BUILDING OF FOREST ROADS DATABASE BY GPS/GIS TECHNIQUES FOR TURKISH FORESTRY

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Abstract: *The forestry operations spread out 20.5 million ha area that much of them locate on mountainously region in Turkey. The optimal forest road length planned for these areas is 201080 km. Total of 132693 km forest roads (65.75 %) could be constructed up to 1998. These forest road networks plans should be revised according to new assessments on forest managing aims and new technological developments.*
There is a need detailed forest road database for revising of available forest road network plans and transportation planning. Global Position System (GPS) is powerful data collecting tool for building of forest road database point of view accuracy and economical aspects. Large amount of data can be collect in a short time. Data manipulation and integration of GPS data with other relevant data of forest road network can be effectively made by Geographical Information System (GIS).
The research site, Catak Forest District, is 19542.65 ha. Total 10241.72 ha of these areas is forest lands. 248.815 km forest road were inventoried by GPS "Trac Logging" options. Totally 183 waypoint were marked along the measured and mapped roads according to their importance point of view planning and construction priority.
As results of this research, a comprehensive forest road database built up for Turkish forestry. In investigated district, there were determined that total of 7.395 km forest road has wet road surface, 12.705 km forest road located on rocky terrain and 47 number of pipes and culverts should be constructed. The usage of GPS and GIS technologies is determined accurate, effective, fast and economical method for inventory of forest road.

1. Introduction

Forest roads are the most important infrastructure for forestry activities. Forest roads connect the forest lands to existing public roads. They provide forest access for such activities as managing timber, improving fish and wildlife habitat, fighting fires, and recreation.

The forestry operations spread out 20.5 million ha area that much of them locate on mountainously region in Turkey. 17 million m³ logs are transported on forest roads per year. Furthermore, they play an important role on other forestry practices such as forest protection, forest cadastre, tending, erosion control and plantation.

General Directorate of Forests started the studies of systematic forest road network planning in 1964 and completed them in 1974. In these studies, only the productive forest area took into account and total road length planned as 144425 km. In recent years, the improvement of forestry techniques, the wants of rational forestry and the results guided after the application of the plans.

According to the new plans total road length is planned as 201810 km. At the end of the year 1998 the 65.75 % of this, 132693 km is constructed (Acar and Gumus, 2000).

Planning of forest road network are done on 1/25000 topographic maps and using information on same scale stand maps, and the plans are finalized by field checking. However, these maps do not posess adequate information for proper planning. This results in construction of overcostly and improper roads that are short lived.

These is not any complete inventory of 132693 km of forest roads completed in our country. Existing forest roads are inadequate in the face of changing forestry policies and usage goals. Roads that are planned and constructed for transporting only primary and secondary forest products are inadequate today's forestry activities. Thus, new planning is unavoidable.

Developments in computer and software technology since early 1990's have enabled an efficient use of information systems. These developments are also reflected in planning forest roads. Especially in recent years, use of GIS and GPS systems in planning and data collecting have gained a lot of momentum. Studies have been started to collect data on forest roads and efficient use of these data in databases (Harrington, 1999; Milligan and Davis, 2000; O'Brien, 2000; Macdonald and O'Brien, 2000; Fernández, 2001; Skally, 2001).

This study was carried out to develop an inventory method of existing forest roads, which is very important in Turkish forestry and planning according to developing needs. The goals of this study are; (1) to determine exact quality and quantity of existing roads establishment of road information system using GIS and GPS integration, and (2) to prepare information, collected on existing roads using GPS and constructed non-graphic and graphic GIS data base, for forest network and transportation planning.

2. Material and Method

2.1. Material

Research are is located in Çatak Forest Disctric, Maçka Forest Enterprise ($40^{o}\ 50^{'}\ 00^{''}$ N and $39^{o}\ 19^{'}\ 36^{''}$ E) (Figure 1). Catak Forestry District has two planning series; KTU Research Forest and Catak.

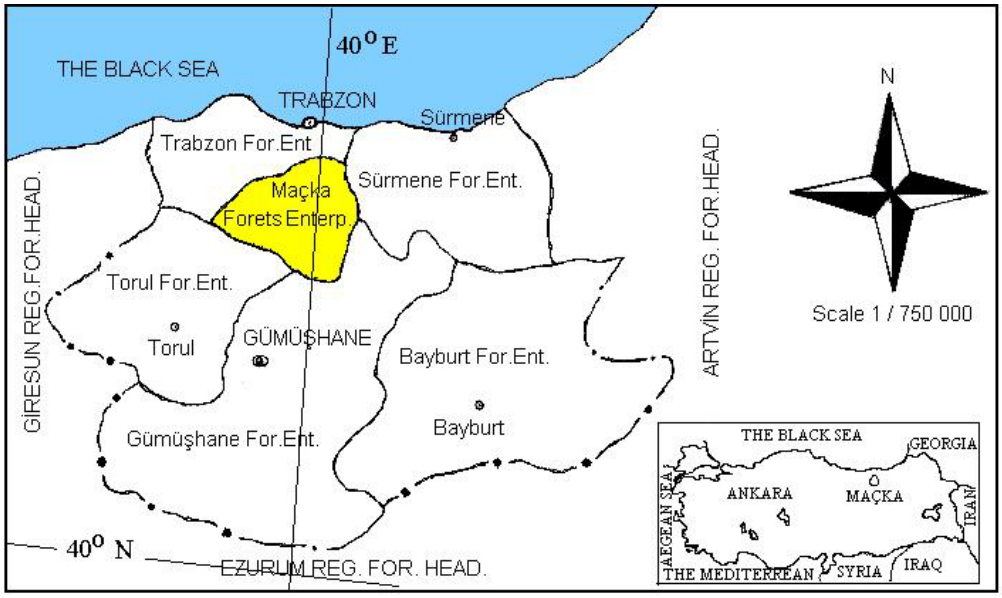

Figure 1: Geographical location of research area

Data were collected using Garmin III Plus GPS receiver and a laptop computer in the field. Locations deemed necessary were photographed using a Fuji FinePix A202 digital camera. Width and slope of existing roads were measured using a 20 m tape and clinometer.

ArcInfo 8.0 and ArcView 3.2a ESRI software packages were utilized in data analyses. GIS work was carried out in KTU GIS Research and Development Laboratory.

2.2. Method

Prior to field data collection, in order to determine topographic features of the study area, 1/25000 topographic map of the study area was digitized and made ready to be used in GIS environment. Digitization was performed partly automatically and partly manually by recording non-graphical data to the data base.

The prepared based map was taken to the field and quality and quantity of existing forest roads were evaluated with respect to how this base map would serve the road network planning and forestry activities. All existing roads were inventoried. For data collection and recording Table 1 (after the References) was developed in GPS.

Perfect routes of existing roads were obtained using GPS receiver's track logging mode at every 10 m. Locations and quality of existing forest roads and hydraulic constructions were recorded using Waypoint mode (Yoshimura vd., 2002). These measurements were conducted using Garmin III Plus GPS receiver and a laptop computer (Figure 2). In all these measurements and recordings vehicle's average speed was 30 km/h.

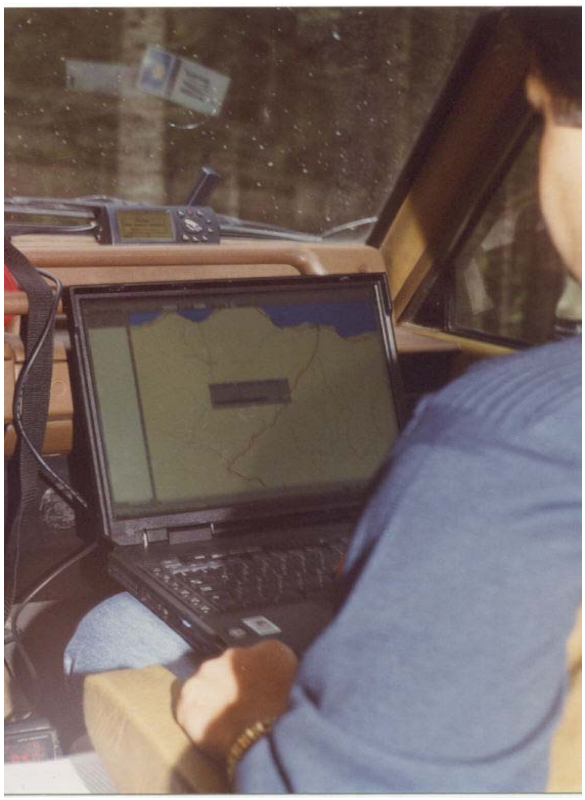

Figure 2: The data collection system made up of a GPS receiver and a laptop computer during the field work

Determined features were recorded on the table according to the WayPoint number and coordinates were recorded in the GPS receiver. Data (.DXF format) were transferred to ArcView software (converted to .SHP format). Road paths and positive and negative cardinal point information were constructed in GIS database.

3. Results

Topography is very important for forest roads. The research area generally has a steep topography. Slopes were often cut by creeks and dry creek beds (Figure 3).

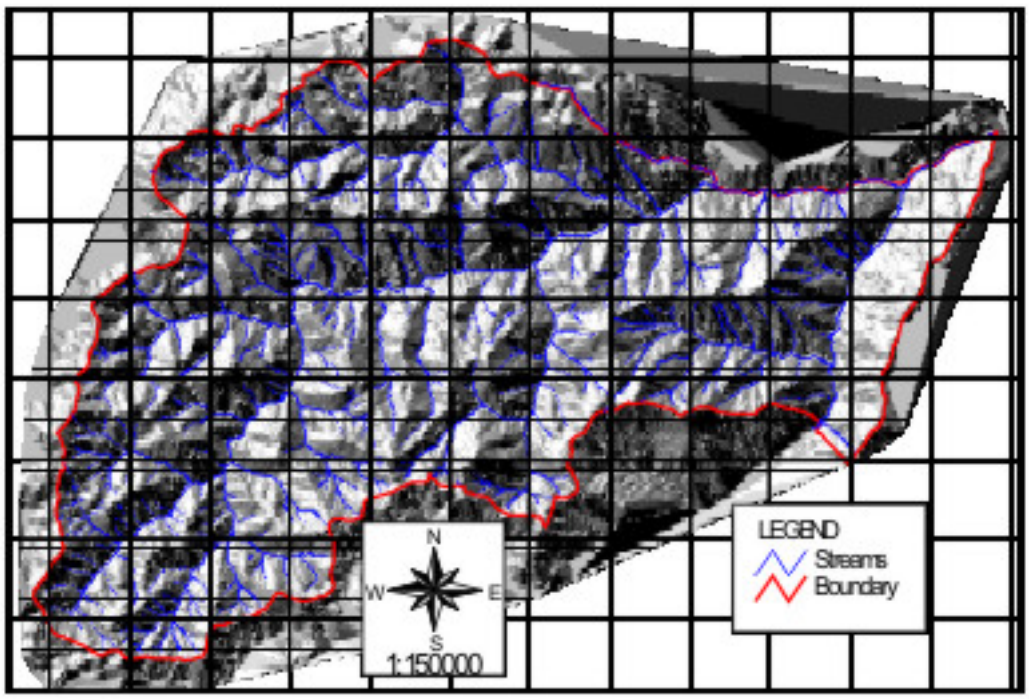

Figure 3: Research area digital terrain model

Total of three slope classes (0-45 % first group, 46-70 % second group and 71 + % third group) were produced on digital terrain model. These values were obtained from Bayoglu (1969).

The research area is 19553.76 and 10508 ha (53.75%) is classified as the first slope class, 7356.98 ha (% 37.62) as the second class and 1688.78 ha (% 8.63) as the third slope class.

Total forested area in the planning unit is 10241.72 ha and most of these are located on slopes steeper than 45 %.

Total length of the road network is 248.815 km. Of this total length 9.626 km is a part of Trabzon – Gumushane states highway and 6.980 km is being constructed by General Directorate of Village Service of Turkey Republic. Total length of forest roads in the research area is 232.209 km (Figure 4).

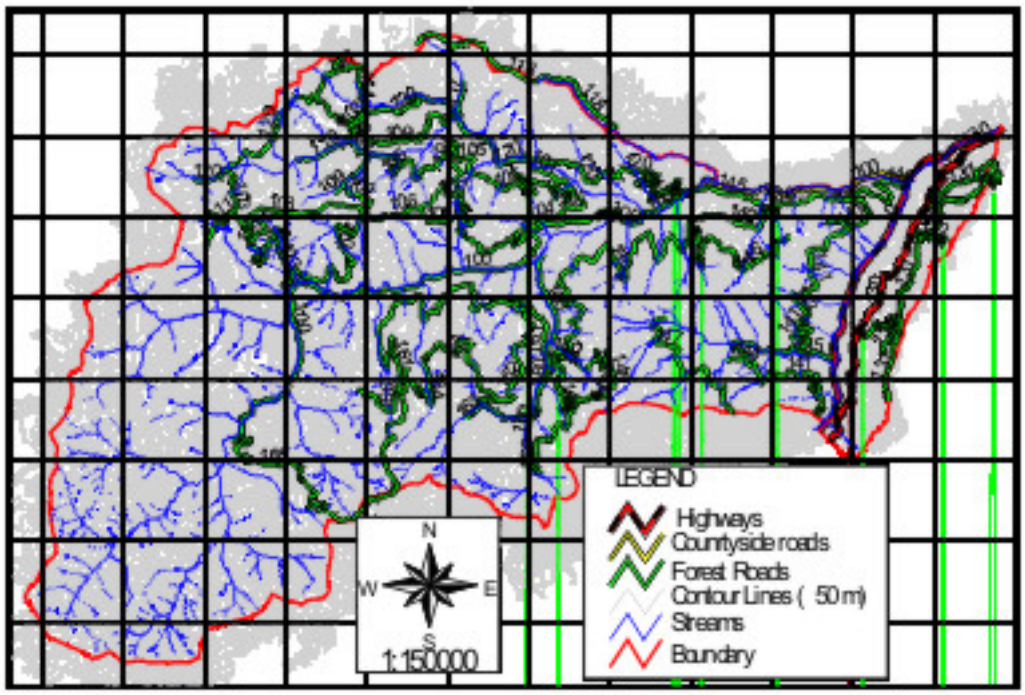

Figure 4: Research area forest road network plan

Of the existing roads, 43.41 km has a longitudinal slope greater than 10 % and 15.505 km has a slope greater than 12 %. These roads are Type B forest roads and their slope values do not meet the standards.

Thus, these sections require significant repairs. Road density value is 22.67 m/ha. 52.47 % of the roads are located on side slopes greater than 70 %.

Slope limits and road surface standards of most of the existing roads are found to be suitable for forestry transportation (Figure 5).

Figure 5: Available forest road suitable for technical standards

Totally 183 waypoint were marked along the measured and mapped roads according to their importance point of view planning and construction priority.

In investigated district, there were determined that total of 7.395 km forest road has wet road surface, 12.705 km forest road located on rocky terrain and 47 number of pipes and culverts should be constructed.

4. Recommendations

The usage of GPS and GIS technologies is determined accurate, effective, fast and economical method for inventory of forest road. Forest roads database could be use for road network and transportation planning. Furthermore forest road network planning should be made according to road functions.

5. References

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Table 1: Forest Road Inventory Forms for GPS Receivers

Catak Forest District Available Forest Road Inventory Information																				
Observation date: …… /…. / 2002																				
Garmin GPS III Plus																				
Waypoint Number	Forest Roads						Hydraulic Constructions								Route Evaluation					
							Available				Recommended									
	Code	Slope	Up.Con	Width	Cros.	R. Bend	Bridge	Culv.	Pipe	Hamp	Bridge	Curves	Pipes	Hamp	H. Side Slope	H. Cut Slope	Wet Sur.	Roky Terrain	Pure Surface	Settling Areas
1																				
2																				
3																				
4																				
:																				
:																				

Up. Con. : Upper Construction
Cros. : Crossroad
R. Bend : Road Bend
Culv. : Culverts
H. Side Slope : High Side Slope
H. Cut Slope : High Cut Slope
Wet Sur.: Wet Road Surface