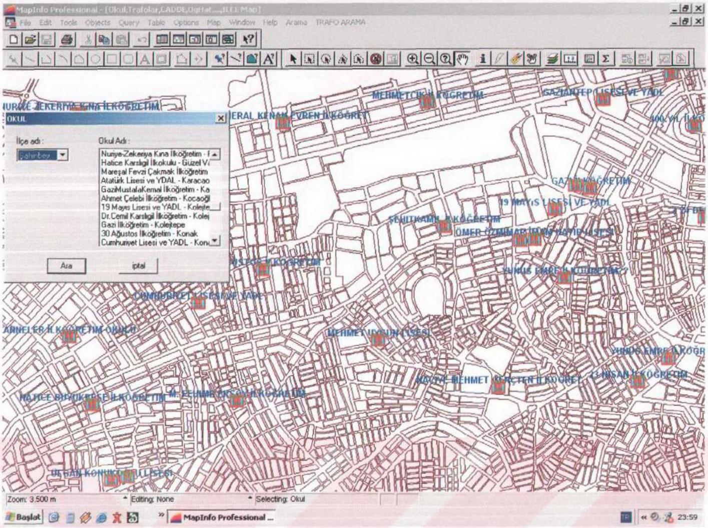


Figure 4.13 Schools

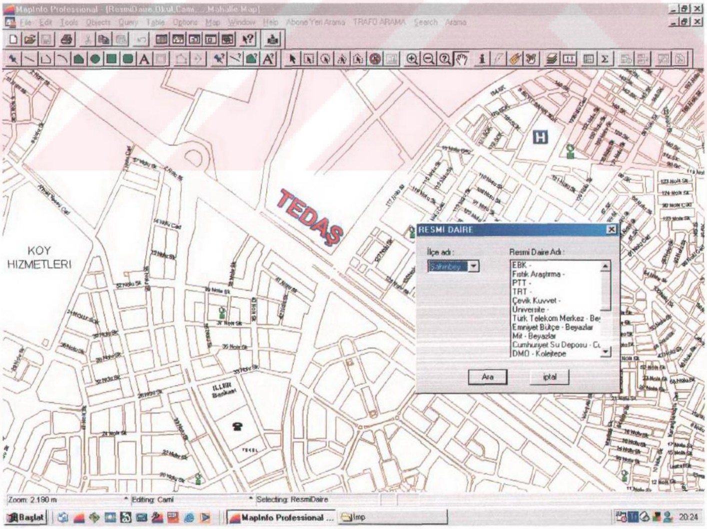


Figure 4.14 Government offices

4.4. Medium Voltage Layer

Gaziantep electricity distribution network utilizes two different medium voltage levels (15kV and 30kV). 2900 km medium voltage lines were digitized and as default for 15kV red, for 30kV blue color are used. That is, the voltage levels are symbolized by red and blue color, as shown in Figure 4.15. In addition, feeder names are input to the attributes table of "medium voltage layer". By this way the network can be colorized by the feeder names. Each feeder path, district supplied by the feeder, and the related transformers can easily be viewed as in Figure 4.16. Underground cables are shown by dashed lines and colorized as to voltage level. Besides, as it can be seen from the attributes table, 3rd party customer lines can be distinguished. The attributes table formed for medium voltage layer is shown in Figure 4.17.

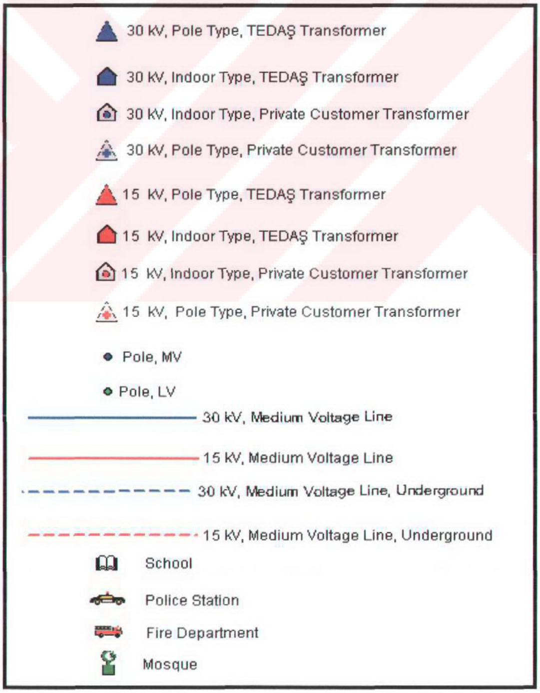


Figure 4.15 Legend

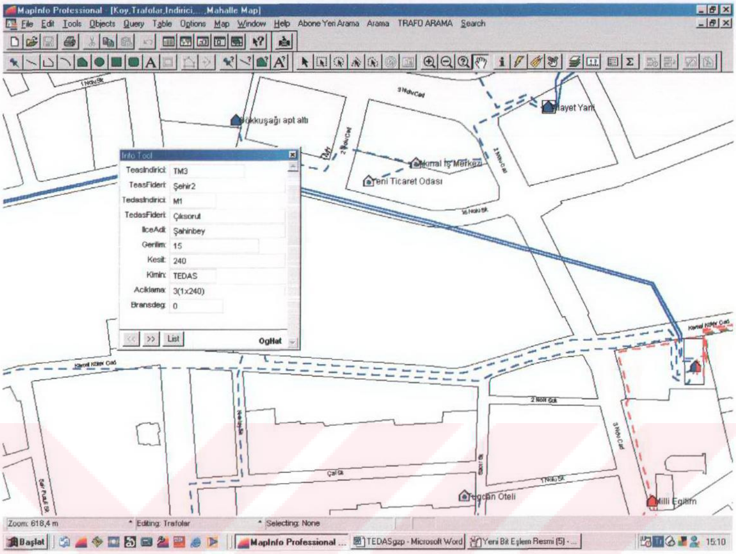


Figure 4.16 A view from medium voltage layer

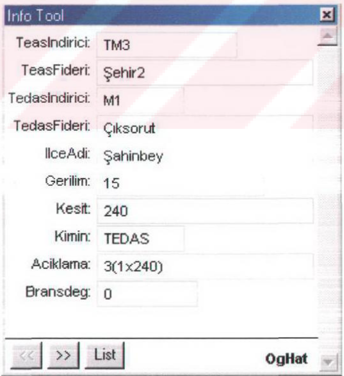


Figure 4.17 Medium voltage layer attributes table

4.5. Low Voltage Line Layer

1220 km low voltage line was digitized and recorded with their attributes as in Figure 4.18. Green color is used for low voltage lines as default.

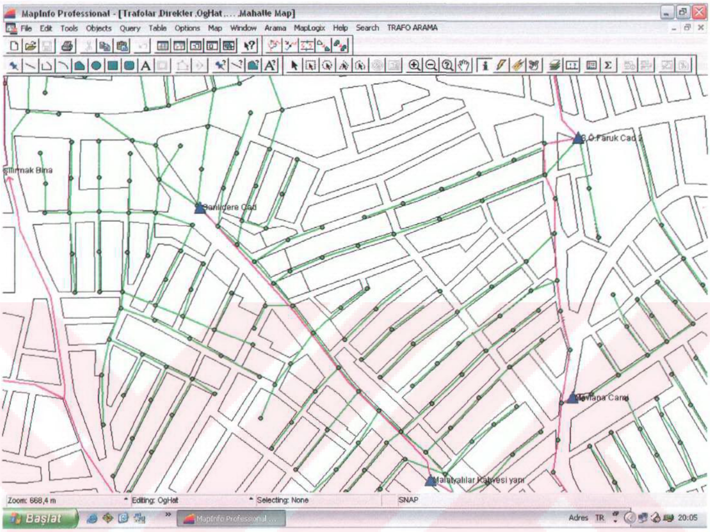


Figure 4.18 A view of low voltage line

4.6. Transformers Layer

To represent transformers, symbol of triangle or polygon is used. While pole-type of transformers is symbolized triangle, indoor type of one's is symbolized by polygon. Transformers are also colorized as to their supplying source, which is blue for 30kV and red for 15kV. To distinguish between difference customer and TEDAŞ transformers, different symbols of triangle and polygon are formed, as shown in Figure 4.19. This legend is easy to understand for every electrician, as in Figure 4.15.

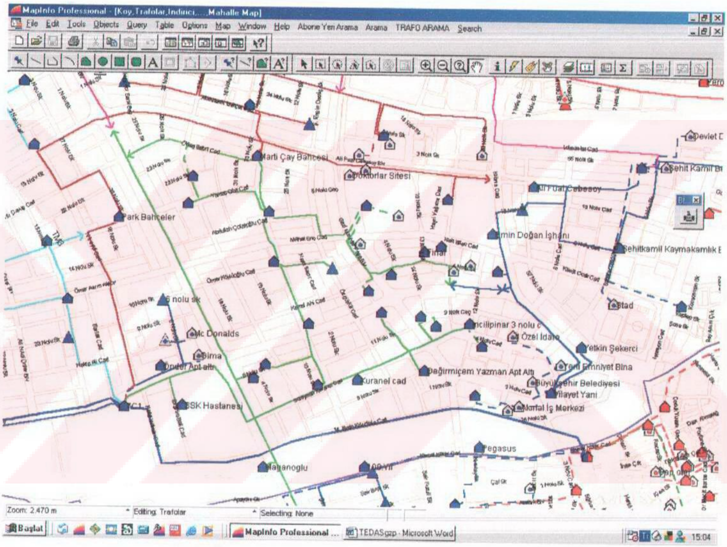


Figure 4.19 Transformer layer

5200 transformers are classified and coordinated as the ones belonging to TEDAŞ and 3rd party (private customers) and digitized by adding used pole type, construction type, power, brand, serial number, production year, subscriber no, subscriber name, energy counter brand, energy counter serial number attributes. All transformers have been located using GPS. Attributes table formed for transformer layer, as shown in Figure 4.20 and 4.21.

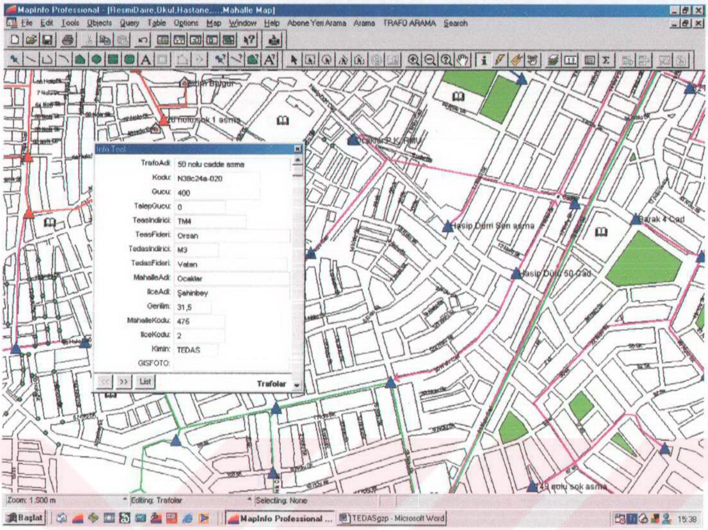


Figure 4.20 Transformer layer and attribute's table

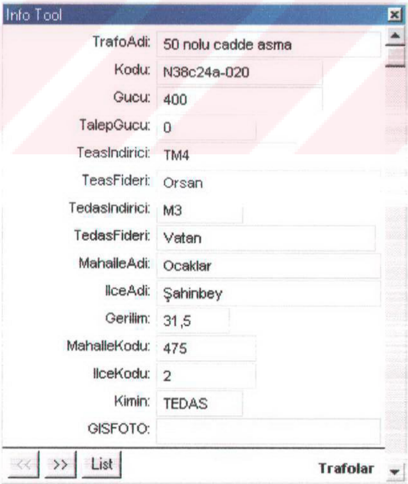


Figure 4.21 TEDAŞ transformers attributes table

Especially, when dealing with the 3rd party customers' transformers information such as energy counter brand is input as in Figure 4.22. Readouts from each energy counter is planned to be an input for the developed system database in order to estimate and analysis a load curve for subscribers in the future.

After collecting the monthly or seasonal energy consumption habit in the database this data can be used for the best planning and decision-making for the feeder. For instance n years later the cross-sectional area of conductor type can be improved or the feeder load can be splitted. Private transformer info tool is shown in Figure 4.23.

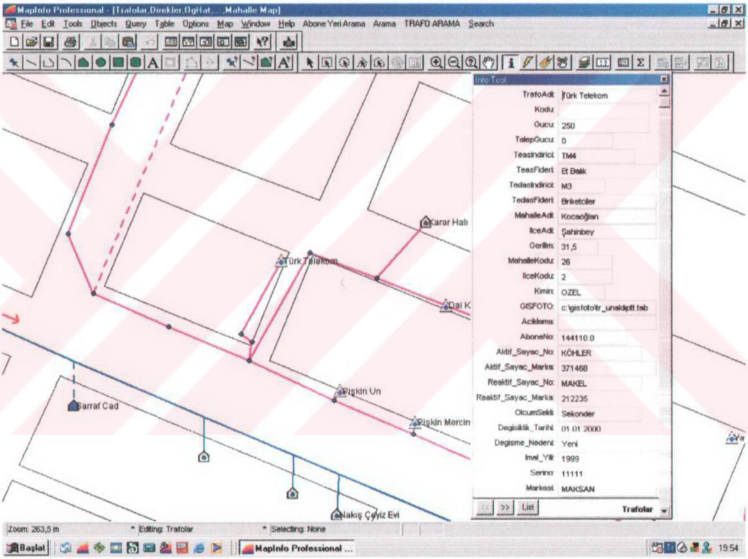


Figure 4.22 Private transformer and attribute's table

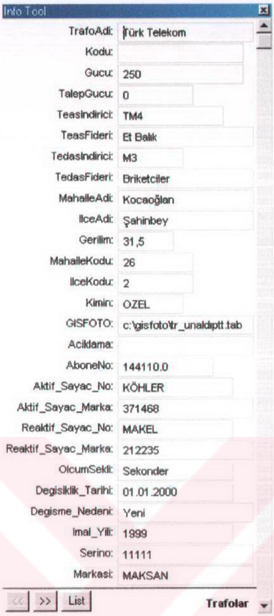


Figure 4.23 Private transformer attribute table

4.6.1. Unique code system

In city center, Gaziantep, there exist 900 transformers which belong to TEDAŞ and they are mostly named with their street location (as next to X mosque, in the vicinity of Y police station, Z hospital) by the TEDAŞ staff. As it is well known, Gaziantep is a metropolitan city and gets huge amount of migration. By time new districts are formed and street names are continuously changing. That is why a new coding system has been developed for transformers. This new developed coding system gives a unique number to each transformer defined in city development plan by the location in (1/5000) scale as N38c18d-020. In this code system, first seven digits show the name of the city development maps of scale 1/5000 and last tree digits show the number of transformers on this map. As this is the one and only factor not changing which defines the location of the transformers. Info tool of TEDAŞ transformers can be seen in Figure 4.21.

4.6.2. Reporting tools

While digitizing, the transformers must certainly classify as TEDAŞ and 3rd party customer. During this study TEDAŞ and 3rd party customers were combined into a single transformer layer, but it is also possible to classify them in separate layers. Because, in analysis and planning phase is a crucially important point. It is the main principle of "Find Transformer" query module which was developed specifically for this study written in Mapbasic®. (Figure 4.24, 4.25, 4.26) (details in Appendix III-IV)

This developed module can find the information for the required transformer in less than 1 sec. This module is mostly used during planning sessions as TEDAŞ Gaziantep has approximately 7000 transformers. As it can be seen in Figures 4.25 and 4.26, all recorded customers can be found using "Find Transformer" and the all attributes of transformers are recalled immediately.

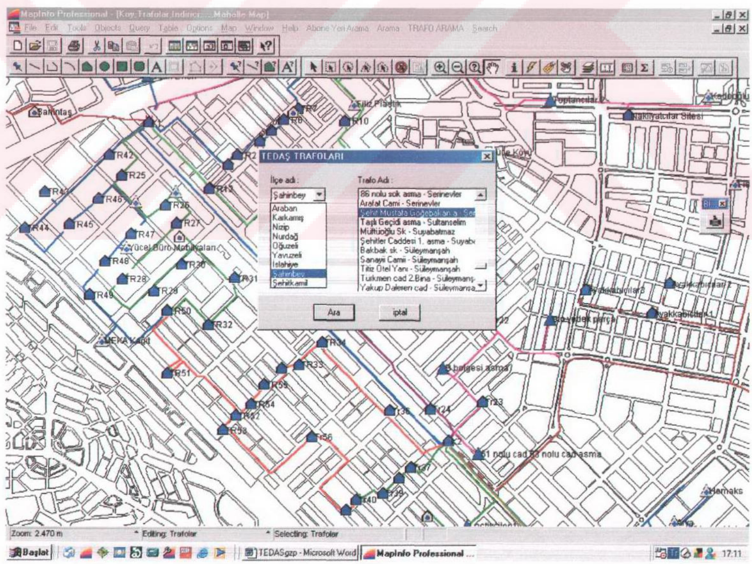


Figure 4.24 Geographical query module of TEDAŞ transformers

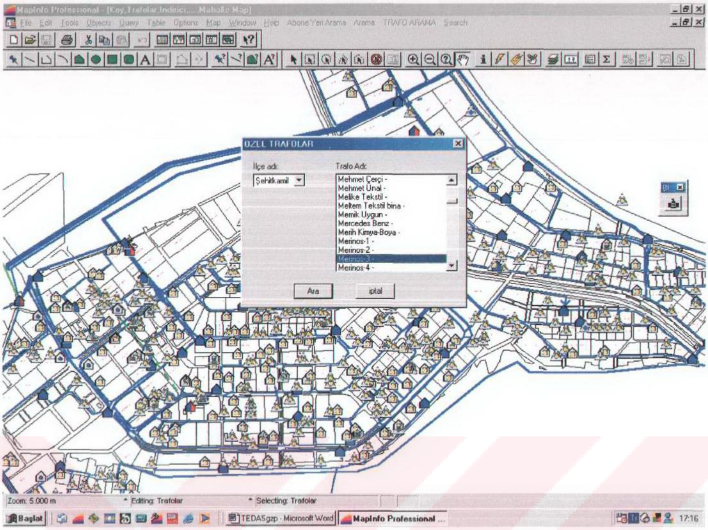


Figure 4.25 Geographical query module of 3rd party customer transformers

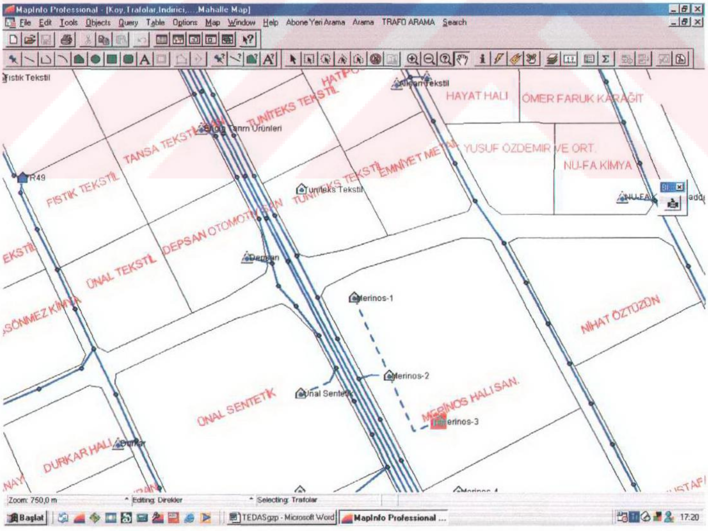


Figure 4.26 How "Find transformer" module works for 3rd party customer transformers

From time to time, the system needs reporting requirements. With respect to this matter GIS's (MapInfo) SQL database management system provides significant convenience. The data in the database can be examined easily by SQL's SELECT command. This selection is a subset of data rows in a table, chosen based on the contents of one or more columns from the table. We create selections by formulating questions, or queries, about our data.

With respect to transformer size, geographic locations, etc. constraints very useful reports can be produced. For example; using MapInfo's Sql's Select command, selection of TEDAŞ's transformer with voltage level of 30kV and size of 630 kVA takes only 1-2 seconds as shown in Figure 4.27. Furthermore, the locations of transformers can be found geographically. This kind of reports usually needed in TEDAŞ's planning department. Because of this kind of reports is used as decision support system. If GIS was not used, obtaining this knowledge will be labor consuming process and perhaps the results will be unreliable.

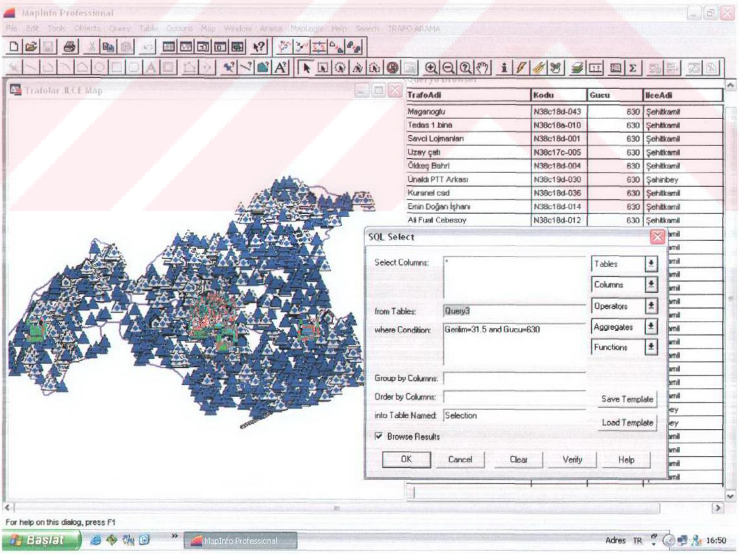


Figure 4.27 Selection of TEDAŞ's transformer with voltage level of 30kV and size of 630 kVA

4.6.3 Maintenance tool

As mentioned before, electricity distribution network has a dynamic structure. Loads vary with time of the day, day of the week, and season. In some periods the demand to electricity are extreme, for example, in winter the transformers breakdown 3 of 4 times of a week and must be changed instantly. If TEDAŞ has not enough transformers in its warehouse, it must use a bigger size transformer instead of broken transformer. For example, it may be installed a 160 kVA transformer instead of a 100 kVA transformer, or a 400 kVA transformer instead of a 250 kVA transformer. As a result of this process, idle capacity and high costs are occurred. Each year TEDAŞ includes roughly 30-40 transformers into the network, in other words the electricity equipments in the survey changes constantly. Before GIS, what kind of process was exposed to which transformer can not be known with time, due to lack of reliable data. As a result, It can not be forecasted which size of transformers needed and how many transformers needed in which period?

By using GIS, a new tool was also developed for maintenance planning gathering statistical data. By this way reason of transformer failures and maintenances done are recorded and this information can be accessed with a mouse click as in Figure 4.29. (for details see Appendix IV)

In order to this tool, statistical data which is required for an inventory planning and control subsystem can be collected. Therefore, spare parts can be forecasted accurately and also can be ordered beforehand. In this way, maintenance process can be managed by lower cost and in a short time.

In addition, the images of transformers are associated with the transformer layers as in Figure 4.29.

4.7. Poles Layer

Poles are located on one layer as medium voltage poles and low voltage poles. Attributes are input for TEDAŞ and 3rd party customers and their types. Approximately 15000 poles have been digitally registered. Poles layer attributes table is as in Figure 4.30 and 4.31.

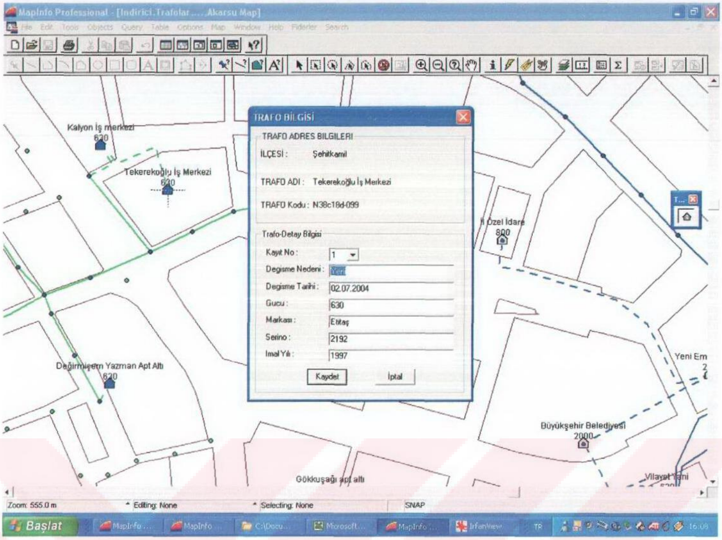


Figure 4.28 A view from maintenance tool

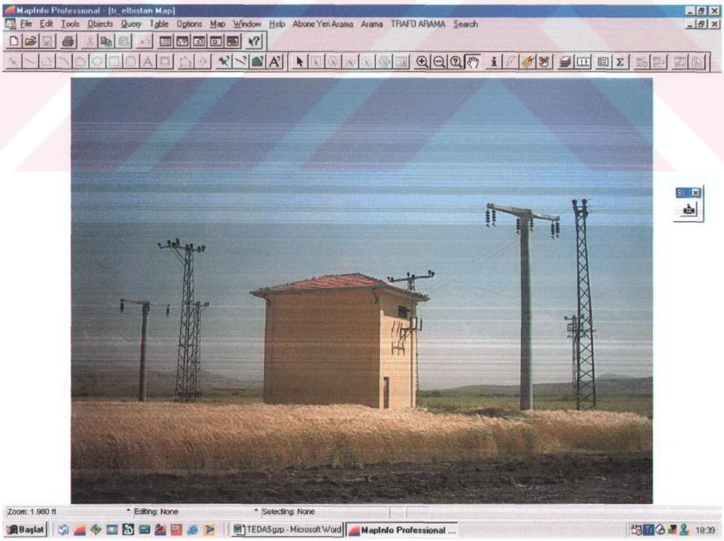


Figure 4.29 An associated image from the transformer layer

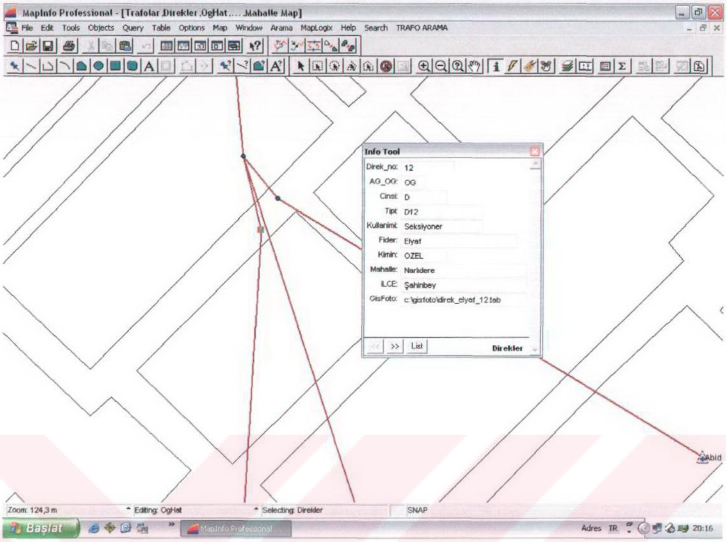


Figure 4.30 A view of poles layer

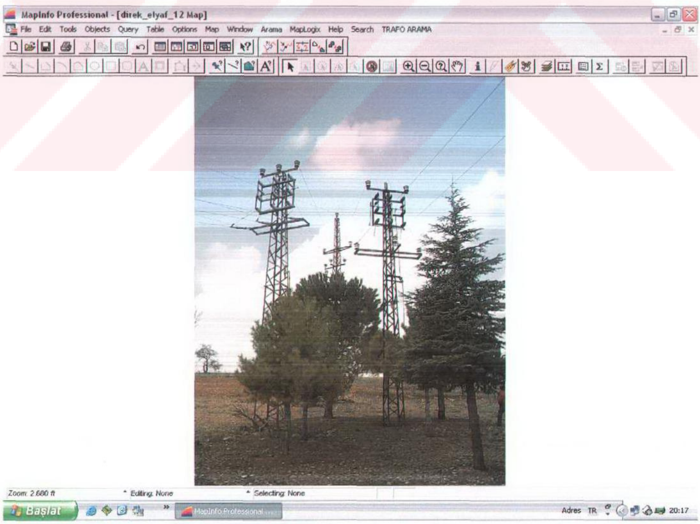


Figure 4.31 An associated image from the poles layer

4.8. Voltage Drop, Power Loss, Calculation of K and C Coefficients

The electricity distribution planner is usually restricted by permissible voltage values, voltage dips, flicker, etc. as well as service continuity and reliability. The planner ultimately has a significant influence on additions to and/or modifications of the subtransmission network, locations and sizes substations, service areas of substations, location of breakers and switches, sizes of feeders and laterals, voltage levels and voltage drops in the system, the location of capacitors and voltage regulators the loading of transformers and feeders.

The location of substation is dictated by the voltage levels, voltage regulation considerations, subtransmission costs, substation costs and the costs of primary feeders, mains and distribution transformers.

As discussed above electrical calculations are the main points for the electricity distribution planning works. As the body is dynamically changing and growing. On electricity distribution network of Gaziantep, the distribution is done via five different types of conductor in medium voltage level, three different types of conductor forms (Table 4.1) and two different voltage levels (30kV and 15kV). In the network continuous additions occur and new transformers with different types and voltage ratings are integrated to the network. As the network expands electrical calculations become cumbersome. For example for any point a feeder which has 60-70 transformers on it and which is thirty km in length voltage drop and power loss calculations may take days. Because on calculations the size of the transformers, number of branching, transformers on each branch, connection point of transformers on the line and conductor type used on the branch are to be regarded carefully. Those data must be valid in case of quantity, quality and accuracy of data. Additionally during these calculations highly complex formulas are to be used. The derivations of those formulas are below.

UNITS :

P = kW	Power
N = kVA	Apparent Power

$I = A$	Current
$L = km$	Length of Line
$R_0 = \Omega / km$	Resistance of Conductor at 20ºC
$X_L = \Omega / km$	Inductive Reactance
$U = kV$	Line Voltage
$f = Hz$	Frequency
$r = mm$	Conductor Radius
$d = cm$	Geometric Mean Distance
λ = (H.km/phase)	Inductance
$\cos\varphi = 0.8$	
K:	Coefficient
C:	Coefficient

4.8.1. Absolute voltage drop

$$\Delta U = L\, I\, \sqrt{3}\, (R_0 \cos\varphi + X_L \sin\varphi) \quad [\text{Volt}] \tag{4.1}$$

4.8.2. Relative voltage drop

Voltage drop is the difference between the voltage at the transmitting and receiving ends of a feeder, main or service. Percent voltage drop is the ratio of voltage drop in a circuit to voltage delivered by the circuit, multiplied by 100 to convert to percent. Voltage Drop Analysis Tool : Calculates the voltage drop over the radial configured medium voltage distribution system network for present status and in case of adding new transformer centers, loads or cables.

$$\%e = \frac{\Delta U}{U}\frac{100}{10^3} = \frac{L\,N\,(R_0 \cos\varphi + X_L \sin\varphi)}{U^2} 10^{-1} \Rightarrow \tag{4.2}$$

$$\%e = \frac{L\,N}{10U^2} \cos\varphi\,(R_0 + X_L \tan\varphi) \Rightarrow \tag{4.2a}$$

$$\cos\varphi = 0.8 \Rightarrow$$

$$\%e = \frac{L\,N}{10U^2}\, 0.8\, (R_0 + X_L\, 0.75) \Rightarrow \tag{4.2b}$$

$$\%e = \frac{L\,N}{U^2}\;0.08\;(R_0 + X_L\,0.75) \Rightarrow \qquad (4.2c)$$

$$\%e = L\,N\;\underbrace{\frac{0.08\;(R_0 + X_L\,0.75)}{U^2}}_{10^{-4}\,K} \qquad (4.2d)$$

$$\mathbf{\%e = L\,N\;10^{-4}\,K \quad \%e < \%10 \quad must\ be.} \qquad (4.2e)$$

4.8.3. Calculation of K

$$10^{-4}\,K = \frac{0.08\;(R_0 + X_L\,0.75)}{U^2} \Rightarrow \qquad (4.3)$$

$$X_L = 2\,\Pi\,f\lambda$$

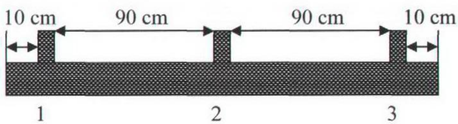
$$K = \frac{0.08\;(R_0 + (2\,\Pi\,f\,\lambda)\;0.75)}{10^{-4}U^2} \Rightarrow \qquad (4.3a)$$

$$\lambda = [\,4.6\log(\frac{d}{r}) + 0.5\,]\,10^{-4}$$

$$K = \frac{0.08\;\left\{R_0 + \left(2\,\Pi\,f\;[\,4.6\;\log(\frac{d}{r}) + 0.5\;]\;10^{-4}\right)\;0.75\right\}}{10^{-4}U^2} \qquad (4.3b)$$

4.8.4. Calculation of d

A – STRAIGHT LINE



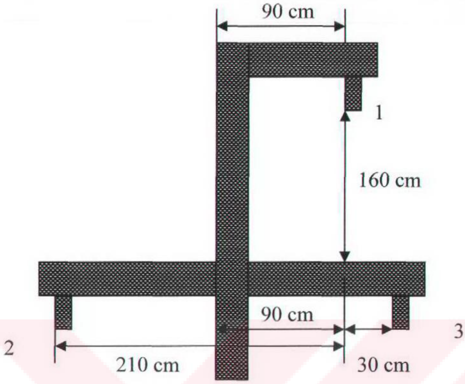
$d_{12} = 90$ cm
$d_{23} = 90$ cm
$d_{13} = 180$ cm

$$d = \sqrt[3]{d_{12} \;x\; d_{23} \;x\; d_{13}}$$

$$d = \sqrt[3]{90 \;x\; 90 \;x\; 180}$$

$$d = 113.4$$

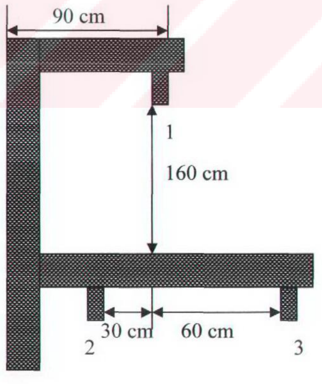
B – TRIANGLE LINE



d_{12} = 264 cm
d_{13} = 162.78 cm
d_{23} = 240 cm

$$d = \sqrt[3]{d_{12} \ x \ d_{13} \ x \ d_{23}}$$
$$d = \sqrt[3]{264 \ x \ 162.78 \ x \ 240}$$
$$d = 217.67$$

C – FLAG CONSOLE LINE



d_{12} = 162.78 cm
d_{13} = 170.88 cm
d_{23} = 90 cm

$$d = \sqrt[3]{d_{12} \ x \ d_{13} \ x \ d_{23}}$$
$$d = \sqrt[3]{162.78 \ x \ 170.88 \ x \ 90}$$
$$d = 135.78$$

4.8.5. Medium voltage power loss calculations

Power Loss Analysis Tool: Calculates the power loss and cable suitability for possible power flows over cables.

$$N\,(kVA) = \sqrt{3}\;U\,I \qquad \Rightarrow \qquad P\,(kW) = \sqrt{3}\;U\,I\;\cos\varphi \tag{4.4}$$

$$\cos\varphi = \frac{P\,(kW)}{\sqrt{3}\,U\,I} = \frac{P}{N} \tag{4.4a}$$

$$P\,(kW) = \sqrt{3}\;U\,I\;\cos\varphi \;\Rightarrow\; I = \frac{P}{\sqrt{3}\,U\cos\varphi} \tag{4.4b}$$

$$\Delta P = 3\,I^2 R = 3\,R\,\left[\frac{P}{\sqrt{3}\,U\cos\varphi}\right]^2 = 3\,R\,\left[\frac{N\cos\varphi}{\sqrt{3}\,U\cos\varphi}\right]^2 \tag{4.4c}$$

$$\Delta P = \frac{R\,N^2}{U} \qquad\qquad R = R_0\;L$$

$$\Delta P = \frac{R_0\,L\,N^2}{U^2} = \underbrace{\frac{R_0}{U^2}}_{10^{-6}\,C}\;N^2\,L \tag{4.4d}$$

$$\mathbf{\Delta P = 10^{-6}\,C\,N^2\,L} \tag{4.4e}$$

4.8.6. Percentage power loss

$$\%P = 100\,\frac{\Delta P}{P} = \frac{100\;\Delta P}{N\cos\varphi} = \frac{100}{\cos\varphi}\,\frac{\Delta P}{N} = \frac{100}{0.8}\,\frac{\Delta P}{N} \;\Rightarrow \tag{4.5}$$

$$\mathbf{\%P = \frac{\Delta P}{N}\;125} \qquad\qquad \textbf{\%P has to be lower than \%5}$$

In the current system, days-long calculations are not so reliable. In this study using MapInfo® intermediate modules for the electrical calculations (Voltage Drop Analysis Tool - Power Loss Analysis Tool) were developed. Thanks to those modules time consuming calculations take as less time as seconds, as shown in Figure 4.32 and 4.33. And expansion scenarios (See Section 4.8) for the new additions to the distribution network can be developed in less time and optimum decisions can be made for planning.

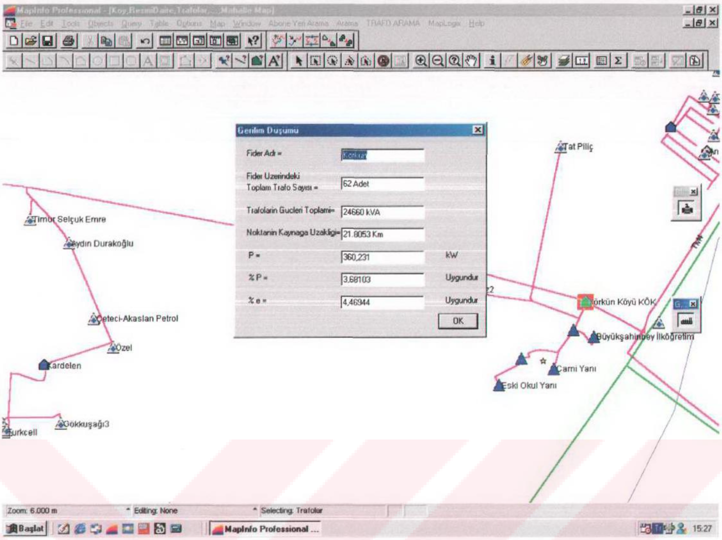


Figure 4.32 A view of voltage drop-power loss analysis tools

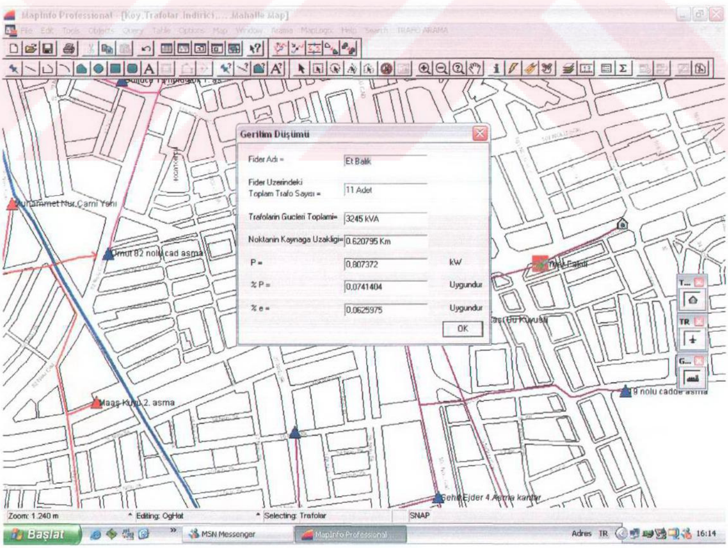


Figure 4.33 A view of voltage drop-power loss analysis tools

TABLE 4.1

(Line Type)	Line Distance d (cm)	Name of Conductor	Conductor diameter (cm)	R	ℓ	XL	34,5 kV		15 kV		6,3 kV	
				Ohm/Km	HzxKm	Ohm/Km	K	C	K	C	K	C
	113,4	**AWG3**-SWALLOW	0,714	1,0742	12,0089	0,3773	0,9122	0,9025	4,8254	4,7742	27,3551	27,0648
		1/0-RAVEN	1,011	0,5362	11,3141	0,3554	0,5396	0,4505	2,8543	2,3831	16,1810	13,5097
		3/0-PIGEON	1,275	0,3366	10,8506	0,3409	0,3981	0,2828	2,1058	1,4960	11,9377	8,4807
		266-PARTRIDGE	1,628	0,214	10,3623	0,3255	0,3079	0,1798	1,6290	0,9511	9,2347	5,3918
		477-HAWK	2,177	0,1194	9,7818	0,3073	0,2352	0,1003	1,2440	0,5307	7,0522	3,0083
	217,67	**AWG3**-SWALLOW	0,714	1,0742	13,3116	0,4182	0,9328	0,9025	4,9346	4,7742	27,9737	27,0648
		1/0-RAVEN	1,011	0,5362	12,6168	0,3964	0,5602	0,4505	2,9635	2,3831	16,7997	13,5097
		3/0-PIGEON	1,275	0,3366	12,1533	0,3818	0,4187	0,2828	2,2149	1,4960	12,5564	8,4807
		266-PARTRIDGE	1,628	0,214	11,6650	0,3665	0,3286	0,1798	1,7381	0,9511	9,8534	5,3918
		477-HAWK	2,177	0,1194	11,0845	0,3482	0,2558	0,1003	1,3531	0,5307	7,6709	3,0083
	135,78	**AWG3**-SWALLOW	0,714	1,0742	12,3688	0,3886	0,9179	0,9025	4,8556	4,7742	27,5260	27,0648
		1/0-RAVEN	1,011	0,5362	11,6739	0,3667	0,5453	0,4505	2,8845	2,3831	16,3519	13,5097
		3/0-PIGEON	1,275	0,3366	11,2104	0,3522	0,4038	0,2828	2,1360	1,4960	12,1086	8,4807
		266-PARTRIDGE	1,628	0,214	10,7222	0,3368	0,3136	0,1798	1,6591	0,9511	9,4056	5,3918
		477-HAWK	2,177	0,1194	10,1416	0,3186	0,2409	0,1003	1,2742	0,5307	7,2231	3,0083

4.9. Case Study: Redesign of Electricity Distribution Network in Kayacık Dam Reservoir Area

The Kayacık Dam in Oğuzeli (Table 4.2) has been constructed by DSI (The General Directorate of State Hydraulic Works). During construction of the dam 17,4 km^2 of land was affected by the dam. The distribution lines, transformers and the electricity equipments which belong to TEDAS and 3rd party customers will be remained under water. Due to these reasons, DSI apply to TEDAS for taking measures and producing alternative solutions. Figure 4.34 shows current position of the region.

GIS service of TEDAS Gaziantep have digitized the map of the area before, producing alternative solutions has been very simple. First, GIS service has asked to DSI for giving the paper map showing region affected by the dam. Consequently, digitization of map of scale 1/25,000 has been completed. Furthermore, information on survey registries was transferred to the database and the dam lake area was digitized to exhibit this region which will remain under water. Figure 4.35 and Figure 4.36 show the region affected by Dam and remained under water, respectively.

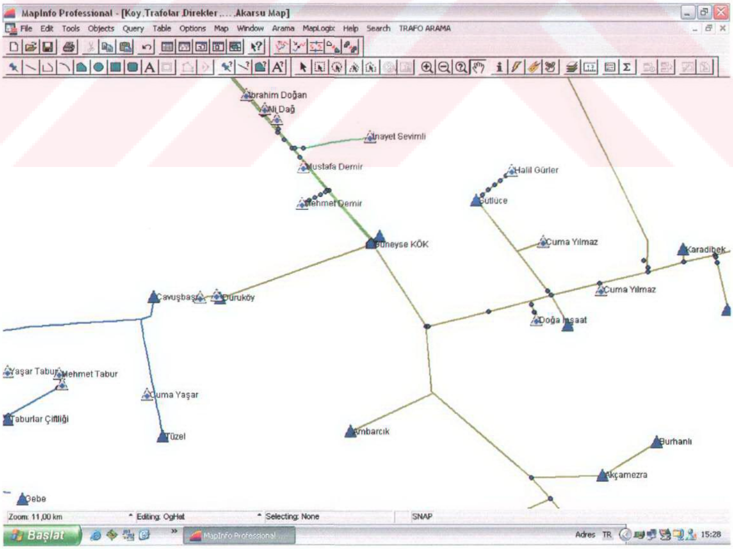


Figure 4.34 Current position of the region

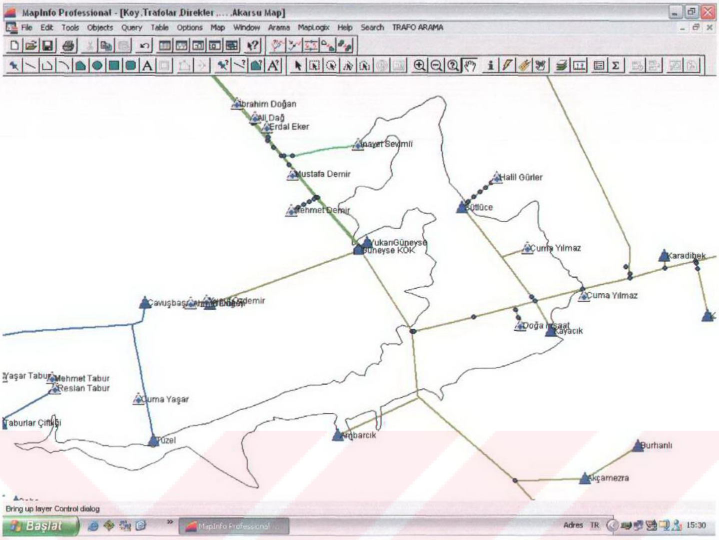


Figure 4.35 Border of Kayacık Dam

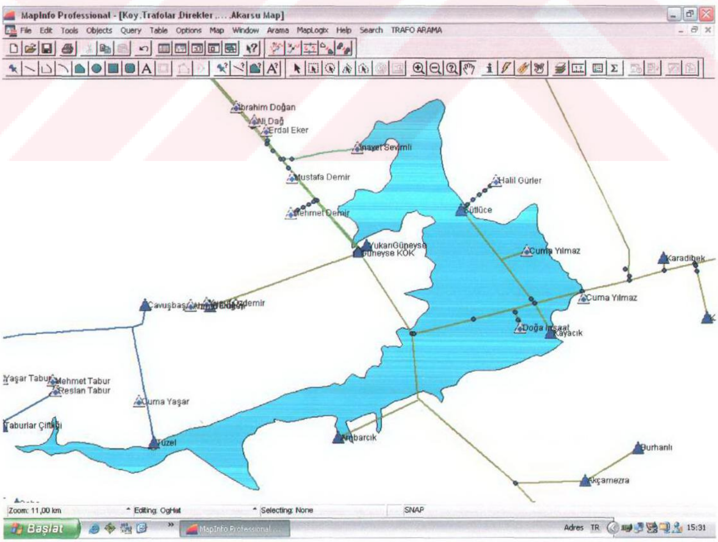


Figure 4.36 Reservoir area

Many alternative solutions have been produced in a short time by using GIS without working on survey. At that time technical constraints, any geographical installation restrictions, and heuristic rules have been taken into account. When technical constraints are taken into account voltage drop-power loss calculation tool written by us have been used. Since digitization of map of scale 1/25,000 are in our database geographical installation restrictions and heuristic rules have been easily analyzed. Due to fact that the region is rural region analysis has been very simple according to urban area. Following heuristic rules for electricity distribution system planning have been taken into account: [17-19].

Distribution line is curved or discarded if there is a big pond between two load points.
If the line passes through cotton industries, it is curved or discarded.
If the line passes through commercial plantation area, it is curved or discarded.
If the line passes through commercial complex, it is curved or discarded.
If the line passes through the residential area, it is curved or discarded.
Substation location is discarded if the land is too expensive.
Substation location is discarded if it creates social and environmental problem.
Substation location is discarded if it falls nearer to the shopping mall.
Substation is discarded for any geographical installation restrictions.
Substation location is discarded if it falls near to school; children play ground or boarding.

Moreover, to reduce the investment costs of feeder we have chosen the scenario including shortest feeder length. As the investment cost is proportional to the feeder length, the problem of minimizing investment cost reduces to that of minimizing feeder length. Shortest path is extremely suitable for distribution system planning. Ownership problem must be taken into account. In addition, line's nearness to road must be considered. The developed 4 different scenario was evaluated as seen in Table 4.3. Factors that are considered in addition to heuristic rules mentioned before, are as follows:

1) Investment costs
2) Nearness to road
3) Ownership problem,
4) Technical constraints

Table 4.2 Technical Details of Kayacık Dam

Location	Gaziantep-Oğuzeli
Purpose	Irrigation
Embankment type	Earthfill
Dam volume	1858 hm^3
Height (from river bed)	50 m
Reservoir volume at normal water surface elevation	116,8 hm^3
Reservoir area at normal water surface elevation	13,1 km^2
Irrigation Area	13680 ha

Table 4.3 Alternative Scenarios

Scenarios	Investment Cost / Feeder Length	Nearness to Road	Ownership Problem	Technical Constraints
A	14 Km	√	Low Cost	√
B	13 Km	Too Far	High Cost	√
C	15 Km	Too Far	Low Cost	√
D	19 Km	√	Low Cost	Failed

After many scenario have been produced in office we have worked on survey with GPS and analyze the scenario which yields the best solution. Finally, we have been decided to realize Scenario A. Red points shown by Lmk in Figure 4.37 have been obtained by GPS. As a result, 14 km length of feeder shown by red line in Figure 4.38 has been decided to construct. Location of distribution substation shown by Lmk 001 feeds 25 villages. But when dam is constructed if solution is not produced it will not feed 18 villages. Therefore, the computations have done for the new substation and Lmk 006 in Figure 4.37 has been decided the best place to construct the new substation.

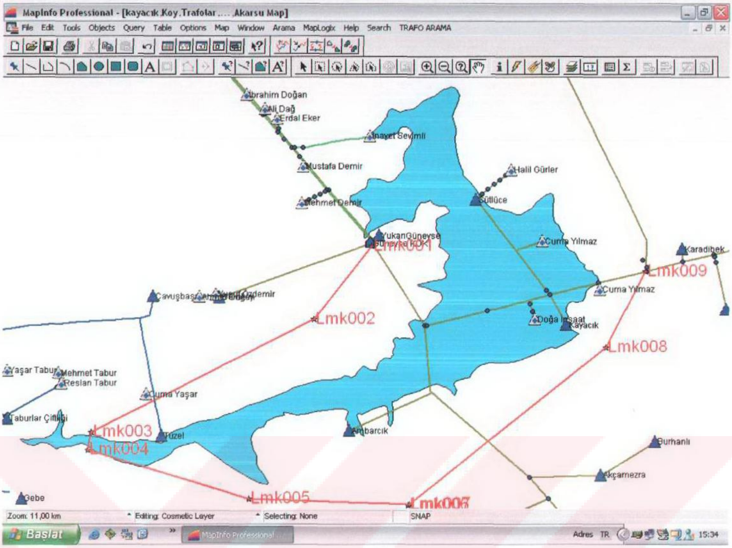


Figure 4.37 The solution

Without using GIS, this work will go on for weeks but the best decision obtained in 2 work-days by using GIS. In this study, technical constraints, geographical installation restrictions, and heuristic rules were considered. It would have been impossible to obtain better results in a very short time if TEDAŞ Gaziantep had been not using GIS. It is always confronted with similar problems in distribution of electricity. It is ensured that the most effective solution to this kind of problems is GIS.

4.10. Results

This study is aimed at to manage the electricity distribution network in a GIS environment which is managed by conventional methods. Presently, Gaziantep electricity distribution network is spread out to 6216 km^2 and can not be controlled. Nevertheless, it is very difficult to analyze the system entirely. Using GIS is the most convenient way to overcome this kind of problems, eliminate the negativeness and provide efficiency

It is particularly revealed that the Urban Information System must have been installed during this study. All kind of knowledge related to city is entered to the system. It is required to manage the database after installing the Urban Information System and electricity distribution network is saved to GIS environment. Due to this reason different reporting tools were developed. For example, it was a difficult problem to find the streets and avenues in a city with 500 villages and 169 districts. Then, different search-find modules were written. This end-user software tool was developed by using MapBasic® on the GIS system. Also, 7000 transformer was located in the city with 390000 subscribers but nobody knows most of the locations of the transformers exactly. Especially, it is not known how and where the underground network is located. If somebody wants to know the structure of the underground network belonging to anywhere, it is found by looking at old drawings and asking to old staffs. After installing most of the equipments; lines, transformers and poles in the city to the GIS environment too many scenarios can be produced with respect to problems solutions. Because, the city can be seen wholly from the GIS environment. Being successful in selecting the most powerful one among the scenarios depends on some kinds of calculations. Because, electricity distribution system has too many constraints such as voltage drop, power loss etc. It is very hard, tiring and labor intensive to make these calculations. In the current system, days-long calculations are not so reliable. In this study using Mapinfo® intermediate modules for the electrical calculations (Voltage Drop and Power Loss Analysis Tools) were developed. Thanks to those modules time consuming calculations take as less time as seconds. Now, expansion scenarios for the new additions to the distribution network can be developed in less time and optimum decisions can be made for planning.

Likewise, from the case study, it is seen that a good solution is found in a very short time for a redesign problem on a part of electricity distribution network. New system is adapted easily due to region's existing condition and electricity network was digitized beforehand. Information on survey registries was transferred to the database and the dam lake area was digitized to exhibit the region which will remain under water. Many alternative solutions (scenarios) have just been produced in a short time by using GIS according to some technical constraints, geographical installation restrictions and heuristic rules. Technical constraints have been analyzed easily by using voltage drop and power loss calculation tools, which are embedded to GIS. On the other hand, an expert user has controlled by using the GIS database whether geographical installation restrictions and heuristic rules constraints are satisfied or not for any scenario. Thus, it has been possible to achieve better solutions for a planning problem in the electricity distribution network by using the GIS application.

As a result, a comprehensive GIS application for the electricity distribution planning problem has been realized in Turkey. Gaziantep electricity distribution network has been gotten under control by this application. Now the distribution network can be effectively managed because the GIS application is used as a management information system. In TEDAŞ Gaziantep, association process arrangement is changed after GIS. The association process arrangement in TEDAŞ Gaziantep after GIS is shown in Figure 4.38 as follows:

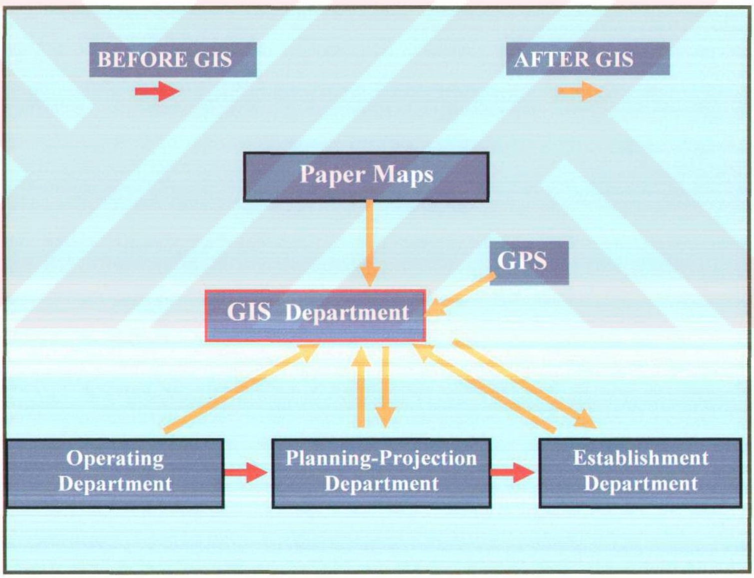


Figure 4.38 Association process arrangement in TEDAŞ Gaziantep after GIS

CHAPTER V

CONCLUSIONS

5.1. Discussion

The proposed application in thesis provides an illustration of how GIS technology can be applied in one typical government office. Numerous other applications are possible for other government offices such as national police, traffic, public health, etc. An integrated GIS allows agencies to share data between agencies and frequently eliminates or minimizes existing duplication of efforts to maintain commonly needed datasets. This sharing of data also increases the probability of different agencies making policy decisions based on current and consistent information. The development of a local government GIS requires a significant investment of public resources. However, in many instances, some of the required resources are already being spent to perform applications that a GIS can perform more efficiently. Before such an investment is undertaken, efforts should be made to plan for how this investment could be used to meet the multipurpose needs and applications of multiple government agencies.

5.2. Conclusion

Electricity distribution planning is an important problem for especially the developing countries. There is chaotic data in an electricity distribution network problem. These data need to be processed effectively for planning and operating of an electricity distribution network. Since most of these data are spatial, in this thesis we presented an application of electricity distribution planning based on GIS for Gaziantep. Therefore, the electricity distribution model for the city is established with GIS and GPS support. The digital map of the electricity distribution network is produced by MapInfo® and some end-user software tools are developed by using MapBasic® software's. For electrical analysis, some calculation tools (Voltage Drop Analysis - Power Loss Analysis), printing tools and a lot of reporting tools (find-subscriber, find-transformer, etc.) are developed. Briefly, an application is developed, which is a modern information system and a tool that manages everyday tasks related to operating, maintaining, planning, design and actual expansion of the city's network.

The GIS Application that we aim to develop for electricity distribution planning is able to analyze complicated structures of power transmission and distribution systems that extend from generation centers to customers and also is able to analyze geographical correlations between these structures. Furthermore, a lot of information is visually presented for decision makers, which subscriber is supplied from which pole (and transformer) and how much load it adds on the network. In addition to that, required operations and updating operations for the network are done by coordinating planning, foundation with few workers in a short time so that more reliable information is provided.

5.3. Future Work

While studies on the system is being continued, this database prepared in digital medium is planned to use as base for TEDAŞ's SCADA (Supervisory Control and Data Acquisition) and ABONE-NET (subscriber information managing system). Real time control of network on the map is possible in different periods by connecting it by SCADA system. Also load analysis on the map is possible provided that the system is connected with SCADA system. Network components are loaded optimally provided that loading case of transmission line and transformers are known. The customers can consumes power without exceeding the voltage drop limits, the customers are informed in the case of out of power. Transmission loss can be limited with choice of appropriate conductors and transmission of power by optimally distance. Furthermore, efficiency of transformers is indicated geographically with subscriber consumption and comparison of transformer measurements. Therefore, location of illegal electricity consumption usage is possible to detect. Also, development of mathematical model is being continued for optimal feeder configuration supported by GIS, optimal conductor size selection and optimization of selection of location of substation.

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APPENDIX I

An Introduction to Raster Image Registration

What Is A Raster Image?

A raster image is a type of computerized image that consists of row after row of tiny dots (pixels). If you have a scanner and scanner software, you can create a raster image by scanning a paper map. After you scan a map image and store the image in a file, you can display the file using MapInfo. There are many different raster image file formats. MapInfo can read the following types of raster image files: JPEG, GIF, TIFF, PCX, BMP, TGA (Targa), and BIL (SPOT satellite).

What Does It Mean To Register A Raster Image?

When you register a raster map image, you enter map coordinates (e.g. longitude/latitude degrees), and you indicate which locations on the raster image correspond to those coordinates. You must register each raster image before displaying the image in MapInfo, so that MapInfo can perform geographic calculations, such as distance and area calculations, when displaying the raster map.

The first time you open a raster image file within MapInfo, MapInfo displays the Register Raster Image dialog. By completing this dialog, you tell MapInfo how to register the raster image. MapInfo stores the raster image's registration information in a table file for future re-use. The next time you run MapInfo, you can re-open the raster table without repeating the registration process. Thus, you only need to register each raster image once.

Raster image files provided by MapInfo are already registered. You do not need to perform the registration process when you display the sample raster data included with MapInfo.

Registering A Raster Image

If you have not yet displayed your raster image in MapInfo, perform the following steps to register the image:

1. Choose File > Open Table. the Open Table dialog displays.

2. Choose Raster Images from the File Format drop-down list. MapInfo displays a list of raster image files.

3. Choose the raster image file you want to open, and choose Open. MapInfo displays the Image Registration dialog. A preview of the raster image appears in the lower half of the dialog.

4. Specify the image's map projection by choosing the Projection button and completing the Choose Projection dialog.

If you created the raster image by scanning a paper map, the paper map may contain information about the map projection used. If you cannot determine the map's projection, use the default map projection (longitude/latitude). Choose OK.

5. Move the mouse cursor over the image preview in the lower half of the dialog, to a spot where you know the map coordinates (e.g. longitude/latitude), and click the mouse button. MapInfo displays the Add Control Point dialog.

6. Complete the Add Control Point dialog by entering the map coordinates that correspond to the location where you clicked on the map image. Choose OK.

If you are entering coordinates in degrees, you must enter decimal degrees as opposed to degrees/minutes/seconds.

7. Repeat steps 5 and 6 until you have entered at least three control points. To ensure accurate results, enter five or six control points. Each control point that you add helps

MapInfo associate earth coordinates with locations on the raster image. Ideally, you should have at least one control point at or near each corner of the image.

The number of control points needed depends on the nature of your raster image. If you are not able to determine your map's projection, or if you are working with an image that does not have an actual map projection, such as an aerial photograph, you may want to enter twenty or more control points.

8. Choose OK when you are done adding control points. MapInfo displays the raster image in a Map window.

When you complete the Image Registration dialog, MapInfo saves the registration information in a table (.tab) file. In later MapInfo sessions, you can re-open the table by choosing File > Open Table, without repeating the registration process, and without having to choose Raster Images as the File Type in the Open Table dialog.

Opening A Registered Raster Image

You only have to register a raster image once. Each subsequent time you open the file, it can be opened like any other MapInfo table.
The sample raster image files included with MapInfo have already been registered (contain a TAB file). If you purchased a raster image from another source, it may already have a TAB file attached. You will not need to register these images either.

To open a registered raster image:

1. Choose File > Open Table.
2. Choose the table file (e.g. Parcels.tab) from the list in the dialog. (The TAB file contains the control point information supplied during the registration process.)
3. Leave the File Format as it is (MapInfo). The registration process already created a MapInfo readable file (TAB file).
4. Choose Open. MapInfo opens the raster image table and displays the image in a Map window.

APPENDIX II

How do we use GPS?

Initialization for first time use

One of the basic functions of GPS receivers is to form coordinate information. Coordinates show variety due to map used in our country. 3 degree in projection of the map scaled as Gauss-Kruger, 1:1000 and 1:5000 corresponds to 6 degree in projection of the map scaled as UTM, 1:25000. The GPS products that we use are able to produce the coordinate for two varieties of systems. All process on GPS (save, navigation) is done on the system represented as primary and on secondary side coordinate is obtained visually in selected system.

As explained above coordinate systems show variety but national map datum is single and it is named as GPS menu as EUR50 or EUROP. Datum refers to the theoretical mathematical model of the earth's sea level surface. Map makers may use a different model to chart their maps, so position coordinates will differ from one datum to another. The datum for the map you are using can be found in the legend of the map. If you are unsure of which datum to use, use WGS84. But we must use European Datum 1950 (EUR50 or EUROP) for our country.

Selecting the coordinate system

To set the coordinate system that will be used to display the position for the "primary or secondary position screen" on GPS. We must select UTM for Primary and GAUSS for Secondary coordinate system. **UTM** is Universal Transverse Mercator metric grid system used on most large and intermediate scale land topographic charts and maps.

A) PRIMARY Settings

i) MENU

ii) SETUP Enter

iii) COORDINATE SYSTEM Enter

iv) PRIMARY Enter

v) UTM Enter

For MAP DATUM

i) MENU

ii) SETUP Enter

iii) MAP DATUM Enter

iv) PRIMARY Enter

v) EUR50 Enter

To set the datum used to compute the coordinates to match the datum used on a map or chart. If we are using a map or chart with our GPS and the datum do not match, we may find irregularities when comparing the coordinates.

B) SECONDARY Settings

i) MENU

ii) SETUP Enter

iii) COORDINATE SYSTEM Enter

iv) SECONDARY Enter

v) TRANS MERC Enter

For MAP DATUM

i) MENU

ii) SETUP Enter

iii) MAP DATUM Enter

iv) SECONDARY Enter

v) EUR50 Enter

If the view of the sky is poor due to large cliffs or buildings, heavy foliage or other obstructions, the satellite signals can be blocked and the receiver may take longer to compute a position fix. We must observe the signal strength and the satellites being used on "Satellite Status Screen" on GPS. Satellite status screen provides us with a graphical display of the satellites in view and which ones are being used to compute the navigation data. The bar graph shows us the relative signal strength being received for each satellite. And then we can mark our points such as waypoint. A waypoint is a point on a map or a survey that we can name and save in our GPS. Waypoints are specific geodesic points stored in the GPS receiver's memory and can be transferred to the PC using the GPS TrackMaker® program. Usually they represent specific places, such as poles, transformers, etc. A Waypoint has the following components:

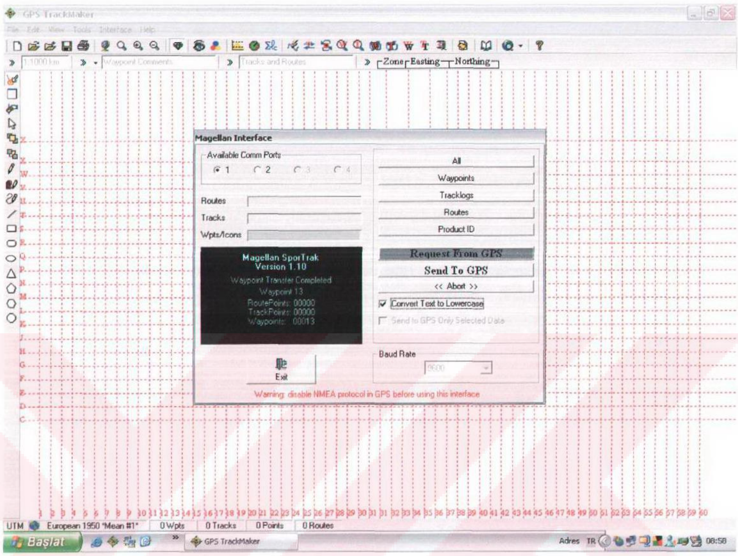
1. Latitude
2. Longitude
3. Name up to 10 characters
4. Comments up to 255 characters
5. Rotation angle of the Waypoint Text
6. Creation date
7. Altitude of the Point
8. Visualization in the screen
9. Specific graphic symbol

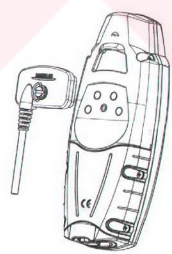
After transferred to the PC, all Waypoint data can be modified using the GPS TrackMaker® program.

Connecting the GPS to PC through Serial Communication Port

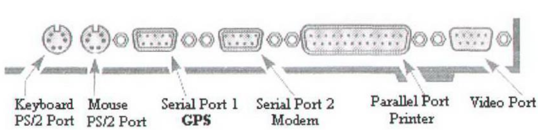
GPS TrackMaker® used for the information from GPS to PC or vice versa supports different formats as ESRI SHP, MAPINFO MIF. Navigation can be done by scanned background picture. The software supports UTM and geographical coordinate systems.

The " Interface " menu allows the user to do the connection between GPS and the computer through the RS-232 serial communication port.





PC Cable: Allows us to connect the GPS to a PC.



How do we integrate to MapInfo®?

Interface ⟶ Waypoints ⟶ Save File X (GPS Trackmaker Text Format *.Txt ⟶ Open Mapinfo® ⟶ Open Table X (File Type: Delimited ASCII *.Txt) ⟶ Delimited ASCII Information Menu ⟶ Choose Other ⟶ Press OK button Table Menu (Mapinfo® already open) ⟶ Create Points ⟶ Create Points For table (select X) ⟶ Choose Symbol ⟶ Choose Projection ⟶ Category (Turkish Coordinate System) ⟶ Category Members (UTM Central Meridian 39) ⟶ Then Press OK button ⟶ and add X layer to Mapinfo (Layer Control) ⟶ X Label Options ⟶ Label with Column 3

APPENDIX III

MapInfo has two commands for selecting objects through querying: Select and SQL Select. Select is simpler and SQL Select is more powerful.

A) Making Queries Using The Select Command

To make a query:

1. Choose Query > Select, the Select dialog displays.
2. Click on the Select records from table drop-down list and choose the table from which to select the records.
3. Type your query expression in the that satisfy box, or click the Assist button to display the Expression dialog which helps you write an expression.
4. Type a name in the Show results in table box for the temporary table that stores the results of your query or choose selection (the default). If Selection is chosen, MapInfo automatically names the table Query 1, Query 2 etc.

To sort the query by the value in some column (optional):

5. Click the Sort results by column drop-down list and choose the column containing the value you want to sort with.
6. Click OK.

A Browser window of your query results displays if the Browse Results box is checked. You can use Select to highlight objects in a map or a table that meet certain criteria and create a results table that you can browse, map, or graph like any other table.

When you are working in a Browser window, the records meeting the criteria of the query are highlighted.

When you are working in a map, the graphic objects of the chosen records are highlighted.

When you are working with both a Map window and a Browser window, the objects and the records are highlighted.

In all cases, a working table is automatically created called Selection. This table contains the results of the query. You can map, or graph this table like any other table. The table can also be saved as a separate table with Save Copy As.

B) General Procedure For Using SQL Select

The general procedure for using SQL Select is as follows:

1. Open the table you wish to query, if you haven't already done so.

The table that you query is known as the base table. If you use SQL Select to perform a query on the World table, the World table is your base table.

2. Choose Query > SQL Select. Fill in the portions of the SQL Select dialog that meet your needs. When you click OK, MapInfo performs the query.

MapInfo extracts data from your base table, stores the query results in a special, temporary table, known as the results table. The results table contains only the rows and columns that meet your criteria. The default name of the results table is Selection (although you can specify a different results table name in the Into Table Named field in the SQL Select dialog).

3. Open a Map window and/or a Browser window if you want to see the query results. By default, MapInfo displays the results table in a Browser window automatically (unless you clear the Browse Results checkbox in the SQL Select dialog).

If your results table is called Selection (the default name), the Browser window shows a different table name, such as Query1 or Query2. This is because the moment you Browse the Selection table, MapInfo takes a "snapshot" of the table, and names the snapshot Queryn (where n is a number, one or greater). MapInfo takes the snapshot because "Selection" is a special table name; Selection dynamically changes every time you select or de-select rows.

In the SQL Select dialog, you can enter a different name for your results table (e.g. you can name your results table My_Query). This prevents MapInfo from renaming your results table Queryn.

4. MapInfo automatically selects all rows in the results table. Thus, after you perform SQL Select, you can perform operations on the entire set of selected rows. For example, you could apply a different fill color to all selected rows (by choosing Options > Region Style), or you could cut or copy all selected rows.

Usually, any alterations you make to the results table are automatically applied to your original (base) table. For example, if you use SQL Select to select some of the rows from the Orders table, and then you delete some of the rows from your results table, MapInfo deletes the corresponding rows from your base table (Orders). However, if your query produces subtotals, you can alter the results table without affecting the base table.

5. Choose File > Save As if you want to make a permanent copy of the results table. If you do not perform Save As, the results table will be deleted when you exit MapInfo.

GEOGRAPHICAL QUERY MODULE OF TRANSFORMERS

```
Include "icons.def"
Include "menu.def"
Include "mapbasic.def"
'-----------------------------------------------------------------
Declare sub main
Declare sub tektr
Declare sub ozeltr
Declare sub ch_tektr
Declare sub ch_ozeltr
Declare sub Hakkinda
Declare sub exitmenu

Global k,wid as integer
Global t_name as string
Dim
ilcekom(10),adreskom(),mahalkom(),tradimahb(),tradimaho(),tradib(),t
radio(),teastip() as string
Dim p,l as smallint
'-------------------------------------------------------------------
SUB MAIN
create menu "TRAFO ARAMA" as

"Tedaş' a Ait" calling "tektr",
"Ozel Trafolar" calling "ozeltr",
"(-",
"Çık" calling exitmenu
Alter Menu Bar Add "TRAFO ARAMA"
end sub
'---------------------------------------------------------------------
SUB tektr
select ilce_adi from ilce where ilce_adi <> "" group by ilce_adi
order by ilce_adi into toplam_ilce
k=1
      do while not EOT(toplam_ilce)
      ilcekom(k)=toplam_ilce.ilce_adi
      FETCH NEXT FROM toplam_ilce
      k=k+1
      loop

select * from trafolar where Kimin="TEDAS" and ilceadi= ilcekom(1)
order by mahalleadi,trafoadi into selt
redim adreskom(tableinfo("selt",tab_info_nrows))
redim mahalkom(tableinfo("selt",tab_info_nrows))
k=1
      FETCH FIRST FROM SELt
      do while not EOT(selt)
      mahalkom(k)=selt.trafoadi+" - "+selt.mahalleadi
      adreskom(k)=selt.trafoadi
      FETCH NEXT FROM selt
      k=k+1
      loop
dialog   Title "TEDAŞ TRAFOLARI"
control statictext position 10,10 title "İlçe adı :"
control Popupmenu title FROM VARIABLE ilcekom value 1 id 1 calling
CH_tektr position 10,20
control statictext position 90,10 title "Trafo Adı :"
control listbox title from variable mahalkom height 90 value 1 id 2
into p position 90,20 width 120
control OKbutton title "Ara"   position 50,120 id 5
```

```
control cancelbutton title "iptal"   position 110,120
      If CommandInfo(CMD_INFO_DLG_OK) Then
      select * from selt where trafoadi=adreskom(p) into sel1
      set map zoom 750 units "m"
      run menu command 306
      end if
END SUB
'----------------------------------------------------
SUB CH_tektr
select * from trafolar where Kimin="TEDAS" into tektr
select * from tektr where ilceadi=ilcekom(readcontrolvalue(1)) order
by mahalleadi,trafoadi into selt
select * from selt where trafoadi <> "" into sel1
      if tableinfo("sel1",tab_info_nrows) =0 then
      redim mahalkom(1)
      mahalkom(1)="bu tipte trafo bulunamadi "
      alter control 2 disable
      alter control 5 hide
      alter control 2 title from variable mahalkom
      else
      redim adreskom(tableinfo("selt",tab_info_nrows))
      redim mahalkom(tableinfo("selt",tab_info_nrows))
      alter control 2 enable
      alter control 5 show
      k=1
            do while not EOT(selt)
            mahalkom(k)=selt.trafoadi+" - "+selt.mahalleadi
            adreskom(k)=selt.trafoadi
            FETCH NEXT FROM selt
            k=k+1
            loop
      alter control 2 title from variable mahalkom
      end if
END  SUB
'-----------------------------------------------------
SUB ozeltr
select ilce_adi from ilce where ilce_adi <> "" group by ilce_adi
order by ilce_adi into toplam_ilce
k=1
      do while not EOT(toplam_ilce)
      ilcekom(k)=toplam_ilce.ilce_adi
      FETCH NEXT FROM toplam_ilce
      k=k+1
      loop

select * from trafolar where Kimin="OZEL" and ilceadi= ilcekom(1)
order by mahalleadi,trafoadi into selo
redim adreskom(tableinfo("selo",tab_info_nrows))
redim mahalkom(tableinfo("selo",tab_info_nrows))
k=1
      FETCH FIRST FROM SELo
      do while not EOT(selo)
      mahalkom(k)=selo.trafoadi+" - "+selo.mahalleadi
      adreskom(k)=selo.trafoadi
      FETCH NEXT FROM selo
      k=k+1
      loop
dialog   Title "OZEL TRAFOLAR"
control statictext position 10,10 title "ilçe adı: "
control Popupmenu title FROM VARIABLE ilcekom value 1 id 1 calling
CH_ozeltr position 10,20
```

```
control statictext position 90,10 title "Trafo Adı: "
control listbox title from variable mahalkom height 90 value 1 id 2
into p position 90,20 width 120
control OKbutton title "Ara"   position 50,120 id 5
control cancelbutton title "iptal"   position 110,120
      If CommandInfo(CMD_INFO_DLG_OK) Then

      select * from selo where trafoadi=adreskom(p) into sel1
      set map zoom 750 units "m"
      run menu command 306
      end if
END SUB
'----------------------------------------------------
SUB CH_ozeltr
select * from trafolar where Kimin="OZEL" into ozeltr
select * from ozeltr where ilceadi=ilcekom(readcontrolvalue(1))
order by mahalleadi,trafoadi into selo
select * from selo where trafoadi <> "" into sel1
      if tableinfo("sel1",tab_info_nrows) =0 then
      redim mahalkom(1)
      mahalkom(1)="bu tipte trafo bulunamadi "
      alter control 2 disable
      alter control 5 hide
      alter control 2 title from variable mahalkom
      else
      redim adreskom(tableinfo("selo",tab_info_nrows))
      redim mahalkom(tableinfo("selo",tab_info_nrows))
      alter control 2 enable
      alter control 5 show
      k=1
            do while not EOT(selo)
            mahalkom(k)=selo.trafoadi+" - "+selo.mahalleadi
            adreskom(k)=selo.trafoadi
            FETCH NEXT FROM selo
            k=k+1
            loop
      alter control 2 title from variable mahalkom
      end if
END  SUB
'-------------------------------------------------------
SUB EXITMENU
End program
END SUB
```

APPENDIX IV

Running A MapBasic Program

Use Run in the Tools menu to run a MapBasic program. MapBasic is a programming language that you can use to customize or automate Maplnfo. To create MapBasic applications, you need the MapBasic compiler, which is a separate product. However, you do not need the MapBasic compiler to run a completed MapBasic application. MapInfo comes with an assortment of completed MapBasic applications. Some examples include:

Symbol application (symbol.mbx). Create custom symbol shapes.
Scale Bar application (scalebar.mbx). Annotate a map with a distance scale.
Named Views application (nviews.mbx). Assign a name to the current map view and use that name to return to that view later.
Overview application (overview.mbx). Open a second Map window that displays an overview of the current map (also referred to as an area detail map).

To run a MapBasic application:

1. Choose File > Run MapBasic Program. The Run MapBasic Program dialog displays.
2. Choose a directory.
3. Choose an application from the list (MapBasic applications have an .mbx extension).
4. Click OK.

MapInfo then runs the MapBasic application.

Issuing Commands Through The MapBasic Window

When you issue a command through the MapBasic window, you must use the correct syntax. When you choose many of MapInfo's menu options, MapInfo displays the commands in the MapBasic window. You can learn something about the syntax of MapInfo commands simply by observing them in the window.

To issue a command through the MapBasic window:

1. Choose Options > Show/Hide MapBasic. The MapBasic Window displays.
2. Type the command.
3. Press Enter and MapInfo executes the command.

When the command does not have the result you want, you can edit the command statement by deleting items, adding new items, or rearranging items.

To reissue a command that you have previously issued:

1. Position the cursor anywhere within the command statement.
2. Press Enter.

This is particularly useful when you want to issue a command several times with small changes each time.

To reissue a series of commands:

1. Choose the series by dragging the cursor over them to highlight them.
2. Press Enter.

To integrate the computer program written in MapBasic the subroutine should be designed in the computer program.

MODULE OF "MAINTENANCE PLANNING OF TRANSFORMERS"

```
Include "Mapbasic.def"
Include "Icons.def"
'--------------------------------------------*
Declare sub main
Declare sub bldg
Declare sub endprog
Declare sub building
Declare sub kapi
'Declare sub yenikayit
Global kayitnox() as string
Dim
degismenedenix(),degisikliktarihix(),markasix(),serinox(),imalyilix()
as string
Dim gucux() as integer
Global tt as integer
'--------------------------------------------*
SUB MAIN
 create buttonpad "TBsss" as
      toolbutton calling building
            icon MI_ICON_REALESTATE_1
            id 1991
END SUB
'--------------------------------------------*
SUB BLDG
run menu command id 1991
END SUB
'---------------------------------------------*
SUB BUILDING
dim x,y as float
dim i,k,ss,kno as integer
dim trafolar_var as logical
dim
trafoadix,ilceadix,kodux,rrr1,rrr1x,rrr2,rrr2x,ppp,pppx,vvv,vvvx,kkk
,kkkx as string
dim ggg,gggx as integer
trafolar_var=0
x=commandinfo(cmd_info_x)
y=commandinfo(cmd_info_y)

i=searchpoint(frontwindow(),x,y)
for k=1 to i
if searchinfo(k,1)="trafolar" then
         ss=searchinfo(k,search_info_row)
         select * from trafolar where rowid=ss into secilen_trafo
trafolar_var=1
end if
next
if trafolar_var then

kodux=secilen_trafo.kodu
trafoadix=secilen_trafo.trafoadi
ilceadix=secilen_trafo.ilceadi

select * from trafobilgileri where kodu=kodux into secilen_trafo

if selectioninfo(sel_info_nrows) then
```

```
redim kayitnox(selectioninfo(sel_info_nrows))
redim degismenedenix(selectioninfo(sel_info_nrows))
redim degisikliktarihix(selectioninfo(sel_info_nrows))
redim markasix(selectioninfo(sel_info_nrows))
redim serinox(selectioninfo(sel_info_nrows))
redim imalyilix(selectioninfo(sel_info_nrows))
redim gucux(selectioninfo(sel_info_nrows))
   fetch first from secilen_trafo
k=1
do while not eot(secilen_trafo)
kayitnox(k)=secilen_trafo.kayitno
degismenedenix(k)=secilen_trafo.degisme_nedeni
degisikliktarihix(k)=secilen_trafo.degisiklik_tarihi
gucux(k)=secilen_trafo.gucu
markasix(k)=secilen_trafo.markasi
serinox(k)=secilen_trafo.serino

imalyilix(k)=secilen_trafo.imal_yili
k=k+1
                fetch next from secilen_trafo
                 loop
vvv=degismenedenix(1)
ppp=degisikliktarihix(1)
ggg=gucux(1)
rrr1=markasix(1)
rrr2=serinox(1)
kkk=imalyilix(1)
else k=1
end if
      dialog title "TRAFO BILGISI" POSITION 10,10
      control groupbox position 5,5 title "TRAFO ADRES BILGILERI"
width 200 height 81

      control statictext position 10,20 title "ILÇESI :"
      control statictext position 60,20 title ilceadix

      control statictext position 10,45 title "TRAFO ADI :"
      control statictext position 60,45 title trafoadix
      control statictext position 10,65 title "TRAFO Kodu :"
      control statictext position 60,65 title kodux

      control groupbox position 5,91 title "Trafo-Detay Bilgisi"
width 200 height 145
      control statictext position 15,107 title "Kayit No :"
      control statictext position 15,122 title "Degisme Nedeni :"
      control statictext position 15,137 title "Degisme Tarihi :"
      control statictext position 15,152 title "Gucu :"

      control statictext position 15,167 title "Markasi :"
      control statictext position 15,182 title "Serino :"
      control statictext position 15,197 title "Imal Yılı :"
      control popupmenu position 75,107 title from variable Kayitnox
calling kapi id 1 value 1 width 30
      control edittext position 75,122 value vvv id 2 width 120 into
vvvx 'Degisme Nedeni
      control edittext position 75,137 value ppp id 3 width 120 into
pppx 'Degisiklik Tarihi
      control edittext position 75,152 value ggg id 3 width 120 into
gggx 'Gucu
      control edittext position 75,167 value rrr1 id 4 width 120
into rrr1x 'Markasi
```

```
      control edittext position 75,182 value rrr2 id 5 width 120
into rrr2x 'Serino
      control edittext position 75,197 value kkk id 6 width 120 into
kkkx 'Imal yili



      control okbutton title "Kaydet" position 55,215
      control cancelbutton title "İptal" position 120,215

if commandinfo(cmd_info_dlg_ok) then

Insert Into trafobilgileri
(kayitno,trafoadi,kodu,ilceadi,degisiklik_tarihi,degisme_nedeni,gucu
,serino,markasi,imal_yili) values
(k,trafoadix,kodux,ilceadix,pppx,vvvx,gggx,rrr2x,rrr1x,kkkx)

end if

      end if

      exit sub

END SUB
'----------------------
SUB KAPI
Dim s1 as integer
Dim vvv,ppp,rrr1,rrr2,kkk as string
dim ggg as integer
s1=readcontrolvalue(1)
vvv=degismenedenix(s1)
ggg=gucux(s1)
ppp=degisikliktarihix(s1)
rrr1=markasix(s1)
rrr2=serinox(s1)
kkk=imalyilix(s1)

alter control 2 value vvv
alter control 3 value ppp
alter control 4 value rrr1
alter control 5 value rrr2
alter control 6 value kkk
END SUB
'---------------------------------------
SUB ENDPROG
end program
END SUB
'*--------------------*
```

January 2005	**M. Sc. in IE**	**Ali VELİOĞLU**

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