FOREST MANAGEMENT INFORMATION SYSTEM (FORMIS) AN APPLICATION OF GIS IN THE FORESTRY IN TURKEY

Assoc. Prof. Dr. Gönül Toz
Department of Photogrammetry, İstanbulTechnical University, İstanbul, Turkey

Assoc. Prof. Dr. Feyza Akyüz
Department of Photogrammetry, Istanbul University, İstanbul, Turkey

Msc. Eng. Hayati Taştan
General Command of Mapping, Ankara, Turkey

Abstract :

To make better decision, to improve productivity, to save time, money and man power in forest management activities, required are dynamic both locational and descriptive inventory data, rather geographic information. Conventional maps and forest inventories on papers are lack of meeting these requirements which are not static and subjected to change rapidlly. As for the Computer Aided Design/Drafting/Display (CAD) and Data Base Management (DBM) systems, their capabilities are confined in manupulation of locational or descriptive data, respectively. Meeting all the requirements in forest management activities, a GIS is the only system to be chosen, since it is able to manupulate locational and descriptive data as well as the relationships between them dynamicaly.

In this paper, GIS activities and Forestry in Turkey are briefly discussed and then terminology and theorytical concepts on GIS, Forest Management and the link between them are reviewed. An Example of a regional plot-based forest inventory (Forest serie of Büyükdüz in Turkey) integrated in a GIS, namely FORMIS (Forest Management Information System) (an application software written in Simple Macro Language of the PC Arc/Info software package) is also presented.

KEY WORDS : GIS, Forest, Managment, Information

1- Introduction

The importance of a GIS has not known widely in Turkey although some activietes in different agencies has already been initiated but not completed yet. On the other hand forest management activities in Turkey back to 1924 and has made considerable progress since then using aerial photographs and satelite imagery but not a GIS.

The primary aim of this study is to show up the importance of a GIS for forest management activities clarifying basic ad hoc aspects and to set up a pilot project on the design and implementation of a Forest Management Information system via a GIS software package.

Determining the problems which are likely to be encountered during the pilot project of a forest Management Information system with the purpose of taking necessary precautions in advance before getting started a project and making a contribution to the studies-espacially in application fields of GIS in Turkey are composing the secondary objectives of this study. Although the application software FORMIS is limited to some extent when all the activities in the forest management are taken into account, our startpoint was the belief that it is always preferable to begin with a small limited but functioning GIS than a large one which never works.

2- GIS Activities in Turkey

GIS activities in Turkey originally started as a pilot project to design a Multi Product Geogrophic Database in General Command of Mapping using the Structured Systems Analysis and Design Method (SSADM) in 1990 (Sarbanoğlu, 1990) but not completed yet. A GIS application software, namely AKBIS (Information system of Ayazağa Campus of the İstanbul Technical University) developed and implemented as a pilot project in 1991 (Taştan 1991) A City Information System project has been initiated for the İstanbul Municipality whereas all the City coverage in IGDS format have already been acquired using analytical stereo plotters. Although a number of universities (e.g. İstanbul-Technical University, Yıldız University, Middle East Technical University), public institutions (e.g. Istanbul Technical University), public institutions (e.g. General Command of Mapping, General Directorate of Land Register and Cadastre) and private agencies (e.g. ISLEM GIS Ltd. MNG Ltd.) are involved in GIS activities, there hasn't been any concrete cooperation yet.

3- Forest Management Activities in Turkey

According to the law issued in 1924, accepted is the principle to manage all the forest in Turkey by use of management plans. It is in 1946 that the forest management plans for Turkey were completed, being the base to the inventory and Statistics of the national forestry. Having been signed an agreement (in 1955) between the General Directorate of Forestry and General Command of Mapping authorized to take aerial photos in Turkey, forest management plans were made via combined inventory methods using 1: 20000 scale aerial photos and statistical techniques. Between 1963 and 1972 forest management plans covering all the forest areas (20 million hectares) in Turkey were completed and applicated. Between 1973 and 1989, applications and revisions of forest management plans were carried out for 11.135 million hectare forest areas. (Eraslan, 1971)

4- Teorotical Concepts on GIS, Forest Management And the link between them

4- 1- Definition of a GIS

A Geographic Information System (GIS) is a compound of geographic data, computer hardware software, personnel designed to collect, storage, manage, query, analize and present large volume of spatial data and associated attributes in order to allow the users to make better decision, to improve productivity, to save time, money and mon power (Altan, Toz, Can, Taştan 1991)

4- 2- Importance of a GIS
In general, the term data corresponds to descrete, recorded facts about phenomena from which people gain information about the real world. In context of geography, data may be considered, as data about geographic features such as roads, buildings, rivers etc, and phenomena, such as weather forecast, earthquackes, etc.Conventional maps provide a very effective graphic information of the geographic features, but they are not very useful for supporting data retrival. Data retrival on these maps is usually done by visual search, a process that is neither efficient nor reliable. Spatial analysis is even more dif- ficult. Even for simple application such as calculation the total area of the clearing in a forest, the amount of manual work involved is sometimes prohibitive.

4- 3- Sources of a GIS
The sources of a GIS may be (Taştan, 1991)
- Conventional maps
- Orthophoto-and photo maps
- digital maps
- aerial photos
- satellite images
- video images
- land observations
- cadastral records
-computer aided drawings
- database files
- text files

4- 4- Requirements of a GIS
A GIS is supposed to satisfy the following main requirements (Rondeux, 1991)
- ability to handle multilayered, heterogeneous data bases of spatialy-indexed data,
- ability to query the data bases about the location and properties of a range of spatial objects,
- efficiency in managing such as queries in an interactive mode,
-ability not to retrieve but also to create new information,
-flexibility in configuring the system in order to accomodate a variety of specific applications.

4- 5- Definition of forest Management
Forest management is the design and implementation of a set of actions in which stands are harvested, products are distributed, cutovers are renewed, and protection against insects, fire and disease is provided (Baskerville, 1986)
These activities are controlled in timing, amount and geographic space so that their cumulative effect generates a desired mix of benefits such as timber, recreation opportunity, etc. from the whole forest over time. The main objectives of the forest management are to
- find one schedule, i.e., design, that appears likely to produce the desired future forest development pattern and flow of benefits,
- implement that scheduil year-by-year,
-monitor forest performance periodicalyy to look for and remedy divergence between expected and actual outcomes (Jordan, Erdle, 1989)

4- 6- Application of GIS in forest management
In forest management activities, locational and descripte data as well as the relationships- between themare required. All of these data and relationships can be regarded as geographical information which are subjected to change dinamicaly. Traditionaly, locational data consist of covertype maps which define the location of all the forest's components such as series, compartments, working circles, felling blocks, sites, stands, utilization, classes, age classes and topography, as well; whereas descriptive data are composed of conventional inventory data which describe the physical conditions of these components such as the annual grawing stock and increment in a working circle, tree species in a stand class, etc. Neither conventional maps nor forest inventories are sufficient enough to supply locational and descriptive forest data. Updating of these maps and inventories is rother cumbersome and time consuming. Although some CAD and DBM systems are able to manupulate these type of data and solve problems to some extent, the relationship between these two different types of data can not be created. A GIS applicated in forest management seems to be an obvious choice, for it is able to manupulate locational and descriple data and the relationships between them, as well; even dynamicaly.

Contrary to common public perception, forest managment involves much more than harvesting and planting trees. Forecasting is a key ingredient in forest management design; cost effective linking (overtime and geographic space) of interventions is a key concern in forest management implementation; an accurate up-to-date log of stand intervention and growth responses is essential in monitoring cumulative forest performance. All require an up-to-date accurate present forest inventory. It is in these four aspects of forest management - inventory, design, implementation and monitoring - that GIS has the most to contribute. (Jordan, Erdle 1989) On the other hand the following main objectives of a GIS for Forest Management can not be overemphasized:
-to provide a geometric frame of reference,
-to document locational, qualitative and quantitative distributions of trees,
-to document all infrastructure for management and harvest (access roads, etc.) (Strobl, 1992)

5- Forest management Information system (FORMIS) as an application of GIS in the forestry in Turkey

FORMIS is a GIS application software for Forest Management activitites. It's written in simple macro language (SML) of the GIS software package PC ARC/INFO. FORMIS geographic data base consists of both locational data (manually digitized covertype maps of the forest serie Büyükdüz in Turkey) and related inventory data.

The FORMIS project has been organized into a series of logical steps, each of which builds upon the previous one as defined in the reference (ESRI, 1990) The first step was to build the database. At this step, the database was designed, locational data were input using a manual digitizer and editted, topology was created, descriptive data were input and finally some transformations were performed. While designing the database, determined was Forest serie as the study area and Gauss-Krüger coordinate system as the reference system. Geographic features, their descriptrive data (attiributes) and data layers required were identified as follow:
- compartments
- working circles
- felling blocks
- site classes

-stand classes
-Utilization classes
- Age classes
- Topography (roads -contrours)

Compartments are numbered from 1 through 76. There are two different working circles, namely working circle for Fir (coded with A) and working circle for Pine-Beech (coded with B), Wor king circle A consists of 5 Felling Blocks (A-1, A-2, A-3, A-4, A-5) and worcking circle B consists of 10 Felling Blocks (B-1, B-2,... B-10). There are 6 site classes in terms of quality) (e.g. site of 1 st quality) The sites of 5th and 6th qualities represent unproductive forest - coppice and clearing, respectively. 14 different stand classes stand for different combinations of tree species and their densities. Tree species in stands are black pine, scotch pine, pine, oak, fir and beech. Inventory data of stands are known as the annual grawing stock and increment in m3/hectare for each tree specie. Utilization classes are determined as felling area, clearing, reserved area, unproductive coppice, regeneration area and unploductive forest. Since there werent,enough information on age classes, this layer hasnt been used. Topographic information on this forest serie consists of roads and contour lines. All of the data layers but the topography are considered to be of poligon type. Roads and contours are of line type. At this first step all the covertype maps were manually digitiezed, editted and topology created. Decriptive data were added using pc ARC/INFO TABLES. Then all the layer were transformed from digitizing table coordinates into Gauss-Krüger coordinate system.

The second step of the FORMIS project was to perform polygon overlay operations in order to build geometrical relationships between diffirent polygon layers (e.g., compartments and stand classes, utilization classes and working circles, etc.)

At the third step the GIS application program FORMIS was written in simple macro language of the Arc/info software, in order to perform some analytical operations on the FORMIS geographic database. This application program is menudriven and has the basic capabilities of a GIS; namely drawing a map (composed or a new one), spatial query, statistics on a certain numeric attribute of a layer, zoom, deleting a map (see figure: 1)

At the fourth step, using application software FORMIS, maps were composed (see figure: 2) and reports were generated (see figure: 3). For example the answers to the following questions can be obtained in a short time using FORMIS although this is a difficult and time consuming task in case conventional maps and inventory data are used:
- what is the total area of the dearings in the forest ? (Result: a map and a report)
- What are the sites of 1st quality ? (Result: a mcp)
- What are total area of the working cirdes (Result: a mop and a report)
-What are the annual growing stock and increment in each stard classes for tree specie black pine ? (Result: a report)
- What is the annual growing stock and increment for working circle A ? (Result: a report)
- What is the total area of reserved areas ? (Result: a map and a report)
- What are the areas of each felling block ? (Result: a map und a report)

6- Conclusions :
Forest management activities handle with georelational, rather geographic data. Conventional maps and inventory data are not sufficient to meet all the forest management activities, if an optimization with parameters time, man power, money, productivity and envirunment protection are taken into account. While creating forest management plans, information required can be obtained from a forest management information system. Mapm and/ or reparts answering to custom queries covering defined forest area are to be created and presented, more accurately, more quickly, more rentable as compared with conventional methods. Thus, more realistic forest management plans can be prepared. Finally we want to conclude with Mr. Zonneveld's words: "The green dress of Mother Earth is alreadly severely damaged through the misuses of it. Her ever-increasing nakedness has already progressed so far that we, her children, should be ashamed of it (van Wijgarden, 1991)"

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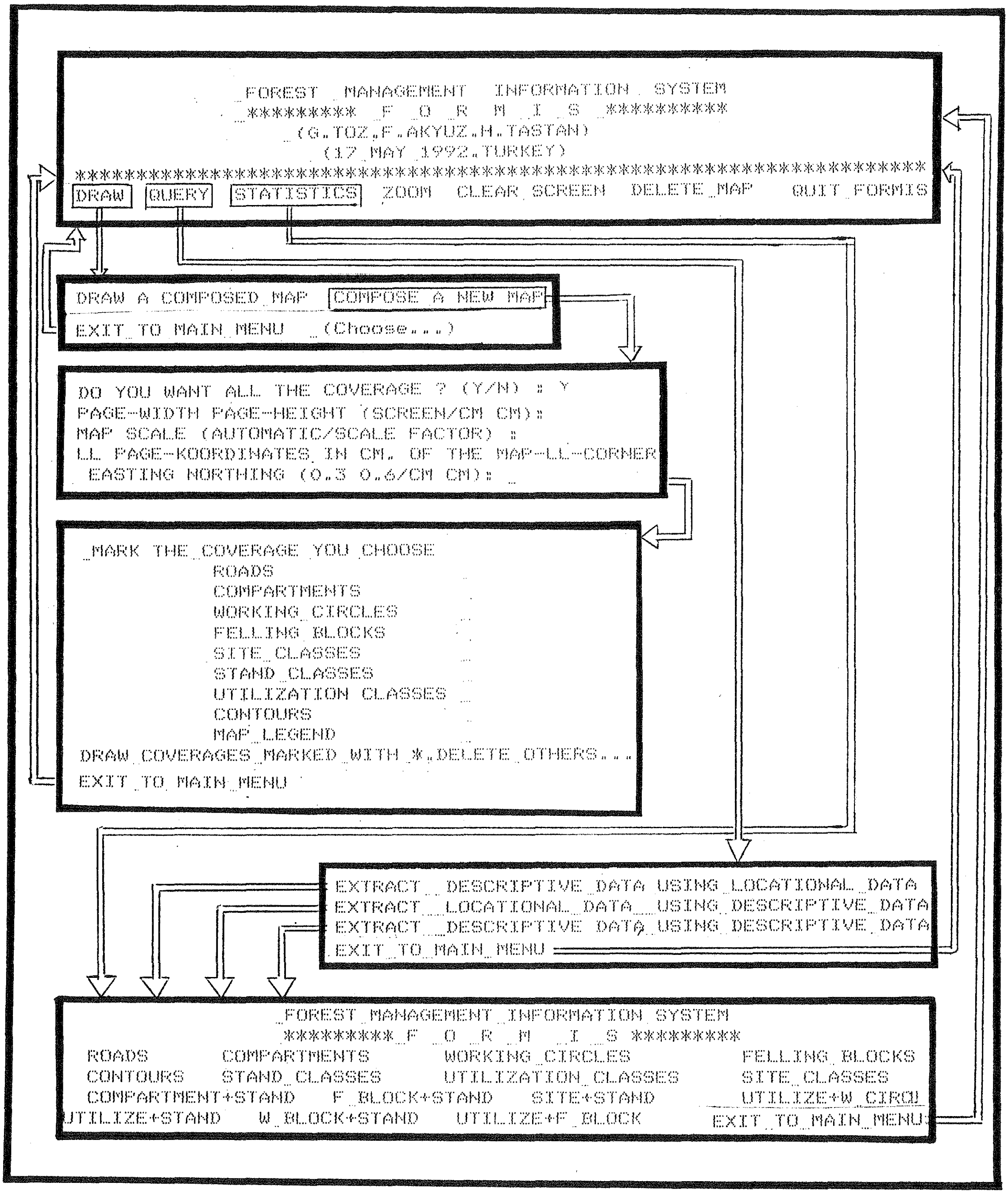
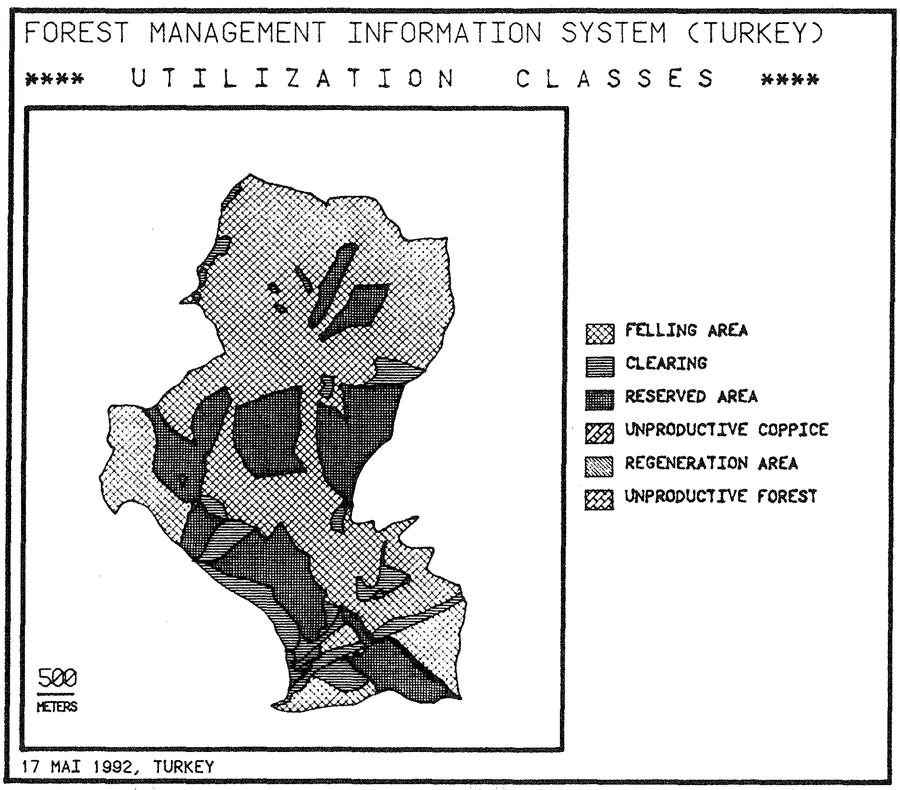


Figure: 1 Menudriven Application
Software FORMIS.



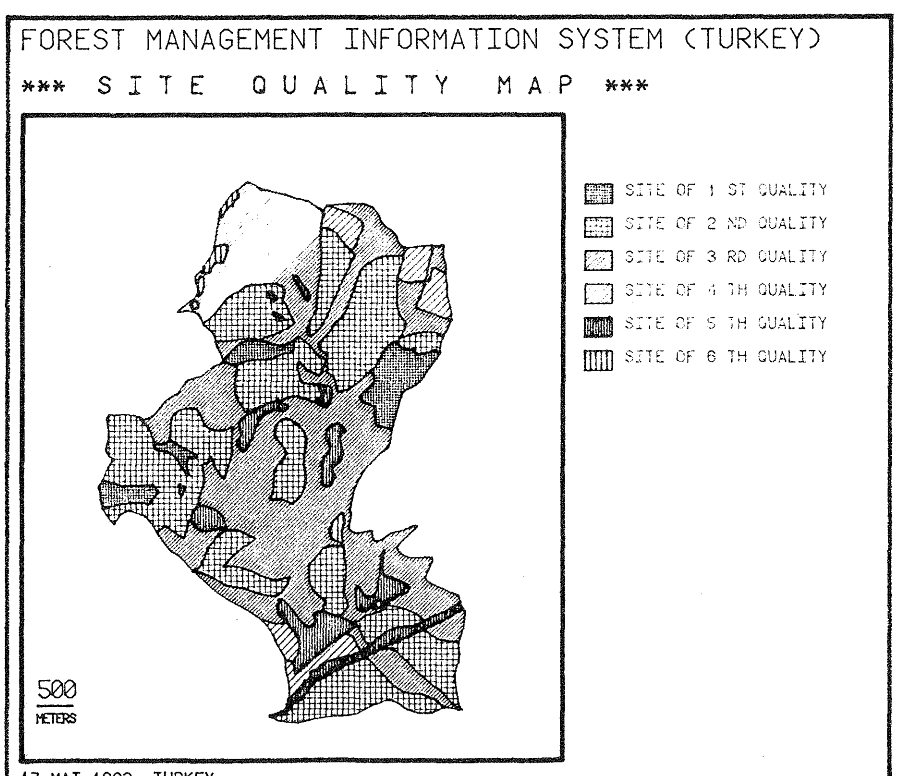
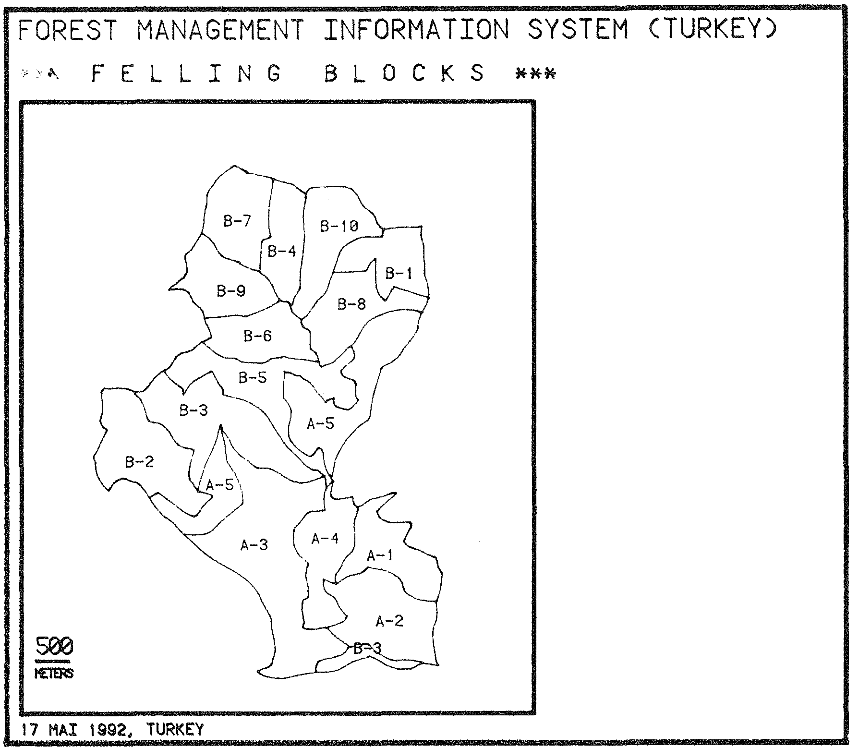


Figure:2 Some Maps created by FORMIS.



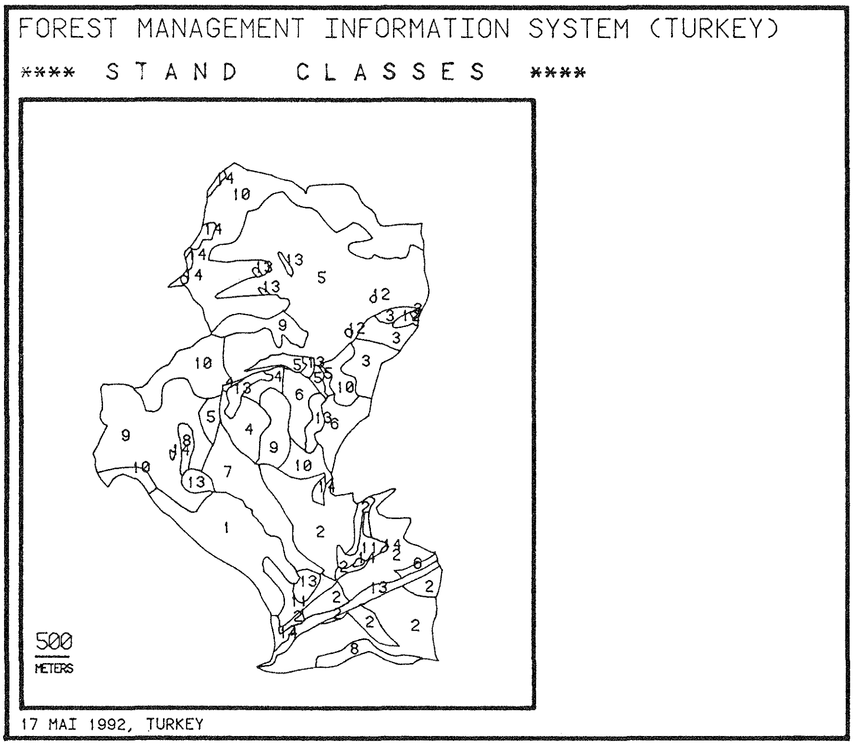


Figure: 2 Some Maps created by
FORMIS (cont).

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F O R M I S

INVENTORY OF GROWING STOCK
AND INCREAMENT

STAND CLASS	AREA (ha)	STOCK (m3/year)	INCREAMENT (m3/year)
14	1.457556	0	0
2	4.364238	1459	25
13	39.059700	0	0
2	15.589160	5220	94
13	14.318820	0	0
2	18.177050	6086	108
2	146.197100	48972	889
2	18.342430	6142	110
2	4.776831	1599	27
2	2.027438	677	10
14	8.190856	0	0
8	25.582900	8045	149
*** Total ***			
489	2374.691961	779190	14618

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F O R M I S

INVENTORY OF AREAS FOR FELLING BLOCKS

BLOCK	AREA (ha)
B-7	119.023900
B-4	92.630580
B-10	132.046000
B-1	96.060560
B-9	110.733900
B-8	126.899400
B-6	107.501100
A-5	182.943700
B-5	174.348100
B-3	205.605900
B-2	177.437600
A-5	79.926430
A-3	333.271500
A-4	124.382000
A-1	119.909600
A-2	166.183400
B-3	25.732890
*** Total ***	
	2374.636560

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F O R M I S

W O R K I N G   C I R C L E S

WORKING CIRCLE	TYPE	AREA (ha)
B	FIR	1342.287000
A	PINE_BEECH	182.943700
A	PINE_BEECH	823.672800
B	FIR	25.732890
*** Total ***		
		2374.636390

Figure: 3 Some Reports created by FORMIS.