MANAGEMENT AND IMPROVEMENT OF A FOREST ROAD NETWORK

Vasileios C. Drosos and Chrisovalantis Malesios

Abstract

The road network of the public forest complex "Smixi-Avdella-Perivoli", which was constructed in the last 40 years, has served the management of this forest. Thus, gradually a satisfactory level for the forest operations timing and efficiency had been achieved. Due to technical and economical aspects that were prevailed at each era the construction of individual roads differs from the regular geometric standards. Yet the frequent use in conjunction with weather conditions have caused some damage to forest roads, creating passability problems, especially during the winter months. Overall, despite shortages in technical works and the poor condition of road, most roads are pretty good traced and cross woodlands with magnificent landscapes. This paper deals with the presentation of the existing road conditions and with the improvement of the road net and skidding conditions of the timber, in order to meet the modern needs of the forest exploitation.

Key words: *Management; improvement; forest road network.*

INTRODUCTION

From the moment that we can exploit it, a forest can be easily converted from a natural treasure to a financial source. Forest's exploitation occurs in times by the means and methods we have at our disposal; and we exploit it so as to serve purposes according to the needs of times.

The first human beings used forests as a source that gave them fuel, food, accommodation, water etc. As the years went by stone tools were replaced by metal ones and thus the industry revolution begun and with it the construction of forest roads and forest works which had as a result the rise of productivity in both soil and material works. The potential that is offered by the use of modern digging machines apart from precious help, caused problem s in the balance of the forest habitat (Giannoulas, 2001).

The opening-up of a forest area occurred some years ago with only financial and technical criteria! But since 1980 environmental criteria that aim to the most beneficial way of constructing forest roads have been applied.

Forest opening-up is the total number of installations and works whose goals are:

1. The access to isolated forests areas.
2. The transport of staff, means, materials and machineries that are meant for exploitation, cultivation and protection of forest.

3. The skidding, move and transport of wood from stump landing area to consumption and elaboration areas.

This was the definition of opening up some years ago. Nowadays we have to add the circulation of visitors and travellers in the forest. The opening-up must satisfy, the following demands:

1. The access to every stand and department of forest.
2. The transport of means (machineries, tools, materials), which are used for exploitation of forest as well as for construction of technical works, control of torrents, utilization of mountainous pasture and areas and construction and function works of development and culture.
3. The extraction of products especially wood and their transportation from stump landing area to consumption and elaboration areas.
4. The approach of labourers in areas where forest works takes place.
5. The transport of staff who deal with the protection and supervision of the forest.
6. The gathering and elaboration of wood to forest road (allocation of areas where the wood is gathered).
7. The exploitation of forest in functions which are mentioned to tourism and recreation as well as agricultural exploitation of the land found into forest areas.
8. Space order and division of forest in frame of forestry plan.
9. The aquatic economy.
10. The public transportation of people who live in mountainous areas.
11. The defence of the country.

The above demands from the opening-up have as a goal the economical development of an area.

It also concluded that any logging is needed to construct road network to meet the technical and financial requirements associated with the optimum opening up of the forest and allow for smooth, fast and comfortable transportation of timber, personnel, equipment and materials in the forest.

This paper deals with the presentation of the existing road conditions and with the improvement of the road net and skidding conditions of the timber, in order to meet the modern needs of the forest exploitation.

The purpose will allow:

1. Rational opening of the forest based on the principles of economy, sustainability, protection of the stands and the use of appropriate means and methods for fast, easy and satisfactory in all respect skidding of the timber.
2. Reducing the costs of skidding, construction and maintenance of the forest roads network.
3. Future improvements to the surface of forest roads with the construction of robust and economic superstructure.
4. Further mechanization of skidding and transportation of the timber, because the number of forest workers goes continuously decreasing.
5. The tourist development of the area, in which with the varied and very beautiful landscapes for recreation and the creation of suitable facilities for winter sports (skiing, etc.) will increase the already existing tourism potential in the region.

MATERIALS AND METHODS

The under study forest area is included between geographical coordinates -2°29′30′′ and 2°45′18′′ longitude from the meridian of Athens and the parallel 39°49′40′′ and 40°03′20′′ latitude. The total area is 16,095.24 ha without the valley of Vallia Calda (warm valley in the Vlach language), which is part of Pindos National Park and 20.154,64 ha with this one (Table 1). The public forest complex of "Perivoli - Avdella - Smixi" lies in the northwest corner of Western Macedonia on mountainous complex of Pindos (Figure 1). The region clad in pine, beech and Bosnian pine trees. The main forest species of the complex are: black pine (*Pinus nigra var. pallasiana* and *Pinus nigra var. austriaca*), Bosnian pine tree (*Pinus heldreichii*), beech (*Fagus silvatica*), fir (*Abies borisii regis*), oak (*Quercus sessiliflora*), hornbeam (*Alnus glutinosa*), maple (*Acer pseudopla*tanus and *Acer platanoides*), ash (*Fraxinus ornus*), poplar (*Populus tremula*), the rarer European yew (*Taxus baccata*), Europian hooly (*Illex aquifolium*), cendar etc. Its cheerful, hospitable inhabitants pride themselves on their rich history and tradition and their significant contributions to the national causes. The region has height above the sea level that ranges from 700 m (Ampelia Periboliou) to 2249 m (Basilitsa). The slopes are intense and exceed the 45%. Basic rocks of the area are the basically igneous rocks. The climate is continental of the Mediterranean regions of Europe, characterized by bitter cold and a lot of snow in the winter and dryness in summer.

Table 1. Land uses of forest complex of Smixi – Avdella - Perivoli

Land uses	Perivoli (Ha)	Avdella (Ha)	Smixi (Ha)	Total (Ha)	Percentage (%)
a. Forested areas	5,857.04	1,433.62	869.50	8,160.16	**50.70**
b. Partly wooded areas	1,841.62	511.00	270.40	2,623.02	**16.30**
c. Bare lands	1,680.19	2,112.41	1,020.6	4,813.20	**29.91**
d. Fields, arboricultural crops and settlements	28.50	33.10	25.00	86.60	**0.53**
e. Barren lands	257.69	96.77	57.80	412.26	**2.56**
PARTIAL TOTAL	9,665.04	4,186.90	2,243.30	16,095.24	**100.00**
f. Vallia Calda	4,058.90	-	-	4,058.90	-
Total	**13,723.94**	**4,186.90**	**2,243.3**	**20,154.14**	**100.00**

Methodology

For the investigation and the achievement of the research goals that lay down within the scope of this paper were used:

Reliable measurements regarding to the accurate estimate of the area for each land use and the length of the existing forest road network make possible due to the digitization from the silvicultural map of the complex (Figure 2). Then, the creation of the digital terrain models DTM of the area in 3D form and the representation of the forest road network were followed.

The last management plan of the forest from which we utilized factors such as harvesting, management form, the already existing forest species, tree age etc.

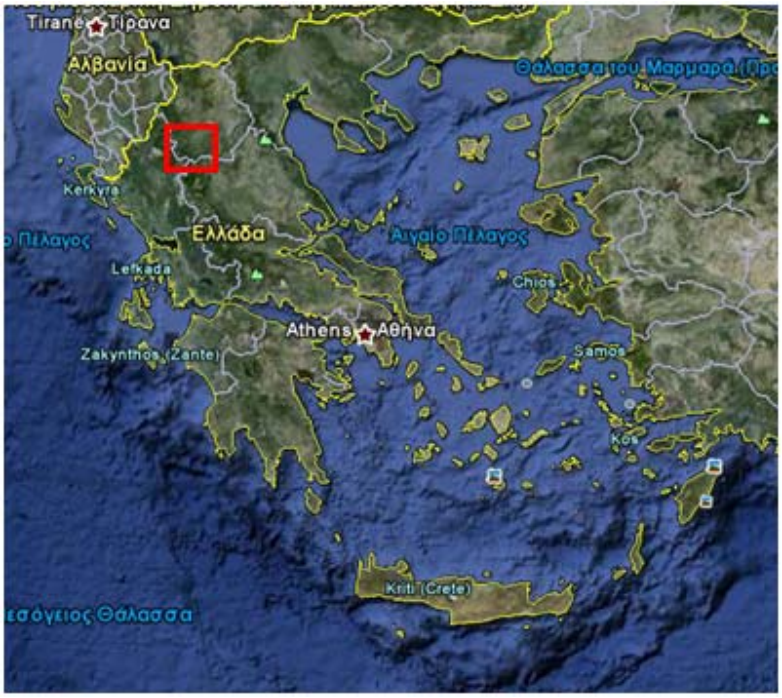

Figure 1. Research area.

To describe the situation that exists in this forest complex in terms of road development methodology of Segebaden (1964) was applied. The calculation of the optimum road density, through the variables affecting it, based on basic and classic views of Stergiadis (1971, 1973 and 1977), Kroth (1973) and Abegg (1978).

Calculations of optimum road density based mainly on model calculations of Kroth (1973). Followed the comparison of the existing road density D_{ex} with the optimum theoretical D_{th} and the optimum economical road density D_{ec} and the D_{max} one.

Data of forest complex are the following:

1. Harvesting 3.56 m^3/year/hectare.
2. Road construction cost 27.44 €/m.
3. Road maintenance cost 0.17 €/m.
4. Fixed skidding costs 5.35 €/m^3.
5. Variable skidding costs 0.85 €/m.
6. Years of depreciation: 30 years
7. Interest rate: 3%.
8. Network correction factor (Segebaden, 1964) c_{net} = 1.3275.

9. Factor of sinuosity (Segebaden, 1964), Mean skidding distance correction factor c_{offr} = 1.98.

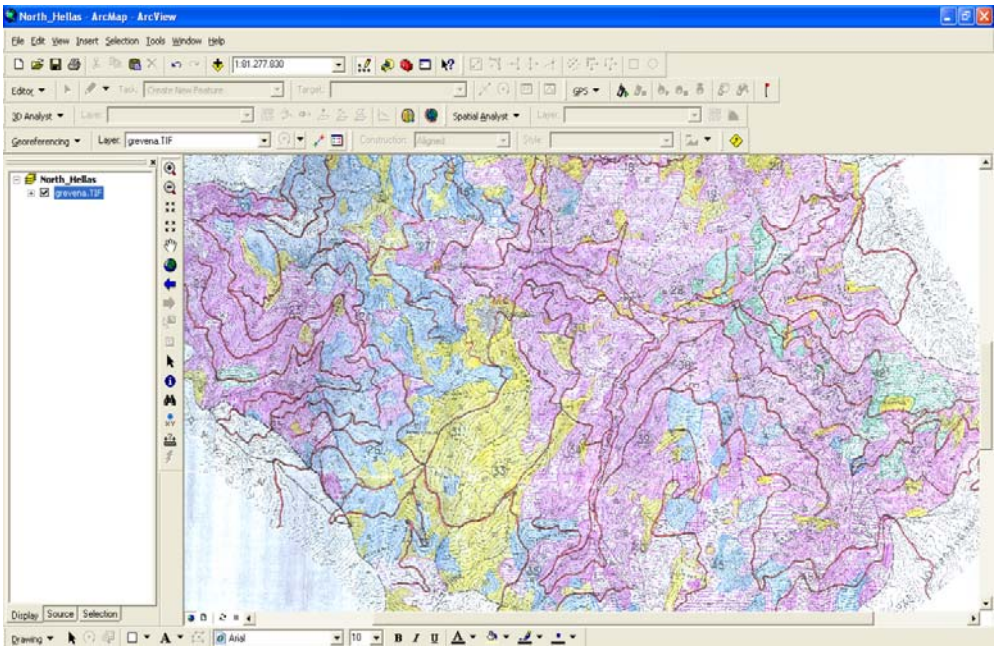

Figure 2. Silvicultural map of the complex.

RESULTS – DISCUSSION

In figures 3 and 4 we have the DTM of the area in 3D form and the representation of the forest road network from the ArcMap.

The data analysis of figure 5 gives the optimum theoretical (D_{th}) and optimum economical (D_{ec}) road density for the under study forest complex that are 20.72 and 25.98 meters per hectare respectively. D_{max} is 65.88 meters per hectare.

The theoretical optimum road density is lower than the existing road density (D_{ex}), which is 25.424 meters per hectare, but the economical optimum road density is a little bit higher. If we accept the social and protective role of forests and roads, except transportation of timber, it serves all other functions of the forest then we can accept the size of the existing road density with some improvements where they need and maybe we must construct a few kilometres of tractor roads in order to help the logging process with tractors because we have lack of animals and specialized forest workers.

These elements and their combination are compound, complicated and demand the use of GIS (**G**eographical **I**nformation **S**ystem) and DEM (**D**igital **E**levation **M**odel), so as to be evaluated and co-estimated for the best economical and technical solution including the environmental cost. The potential offered by personal computers can help on the proper

evaluation of environmental impacts and the control of compatibility with the environment before the project is carried out on the screen of the PC.

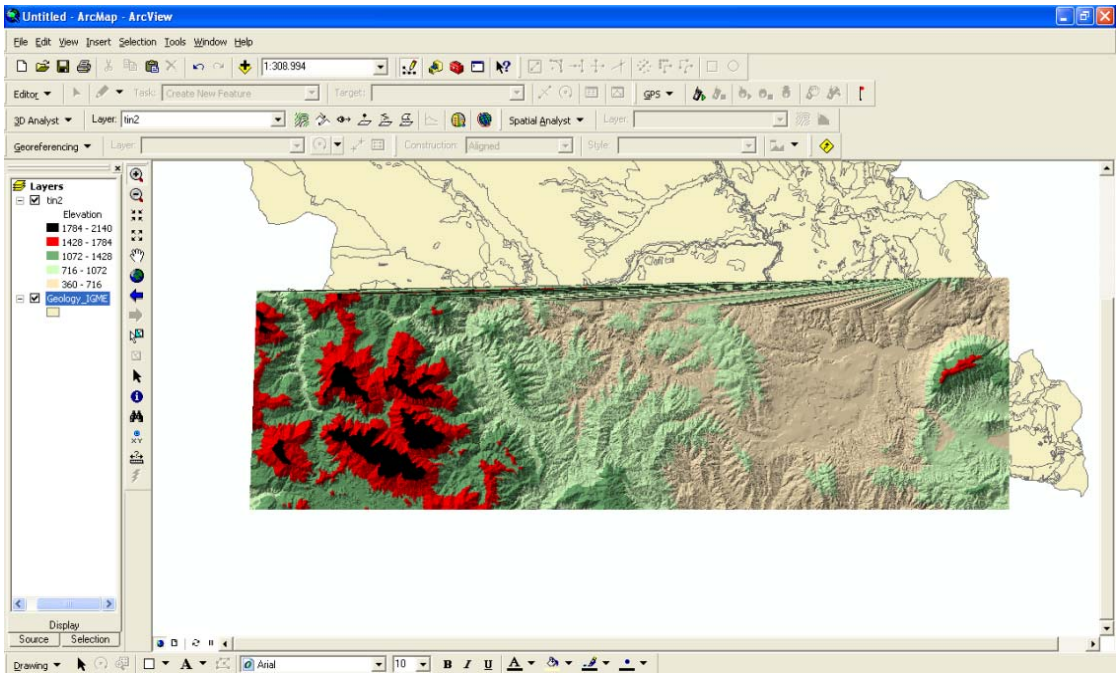

Figure 3. DTM of the area.

CONCLUSIONS

Based on the research we conclude:

GIS techniques should be used nowadays because it fast, easy and show satisfying results for road allocation through the implementation of the procedure defined above. In fact, forest road network map can be used in assessing forest opening up, costs of road construction and maintenance and other factors related to forest operations such as silviculture operation.

The road opening up has been quantified in the forest complex but should be pursued and the qualitative improvement of road net due to the construction of sub grade, since almost 56% of the roads are dirt roads.

It is proposed to improve passability of forest road network in length 288,800 km in order to create the suitable conditions to tackle natural disasters and forest fires in the Public forest of "Perivoliou - Avdellas - Smixis" for the year 2011 with total cost 168,500.00 €.

The construction of pavement for forest roads will lead to improved passability of the roads, resulting in one hand the road network to be operational for longer period with a view to transport the wood and other terms, except dryness term and on the other hand forest road net to suffer less damages and require less maintenance.

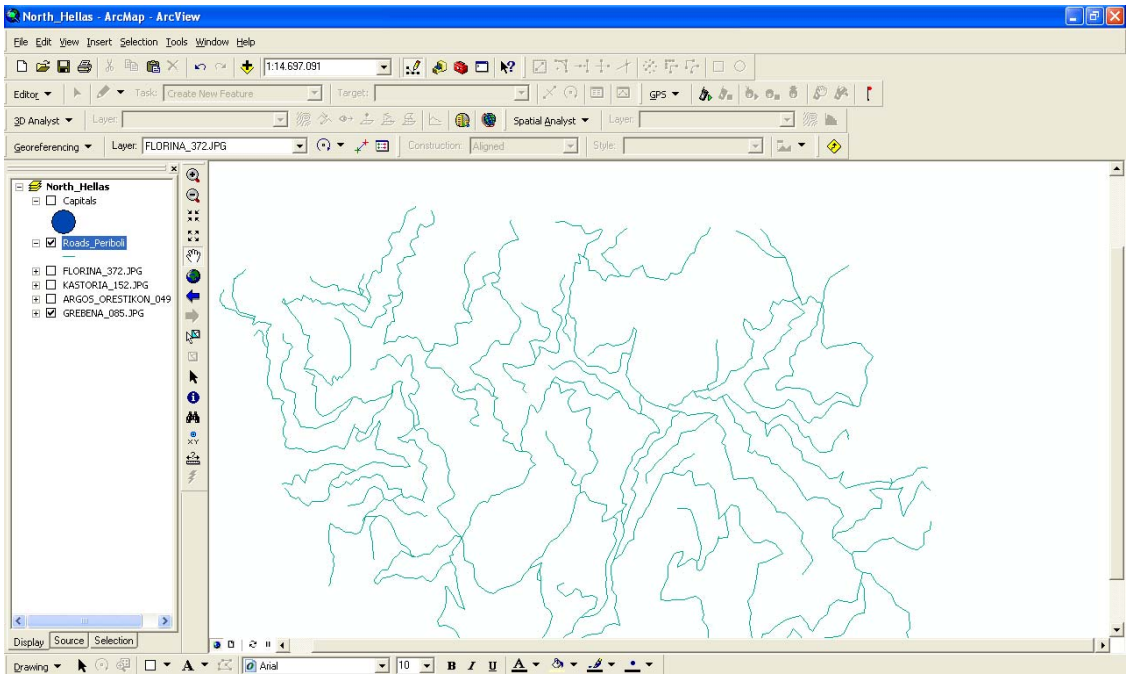

Figure 4. Forest road network of the complex.

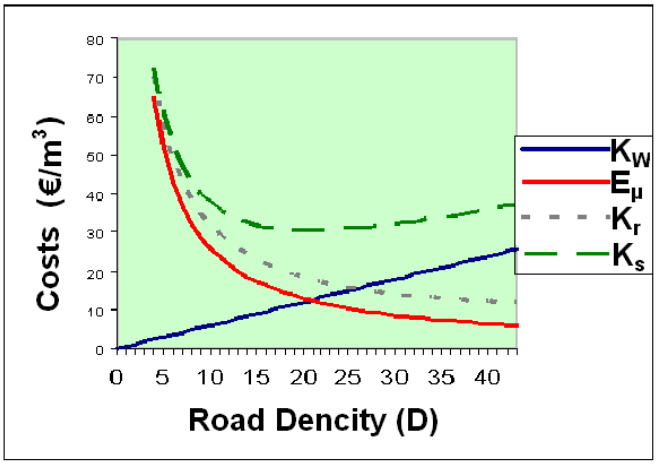

Figure 5. Calculation of the optimum road density for the complex.

3. The holding of the skidding by modern means and new methods, according to both the forestry efforts, as well as the technical requirements.

4. The creation for both the skidding and for the transportation of timber very favourable conditions from technical, environmental and economical point of view, which substantially affect the extent and intensity of forestry operations.

5. The favourable movement of forest workers for better utilization, better supervision and better protection of the forest.

6. The easy transporting of materials and equipment for holding forestry field operations.

7. It will contribute to the sustainable tourism because there are traditional villages with stone bridges, examples of traditional architecture that stand unscathed by time; to wander through the unparalleled beauty of the unique ecosystem of Vallia Calda National Park; to enjoy the snow at Vasilitsa, one of the most modern ski resort in Europe, and experience the thrill of rafting down the Aliakmonas and Venetikos rivers.

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