Geographic Information System(GIS) and Roadeng Usage to Determine the Environmentally Sensitive Forest Road Route in Mountainous Terrain

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Abstract

Road between two known points and placing the various economic and environmental factors that require consideration is a highly complex engineering problems. Engineers, soil conservation and water resources, taking into account the total road construction, maintenance and handling cost is the lowest of the route is difficult to determine. Forest road construction and maintenance costs of raw wood is a significant proportion of the total cost of production. Of forest road network planning, forest villages transportation, production work, social needs, providing transportation to the recreation area, depending on the functional use of forests that are made according to the purpose. In this study, by using GIS and Roadeng Technology planning forest road network planning was make zero line, curve, longitudinal profiles, cross sections, such as the amount of excavation and filling all the planning criteria are determined. Roadeng of software for planning of forest roads; surveillance, compliance of the terrain and the location of the module were investigated. Look at the slope of the land and river maps with GIS software has been created.Roadeng numerical software made its way forest we have done with classical methods and technical processes are automatically offers more detailed and more quickly practitioners do on computers.

Keywords: *Forest road network, forest road planning, Roadeng, GIS, Environmentally Sensitive*

Introduction

Forest roads play an important role in forest management, transportation of wood raw material protection and afforestation activities in mountainous areas. Incorporating the consideration of technical and environmental issues into manual road planning is a difficult job. Manual road planning in mountainous forests, considering technical and environmental issues, is a difficult job. More recently, simultaneous information management with respect to the important factors in road planning and rapid assessment of the roads has been possible by using GIS capabilities Naghdi, et al., (2009); Pentek, et al., (2005); Gumus, et al., (2007).

Previous studies developed forest road networks via manual methods, while in the last few years computer software and hardware have been used extensively and effectively for solving complex problems in forest areas, especially in developed countries (Akay 2003; Rogers 2005; Demir 2007). Today, concepts such as digital map, GIS and land information systems have gained importance in the design of road networks (Akay, 2003; Aruga, 2005; Gümüş, 2008; Çalışkan, 2013). In Turkey, forest roads are divided into three main categories such as primary forest roads, secondary forest roads (Type A and Type B secondary forest roads) and tractor roads. The geometric standards of all types of forest roads are given in Table 1. Each category of forest roads is determined depending on the objective of construction, traffic density, the amount of the load to be transported, tonnages of trucks in accordance with the Communique No. 292 by General Directorate of Forests. As well, the processof forest road planning is conducted according to this communique.

Table 1.Geometrical standards of all types forest roads (GDF, 2008).

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Road features	Unit	Main forest roads	Secondary forest roads				Tractor roads
			A - Type	B – Type			
				HBT	NBT	EBT	
Platform width	m	7	6	5	4	3	3.5
Number of road line	Number	2	1	1	1	1	1
Roadway width	m	3	3	3	3	3	3
Maximum longitudinal slope	%	8	10	9	12	12	20
Minimum vertical curve diameter	m	50	35	20	12	8	8
Shoulder width	m	0.50	0.50	0.50	0.50	0.50	
Ditch width	m	1.00	1.00	1.00	1.00	0.50	
Superstructure width	m	6	5	4	3	3	
Bridge width	m	7+(2 x 0.6)	6+(2 x 0.6)	5+(2 x 0.6)		4+(2 x 0.6)	

HBT: High standard B type forest road, NBT: Normal B type forest road, EBT: Extreme B type forest road

The aim of this study, by using GIS and Roadeng Technology planning forest road network planning was make zero line, curve, longitudinal profiles, cross sections, such as the amount of excavation and filling all the planning criteria are determined.

Material and Method

Research Area

The study area, Turkey, Artvin Regional Directorate of Forestry, Forest Management Directorate of Artvin Merkez, Artvin Central Planning Unit, covers an area of 5113.1 hectares. According to the current total area of 4279.21 ha of forest management plan data research with 5224.71 ha of forests, 945.5 hectares were deforested areas while. The total length of forest roads in the study area 93 km. 1 km. forest roads are planned. forest roads forest roads in the study area is B-type standards.

Method

During the field work, with the help of GPS and topographic maps of the study area were visited existing forest roads. GPS track log opened in all available ways of coordinate values (x, y, z values included) and is stored in the GPS memory length measurement. Meanwhile, the road planning in the current path of those who need art structure, superstructure, major repairs, ditches, road expansion and lase-curve expansion of all jobs in the beginning and ending point of land to be like (at the point of application of art works) made the point recording with GPS amount of work, and to do coordinated work place have been determined.Still in need during office work as well as working with numerical pad with ready computer in the car in the field are monitored all the time, the land must be planned simultaneously new ways and places have been identified on topographic maps.

Digital Terrain Model (SAM) was created. After terrain model created is defined horizontal route of forest road. At this stage, implemented in Turkey "Forest Roads Planning Construction and Maintenance" No. 292 from normal B-Type Secondary notification of specified types of forest road geometric standards of forest roads are used. In that field, lakes, streams and rivers in digitized geographic information systems was made available to the database queries made into layers.

In the planning stages of forest roads Location module is used. After determining the route will pass on the road map, cross sections related to road, profile-all excavation work, such as determination of the amount of padding made, respectively, and has been demonstrated literally a forest road project.

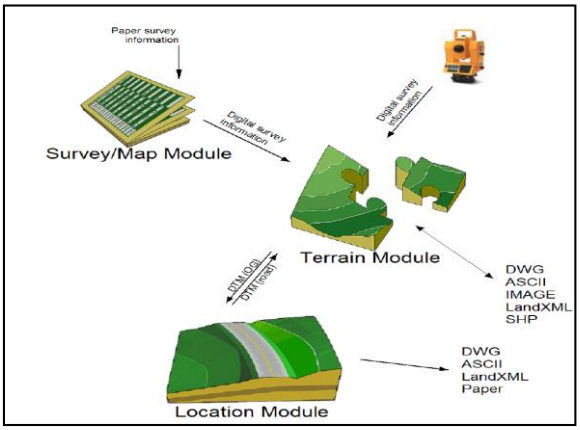

Figure 1. Roadeng Software Module

Result and Discussion

In computer, digital creation of a terrain model, the area is better known to and forest road projects in important tilt-bond slope due to issues such as and bond analysis was conducted for the most important element slope which increases the cost of construction of forest roads. In case of increase or decrease of the slope excavation and filling than changes in the volume and reduce the cost of this increase. The total length of the route to be planned is 1000 m, the slope of the road route has varied between 2-10%. The planned path is B-type forest road. The width of the road, shoulder width of 4 m and 0.5 m is planned to be on both sides. Scrape Slopes Planned ways, depending on the slope of 1: 1 to 3: 1, filling slopes 2:3.

Path of the trench width of 1 m, has been identified as a trench depth of 0.30 m. Forest road planned in the beginning and is set to pass the cardinal points that way after the first endpoints are marked. Considering the general slope of the land, as chosen point of stowage length and slope of the road is planned as a road.

Determining if the road route points, after drawing the route, one and curves per every 20 m, curve, middle and curves cross sections are taken from the last point created longitudinal section taking into account the total length of the path and the path of the black and red jeans were drawn.

All of these drawings will occur along the route of the road as a result of the cut and fill quantities prepared in computer tables have been created. After the work is completed as drawing path planning, the cost will be determined by the selection and soil and ground properties in the area of road construction machinery. Cost is the main factor in the creation of form-filling excavations statements prepared in computer environment. Zero line in the drawing for which calculations are made according to the contour lines, create a triangle pattern on our land has started to curve fitting process. Terrain module using the digital terrain model for this land was created.

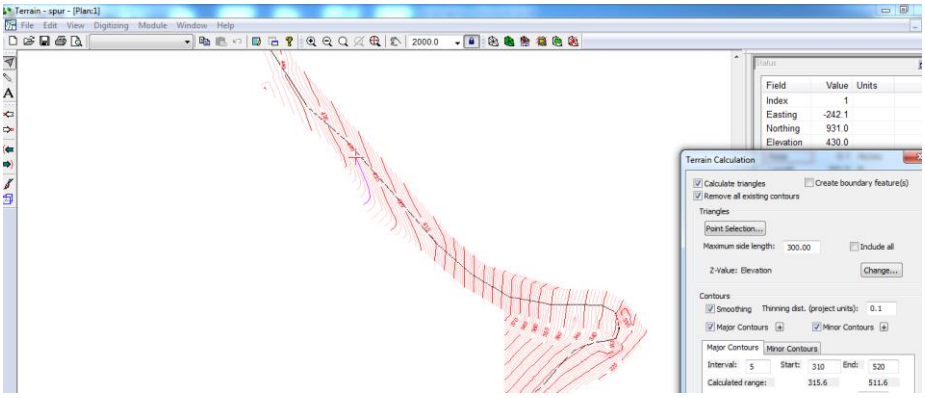

Figure 2. Terrain Module

Location modülü; zero line, curves, generated cross sections and material removal profiles.

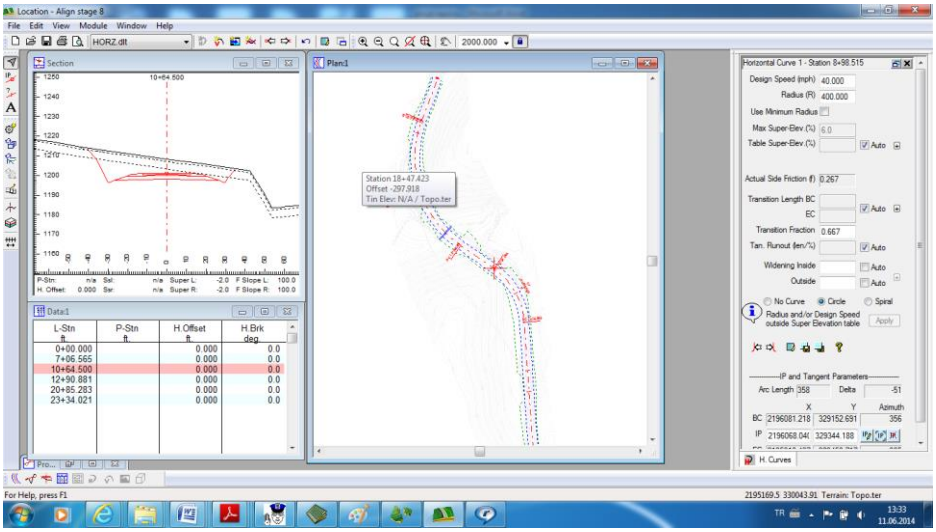

Figure 3. Create curves

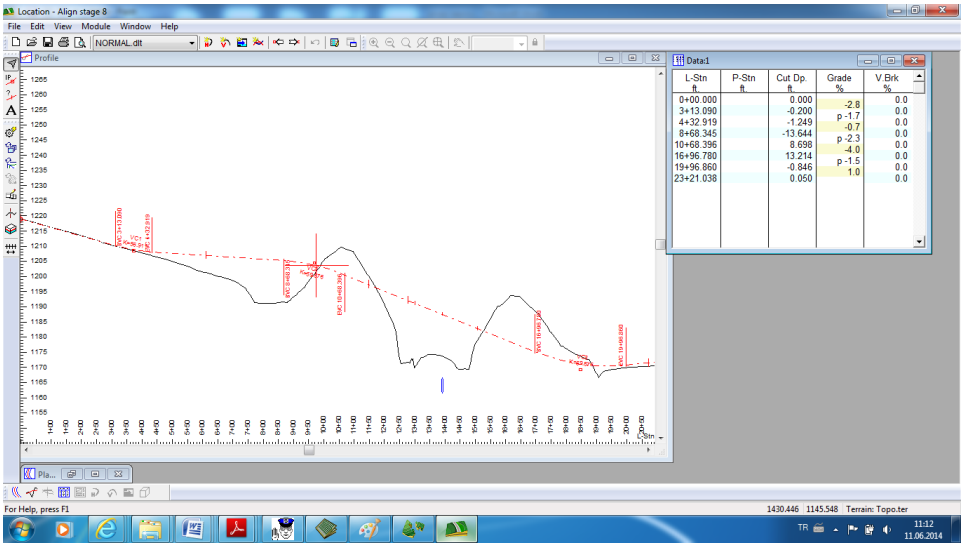

Figure 4. Creating Longitudinal Profile

Establishment of the road taken to the platform sections perpendicular to the axis path after determining the horizontal axis. Cross-section, depending on the terrain conditions along the horizontal axis certain intervals (usually 20 m) and must be taken when necessary. Cross sections are taken typically 10 m in length, including the left and right from the horizontal axis.

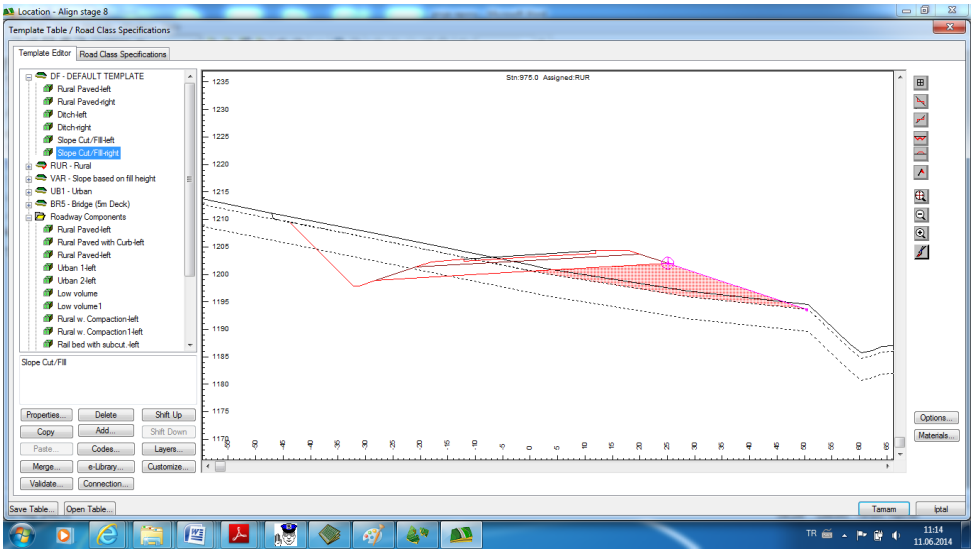

Figure 5. Creating Cross-section

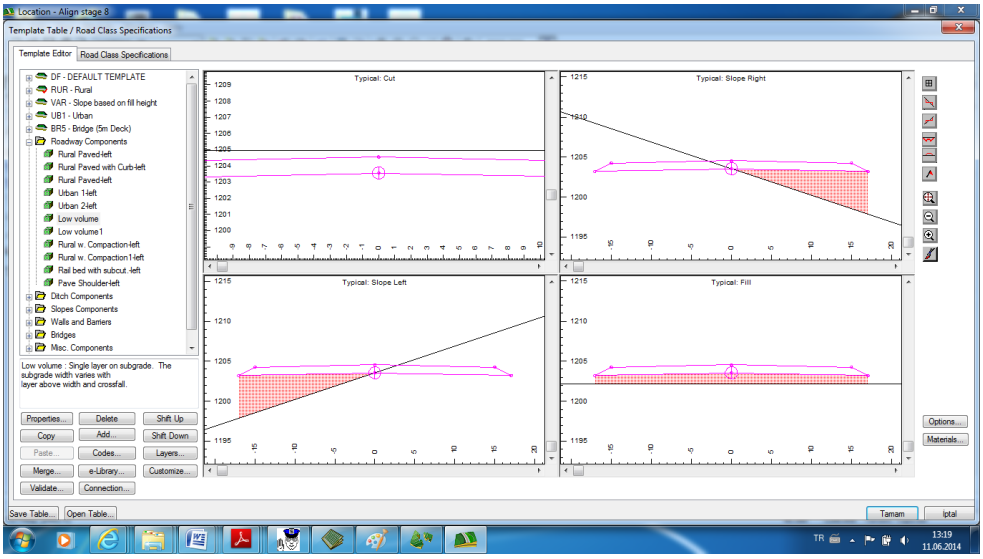

Figure 6. Create different cross sections

To make the area and volume, cubic editor is used. Then material removal profile being formed.

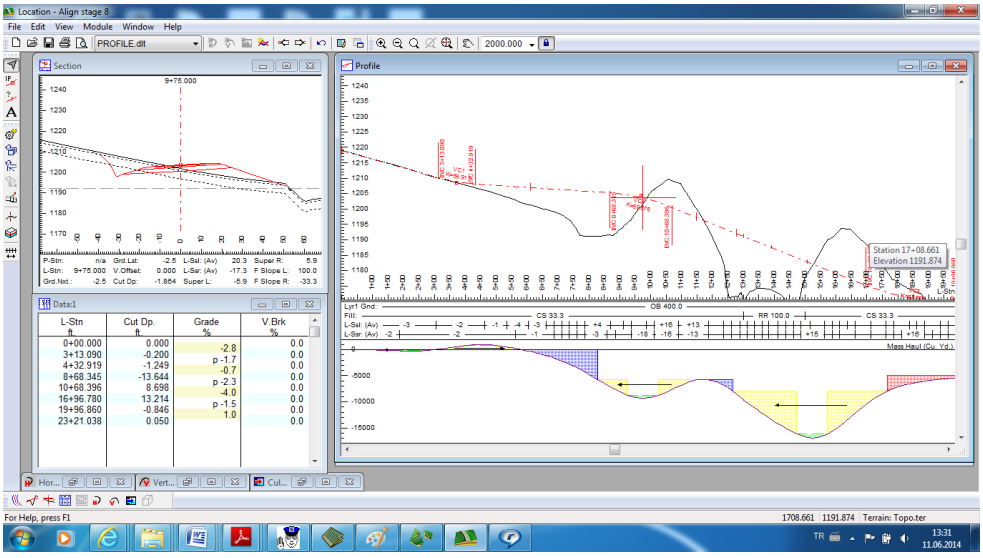

Figure 7. The same screen display different profiles

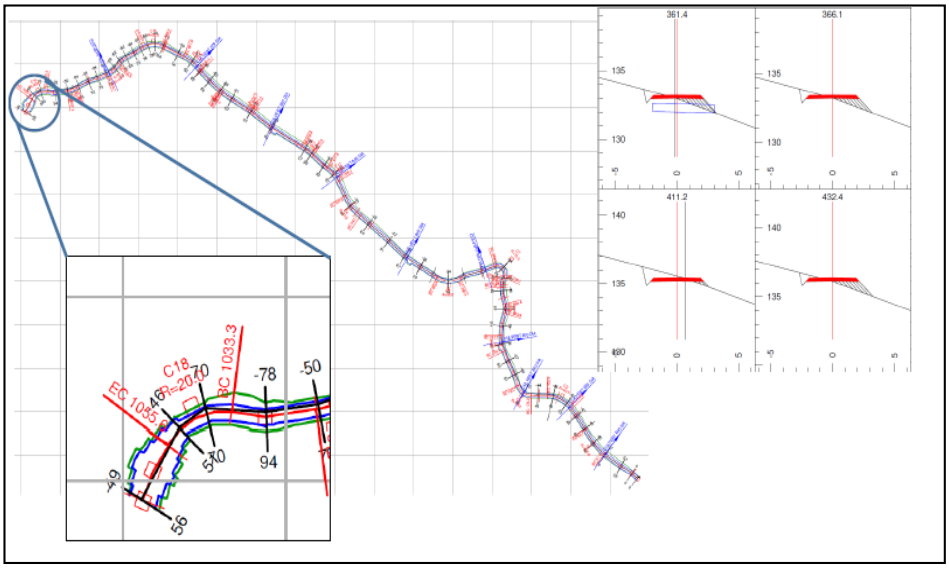

Figure 8. The planned route of the road and some properties

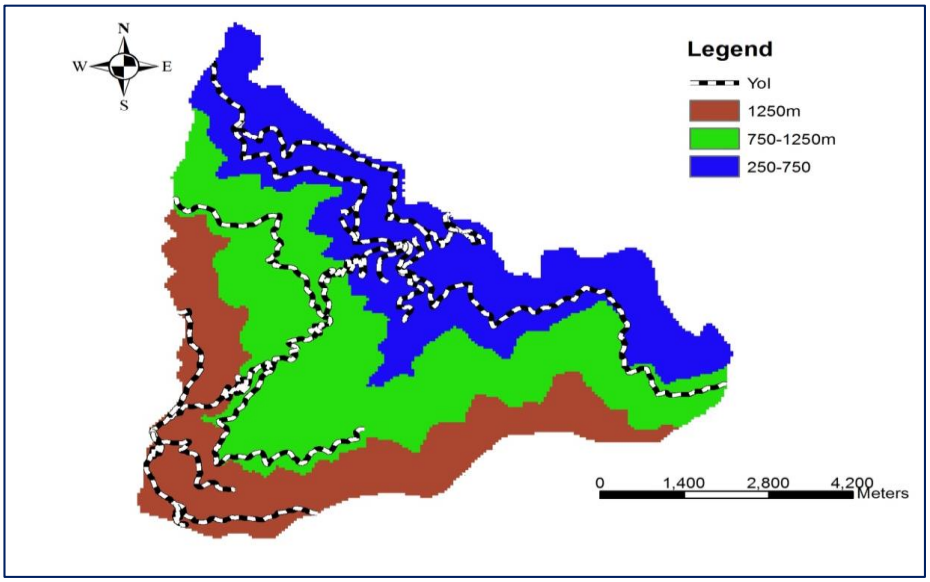

Figure 9. Height map of planning unit

Conclusions

The people living in today's world and people have to deal with a specific area of computer-aided software packages. In this study, the conventional method of forest roads made so far describes how to do the different computer-aided software. Other conventional methods of faster and more easily made and future requirements of the project is seen to be done with

this program. No matter how excellent if done road construction work done on computer must be supported by field studies. Before you start planning the start and end of the road on the basis of land, road type and road space according to use functions, soil types, it is necessary to identify the place as you have to avoid the area we can be rocky and marshy areas. After all this field work and road later after determining exactly which route should pass the office work.

The forest road planning, construction and maintenance of the forest is properly done can be very damaging. route will pass the road when planning work is very important. During the construction work, the experience of using the machine type and operator plays a major role. All in a way that conditions in the study without taking into consideration the trees and saplings to large losses given to forest land. This situation is of great importance for the national economy and the natural environment.

In this study, B-type forest road planning is made. The total length of the path between the start and end points 1000 m and the width of the road is determined to be 4 m. The amount of excavations along the route of the planned road 1472 m3 and 732 m3 of fill amount was found. 6% average gradient of the road, the average slope of the land is 55%. curves along the road route has been used a total of 8. radius of curve 20 - varied from 70 m. All stages in the planning of forest roads have been converted into project deliverables prepared by computer.

Thanks to dynamic modeling of the structure of the data processing software Roadeng at any stage of the project, even if the project completed, the changes made are reflected simultaneously in all phases of the project. Thus, desk and minimizing the time allocated for field work are provided. Moreover, thanks to restrictions and criteria set out in the database created, users of non-standard program gives warning that may arise from errors in the drawings.

The roadeng software is used, the change in the way forest to forest planner shows scheduled quickly and evaluates visual effects with alternative road routes. In addition, properties owned through easier sections of the Location module is easier to profile and volume calculations easier. Turkey needs a forestry practice in this way.

References

[1] Akay A.E. (2003). Minimizing total cost of construction, maintenance, and transportation costs with computer-aided forest road design. PhD thesis. Oregon State University, Corvallis, Oregon. 229 p.

[2] Aruga, K. (2005). Tabu search optimization of horizontal and vertical alignments of forest roads*, Journal of Forest Research*,10: 275–284.

[3] Çalışkan, E., (2013). Planning of Forest Road Network and Analysis in Mountainous Area, *Life Science Journal*, 10(2),2456-2465.

[4] Demir M. (2007). Impacts, management and functional planning criterion of forest road network system in Turkey. *Transportation Research Part A*, 41 (1): 56–68.

[5] Gumus S., Acar H.H., Toksoy D. (2008). Functional forest road network planning by consideration of environmental impact assessment for wood harvesting. *Environmental Monitoring and Assessment*, vol. 142 (1–3): 109–116.

[6] GDF (2008) Forest Road Planning, Construction and Maintenance Bulletin No:292, Ministry of Environment and Forestry, General Directorate of Forestry Department of Construction and Supply, Ankara 2008.

[7] Naghdi, R and Babapour, R (2009). Planning and evaluating of forest roads network with respect to environmental aspects via GIS application (Case study: Shafaroud forest, northern Iran). Proceeding of Second International Conference on Environmental and Computer Science. Pp. 424-427. Dubai. UAE.

[8] Pentek, T.; Picman, D.; Potocnik, I.; Dvorscak, P and Nevecerel, H. Analysis of an existing forest road network. *Croat. J. for eng.*2005, 26(1), 39-50.2.

[9] Rogers L. (2005). Automating aontour-based route projection for preliminary forest road designs using GIS. [MSc thesis.] Washington, University of Washington. 87.

[10] URL-1, www.software.com. May 7th 2016.