

# THE IMPORTANCE OF TIME DIMENSION IN THE VECTOR-BASED TURKISH FOREST INFORMATION SYSTEM

O.Y. Yılmaz

IU, Forest Engineering Faculty, 80895 Bahçeköy Istanbul, Turkey  
[yilmazy@istanbul.edu.tr](mailto:yilmazy@istanbul.edu.tr)

**KEY WORDS:** GIS, spatiotemporal, mapping, updating, versioning, forestry

## ABSTRACT:

A new era has been started in urban and natural resource management when GIS (Geographic Information Systems) was put in use in Canada in 1971. Although, it was not possible to store and update the data desirably in the early times due to the deficiencies in computer hardware and software, those tasks that were difficult and time-consuming to fulfill by traditional techniques began to be performed in a faster, easier, and more reliable way because of recent developments in those areas. The recent development in computer hardware and software offer new possibilities to update temporal changes in geographic data and roll-back inquiries. Temporal changes have important roles in managing and planning dynamic systems such as forests. By means of GIS, these changes can be offered to forestry technicians and managers as a tool for planning and managing the Turkish forest resources in a more scientific way. Moreover, to use GIS would make it possible to control all the work backward in a reliable, fast and confidential way. This project aims to examine the capability boundaries of "Vector-based Temporal Forest Information System Prototype". For this purpose, a prototype of forest information system was developed for a selected area, and possible changes in geographic objects in time were explored through various scenarios. Queries were performed into those temporal changes, which sets an example for the hereafter applications. In the recent years, there has been an intensified effort to establish a system of forest resources management in Turkey. However, these efforts underestimate importance of the time dimension, which this paper argues as central in the forest information system developments. According to this paper, unless time dimension is taken into consideration seriously, it would be very costly to correct mistakes made afterwards.

## 1. INTRODUCTION

Nowadays, one of the most important application areas of GIS is forestry. Using GIS in forestry applications offers new possibilities in data analysis. Due to image processing and photogrammetric system has been integrated in GIS these possibilities are increased (Persson and Janz 1997). As a result, it is possible to make reliable and quick spatial analysis and to store the data in a database and be able to use it whenever it is needed. Beside this spatial analysis, it has been recognized that time related data offer many advantages and new researches in this subject has been carried out. However, in the beginning geographic objects were processed only in spatial and attribute dimensions and time dimension was not process or store due to deficiencies of hardware and software. (Peuquet 2001; Renolen 1997; Faria et.al. 1998; Gorolwalla et.al. 1997; Tryfona 1998).

One of the base goals of GIS is monitoring and analyzing changes in spatial information. Non-temporal GIS has considered the snapshot of geographic object and not deal with the temporal status. But temporal GIS has offered monitoring temporal changes in geographic object by storing temporal data. Thus, it became possible to provide answers to the queries; "Where and when did change occur?", "What types of change occurred?", "What is the rate of change?", "What is the periodicity of change?" (Langran 1993).

Because forestry applications are based on the living objects they have changed and developed continuously, analysis of time related information has an important role in evaluating the past applications and preparing future plans. After time dimension has integrated into GIS, it became possible to carry out analysis easily and quickly based on time and space such as "What is the growth of Mb3 stands in Karaköy Forest

Chief Unit in terms of aspects, slopes, and silvicultural treatments in the last 40 years?".

Temporal GIS offers great possibilities to modeling complicated ecological systems such as forest and technical works in forestry. It is also possible nowadays to evaluate temporal GIS data with either integrated to GIS software or self-executed statistics, geostatistics, and simulation software and these evaluations would be made great contribution to forest sustainability efforts. Thus, GIS not only provides monitoring of forest economically but also protects this resource by taking preventive measures.

This paper presents the results of the project, "Developing Vector Based Forest Information System Prototype", supported by Istanbul University Research Foundation were given. The project aims to identify the importance of time dimension in GIS and possibilities offered by temporal GIS in creating, storing, updating, displaying, and analyzing temporal data; results of project

## 2. METHODS

### 2.1. Data Used

In this 1/25000 scale topographic and 1/25000 scale forest management maps (year:1964,1983,1995) of the Çanakkale Regional Forest, Bayramiç District Forest Directorate, Karaköy Forest Chief Unit were used.

The project area ranges between 39 53 24 – 39 45 48 latitudes and 26 41 15 – 26 56 21 longitudes.

## 2.2. Hardware and Software Used

Following hardware and software were used to realize this project.

Hardware: The server has got Intel SBT2 server board, two Intel Pentium III Xeon Processors, 512 MB ECC SDRAM, and one HP-1120C printer.

Software:

Geomedia Professional 4.00.22

Oracle 9.2.0.1.0 Enterprise Edition.

## 3. RESULTS

This project has investigated three combinations of geographic objects changes that require processing (table 1).

	<i>graphic data</i>	<i>attribute data</i>
1	fixed	changes
2	changes	fixed
3	change	change

Table 1. Combinations of change in geographic objects

First of all, a geographic database was constructed to implementing this project. Then a “versioning” process that adds a new line into database table for only the changed object has been made. Thus the first version for graphic and attribute data of geographic objects in a particular time was achieved. After that when there were new temporal changes in geographic objects new versions have been made. In this paper it is accepted that displaying temporal changes on the “mesceretipi (stand type)” geographic object has complicated and intensive data structure in database.

Following examples are given to explain how these temporal changes in both graphic and attribute data of “mesceretipi” geographic object is edited, queried, and displayed.

While in 1964 geographic object stand type and stand number were respectively ÇkKkKnbd3 and 5 (figure 1), in 1983 its stand type was changed to Çkbd3. In this situation (version 2), this new stand type was the same as stand number 23 and they have had to merged into one stand type (figure3). When this attribute change were edited in revision set and then committed, a new line was automatically added to database table through database management system (figure 2, 4).

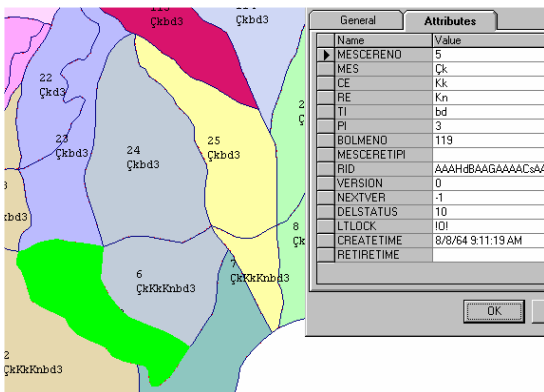


Figure 1. Graphic and attribute data of geographic object in 1964 (first version)

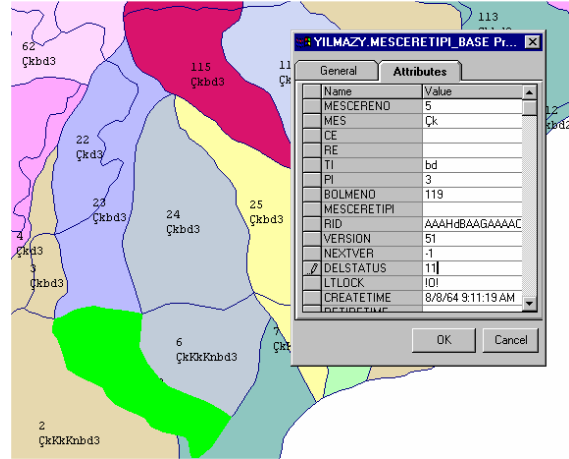


Figure 2. Editing of attribute changes in 1983

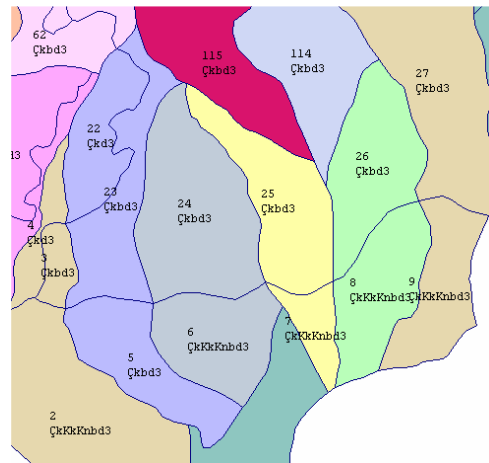


Figure 3. Two neighbor Çkbd3 stand types (stand no 5 and 25)

MESCRETENO	MES	CE	RE	TI	PI	BOLMENO	VERSION	CREATETIME	RETIRETIME
1	Çk	Kk	Kn	bd	3	128	0	08-Aug-1964 09:11:19 AM	
2	Çk	Kk	Kn	bd	3	127	0	08-Aug-1964 09:11:19 AM	
3	Çk			bd	3	127	0	08-Aug-1964 09:11:19 AM	
4	Çk			d	3	127	0	08-Aug-1964 09:11:19 AM	
5	Çk	Kk	Kn	bd	3	119	0	08-Aug-1964 09:11:19 AM	08-Aug-1964 09:11:19 AM
6	Çk			bd	3	119	51	08-Aug-1984 04:33:22 PM	
7	Çk	Kk	Kn	bd	3	120	0	08-Aug-1964 09:11:19 AM	
8	Çk	Kk	Kn	bd	3	121	0	08-Aug-1964 09:11:19 AM	
9	Çk	Kk	Kn	bd	3	122	0	08-Aug-1964 09:11:19 AM	
10	Çk	Kk	Kn	bd	3	115	0	08-Aug-1964 09:11:19 AM	

Figure 4. Database table representation of changes in 1983

Because of new situation (e.g. two same type neighbor stand type) two stand types were merged by using GIS software merge function (figure 5). After merge operation in revision set and committing this change new version were created (figure 6) and new lines were added automatically into database table (figure 7).

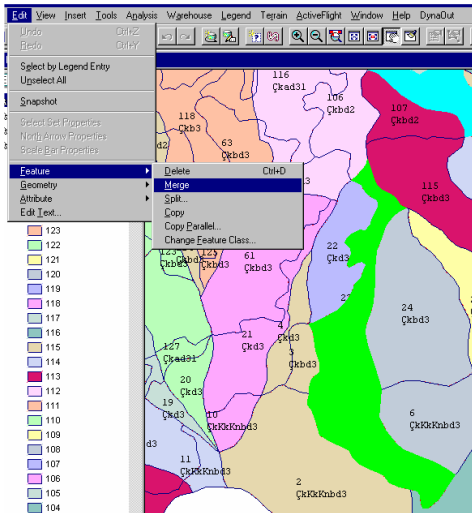


Figure 5. Merging two same stand types

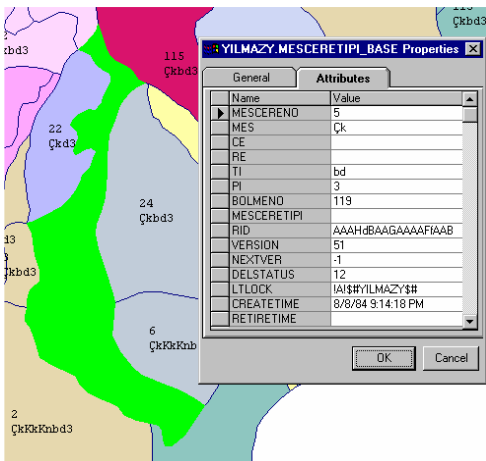


Figure 6. Graphic and attribute data of merged stand type

Editor: "YILMAZY"."MESCIERETIPI\_L1" - system@YIY\_OYY

MESCIERENO	MES	CE	RE	TI	PI	BOLMENO	VERSION	CREATETIME	RETIRETIME
25	Çk			bd	3	121	0	08-Aug-1964 09:11:19 AM	
6	Çk	Kk	Kn	bd	3	120	0	08-Aug-1964 09:11:19 AM	
24	Çk			bd	3	120	0	08-Aug-1964 09:11:19 AM	
22	Çk			d	3	119	0	08-Aug-1964 09:11:19 AM	
5	Çk			bd	3	119	51	08-Aug-1984 04:33:22 PM	08-Aug-1984 09:14:18 PM
23	Çk			bd	3	119	0	08-Aug-1964 09:11:19 AM	08-Aug-1984 09:14:19 PM
5	Çk	Kk	Kn	bd	3	119	0	08-Aug-1964 09:11:19 AM	08-Aug-1984 04:33:22 PM
5	Çk			bd	3	119	51	08-Aug-1984 09:14:18 PM	
23	Çk			bd	3	119	51	08-Aug-1984 09:14:18 PM	
21	Çk			d	3	118	0	08-Aug-1964 09:11:19 AM	
61	Çk			bd	3	118	0	08-Aug-1964 09:11:19 AM	
10	Çk	Kk	Kn	bd	3	118	0	08-Aug-1964 09:11:19 AM	
40	Çk			ad	31	117	0	08-Aug-1964 09:11:19 AM	

Figure 7. Database table representation of temporal changes

After that in 1995, this merged Çkbd3 stand type with stand number 5, was changed both graphically and attributively. In this new situation (version 3), previous Çkbd3 stand type divided into Çkd3 and Çkbd3 stand types. To manipulate changes occurred in this stand type, revision set was created and then new graphic and attribute changes were edited (figure 8). After these changes were committed, the new version of stand type was created. Graphic and attribute data of this two stand types are shown in figure 9 and 10. These new graphic and attribute changes of geographic object were also automatically added into database table (figure 11). To make a simple temporal query geographic object "CREATE TIME" and "RETIRE TIME" attributes were used in GIS user-friendly query menu. This query and its results is shown in figure 12,13,14.

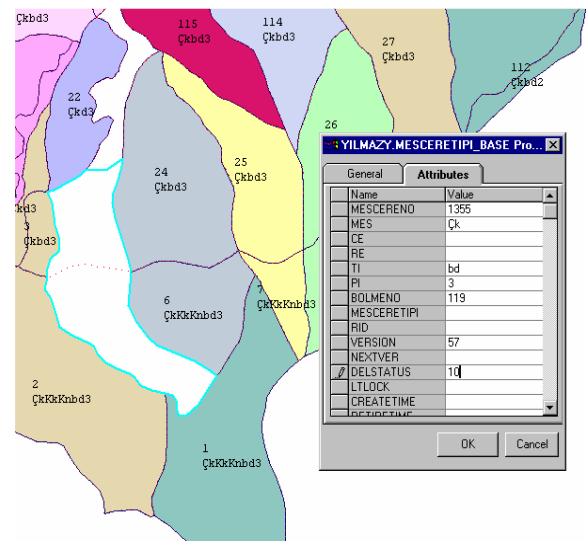


Figure 8 . Editing graphic and attribute data

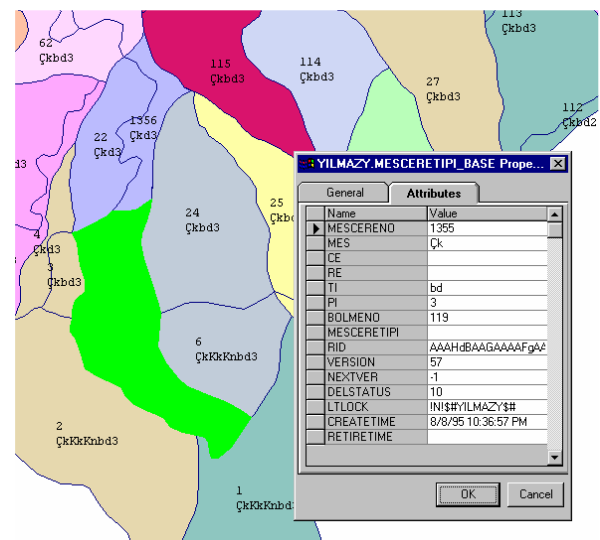


Figure 9. New stand type graphic and attribute data

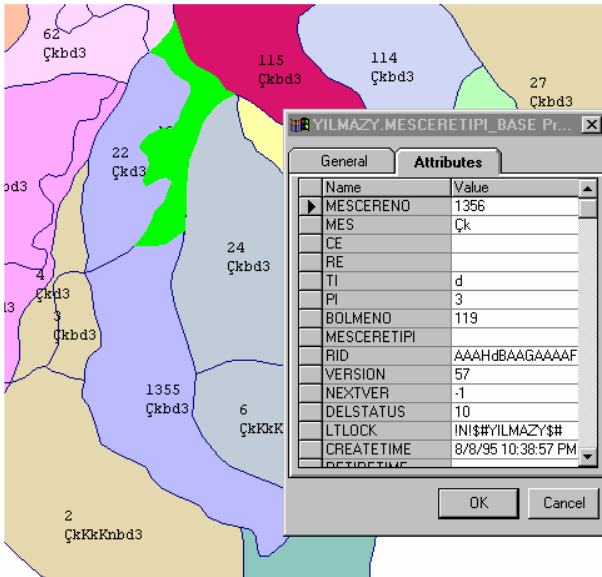


Figure 10. New stand type graphic and attribute data

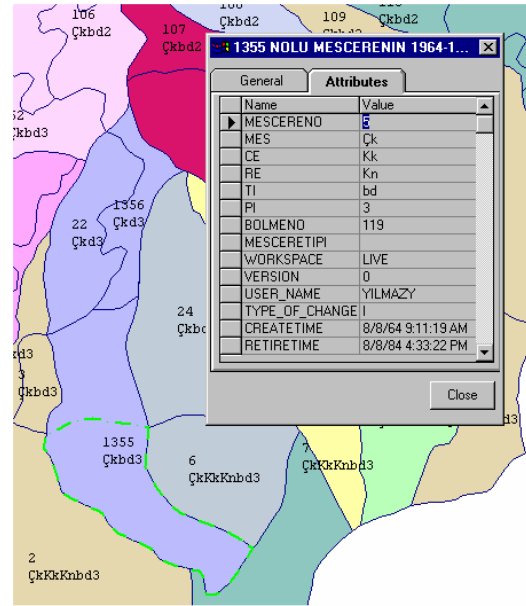


Figure 13. Query result of version 1

Editor: "YILMAZY"."MES CERETIPI.LT" - system@DYY.OYY

MES CERENO	MES	CE	RE	TI	PI	BOLMENO	VERSION	CREATE TIME	RETIRE TIME
110	Çk		bd	2	116	0	0	08-Aug-1984 09:11:19 AM	
112	Çk		bd	2	116	0	0	08-Aug-1984 09:11:19 AM	
113	Çk		bd	3	116	0	0	08-Aug-1984 09:11:19 AM	
19	Çk		d	3	117	0	0	08-Aug-1984 09:11:19 AM	
59	Çk		bd	3	117	0	0	08-Aug-1984 09:11:19 AM	
34	Çk		bd	3	117	0	0	08-Aug-1984 09:11:19 AM	
42	Çk		ad	31	117	0	0	08-Aug-1984 09:11:19 AM	
41	Çk		ad	31	117	0	0	08-Aug-1984 09:11:19 AM	
40	Çk		ad	31	117	0	0	08-Aug-1984 09:11:19 AM	
21	Çk		d	3	118	0	0	08-Aug-1984 09:11:19 AM	
61	Çk		bd	3	118	0	0	08-Aug-1984 09:11:19 AM	
10	Çk	Kk	Kn	bd	3	118	0	08-Aug-1984 09:11:19 AM	
5	Çk		bd	3	119	0	0	08-Aug-1984 09:14:18	08-Aug-2002 10:28:40 PM
5	Çk		bd	3	119	0	0	08-Aug-1984 04:33:22	08-Aug-1984 09:14:18 PM
23	Çk		bd	3	119	0	0	08-Aug-1984 09:11:19 AM	08-Aug-1984 09:14:19 PM
22	Çk		d	3	119	0	0	08-Aug-1984 09:11:19 AM	
1356	Çk		d	3	119	57	57	08-Aug-1995 10:38:57	
1355	Çk		bd	3	119	57	57	08-Aug-1995 10:36:57	
6	Çk		bd	3	119	57	57	08-Aug-1995 10:28:40	
23	Çk		bd	3	119	0	0	08-Aug-1984 09:14:19	
6	Çk	Kk	Kn	bd	3	119	0	08-Aug-1984 09:11:19 AM	08-Aug-1984 04:33:22 PM
6	Çk	Kk	Kn	bd	3	120	0	08-Aug-1984 09:11:19 AM	
24	Çk		bd	3	120	0	0	08-Aug-1984 09:11:19 AM	
7	Çk	Kk	Kn	bd	3	121	0	08-Aug-1984 09:11:19 AM	

Figure 11. Database table representation of changes

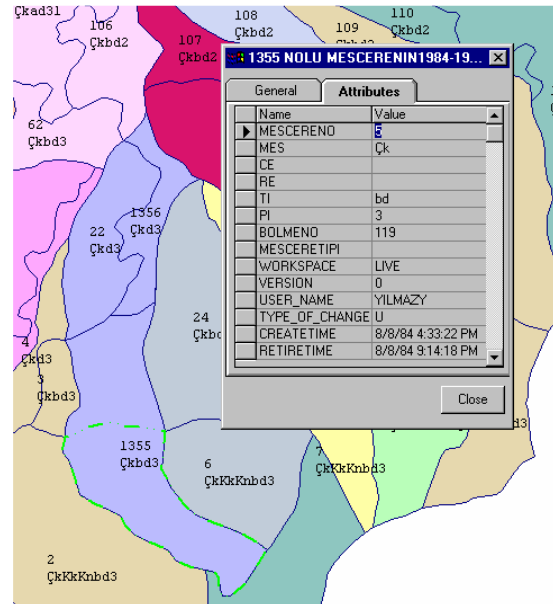


Figure 14. Query result of version 2

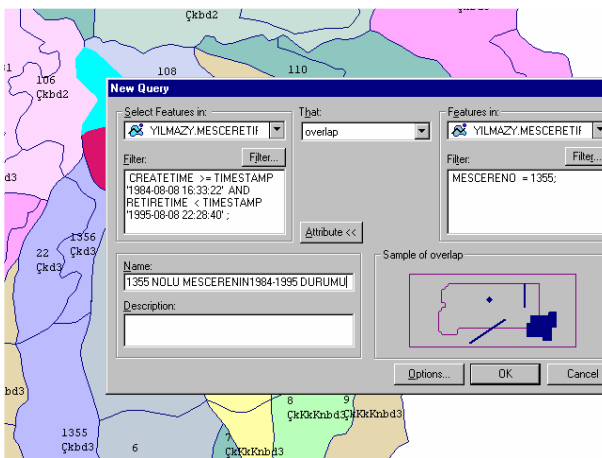


Figure 12. Querying temporal changes

#### 4. DISCUSSION

A new era was started in natural resource management when GIS was first put in use in Canada in 1971. In the beginning, GIS has not the ability to monitoring temporal changes in geographic data. Geographic data were treated with only spatial and attribute dimensions. Afterwards, although temporal changes have been tried to process by various methods it is not possible to develop sound, confident, and easy to use method. But through the researches has been carried out on this subject for the last two decades and developments of computer hardware&software, it became possible and easier to process and query temporal changes and store huge amount of data. In this project, it is aimed that through utilizing vector-based temporal GIS, temporal

changes can be manipulated in a reliable and easier way and avoids data redundancy.

GIS is offered new and modern possibilities to forestry managers and technicians. Those tasks that were difficult and time-consuming to fulfill by traditional techniques began to be dealt with faster, more reliably and more easily in computer environment. Any institutions that claim to innovate their system with GIS must take into consideration to system can be able to support time dimension. Because temporal data offers many advantages and possibilities. To show what advantages and possibilities are offered this project were completed with existed hardware and software.

In this project following operations were completed successfully;

- temporal data are entered and edited easily,
- temporal data are stored nonredundantly,
- temporal data are displayed and analyzed easily.

Data redundancies were minimized by the versioning ability of database management system used in the project. Through this ability new geographic and attribute data line were added into database table for only changed geographic object and the other data belong to nonchanged object were remained fixed. This subject arise an important problem when the system covers plenty of forest areas such as Turkey. In addition to storage of temporal changes with nonredundancy that save large amount of storage capacity, contribution in performance of temporal queries and data rollback is noteworthy.

To monitoring temporal changes user-friendly query menu of GIS software was used. Thus changes in geographic objects could be monitoring and results were displayed as a map and table. Temporal queries directed to monitoring changes in geographic objects offer not only to make more technical forestry applications but also be able to making monetary and administrative inspection of these applications faster and soundly. In this paper only simple queries directed to monitoring stand type changes were illustrated. It is possible to differentiate these queries according to needs and obtain satisfactory results for technical forestry applications. It was demonstrated with this project that it is possible to provide answers to the queries such as "What is the growing rate of Çkbd3 stands in various silvicultural treatments in Karaköy district?", "What is the growing of Çkbd3 stands in various elevation and/or aspect and/or slope in Karaköy Forest Chief Unit?" and all other queries related to time.

In this project it has seen that available temporal data is important in terms of match. That is cutting section border and numbers in consecutive forest management plans (year 1964-1983-1995) were not match. These changes have created for editing and querying stand inventory data.

There has not been any drawback from the standpoint of GIS functions in this temporal forest information system prototype. But it is useful that GIS software has command menu for making some operations such as roll-back data for entering new changes or committing and discarding these temporal changes. There is not any performance problem of available hardware and software for entering, manipulating, querying, and roll-backing of temporal data.

## 5. CONCLUSIONS

Within the recent years, efforts toward establishing a system for managing the forest resources in Turkey have intensified. The modern and efficient way to manage forest resources is GIS and Turkish system needs to be transformed in that direction. For such a transformation, it is important to identify requirements carefully and carry out meticulous system design. It is also crucial to incorporate the time dimension into the system. Thus, it becomes possible to be made temporal analysis, which is very important for forestry technical applications. Such a system is also capable of making monetary and administrative inspection of these applications in a reliable and faster way. In this project, it was tried to show that it is possible to manipulate temporal changes in geographic objects. Because of all the mentioned reasons, the system that will be developed needs to include time dimension. Otherwise, it is most likely to correct mistakes done later on.

## 6. REFERENCES

- Peuguet, D.J., 2001. Making Space for Time: Issues In Space – Time Data Representation, *GeoInformatica* 5(1), pp. 11-32
- Renolen, A., 1997. Conceptual Modelling and Spatiotemporal Information Systems: How to Model Real World, ScanCBS'97  
<http://www.iko.unit.no/home/agnar/publications/ScanGIS97.ps> (accessed 17 July 2001).
- Faria, G., Medeiros, C.B., Nascimento, M.A., 1998. An Extensible Framework for Spatio-Temporal Database Applications, A Time Center Technical Report  
<http://www.cs.auc.dk/research/DP/tdb/TimeCenter/TimeCenterPublications/TR-27.pdf> (accessed 25 June 2001).
- Gorolwalla, I.A., Özsu, M.T., Szafron, D., 1997. A Framework for Temporal Data Models: Exploiting Object-Oriented Technology, *IEEE Proceedings of TOOLS*  
<http://www.cs.ualberta.ca/~duane/pdf/1997toolst.pdf> (accessed 18 September 2001).
- Tryfona, N., 1998. Modeling Phenomena in Spatiotemporal Databases: Desiderata and Solutions, Database and Expert Systems Applications, 9th International Conference, DEXA'98, Vienna, Austria, August 24-28, 1998, pp. 155-165.
- Langran, G., 1993. Time in Geographic Information Systems, Taylor&Francis, London-Washington, DC.
- Persson, R., Janz, K., 1997. Assessment and Monitoring of Forest and Tree Resources, *Proceedings of the IX World Forestry Congress*, 13-22 October 1997, Antalya, Vol. 1, pp. 17-31.