A CASE STUDY USING BY GIS DATABASE FOR DETERMINING DIMENSIONS OF HYDRAULIC CONSTRUCTION OF FOREST ROADS FOR STREAM CROSSING

Erhan Çaliskan*; Selçuk Gümüş; Özgür Topolak**; Hulusi Acar****
* Faculty of Forestry
Kafkas University
08000, Artvin, Turkey
** Faculty of Forestry
Karadeniz Technical University
61100, Trabzon, Turkey
erhan_caliskan@yahoo.com

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Abstract: *Turkey has a 20.7 million ha of forested area most of which is located on mountainous regions. Forest roads are generally used to opening up forests. Especially, climatic and ground features are important factors in Eastern Black Sea Region of Turkey. This situation increases the importance of hydraulic constructions in forest roads.*
This study was realized for 643.01 ha forest area in Eastern Black Sea Region. This area has a rough terrain and receives rainfall in large amounts. In this area forest roads make wood transport. GIS database were built to determine the requirement of forest road hydraulic constructions. Existing forest roads and hydraulic constructions data obtained by GPS receiver were transferred to GIS database. Furthermore, contour lines used to construct digital terrain model and stream system were by digitized built up in the GIS database.
Locations of Hydraulic constructions by overlaying of stream and forest road overages were determined by using GIS database. Dimensions of Hydraulic constructions were calculated by Talbot formula in determined points.
According to study result, study area was 643.01 ha. Total forest road length is 14496m, and the stream length is 16722 m. Tree hydraulic constructions exist but it was determined that a total of 25 hydraulic constructions should be available. In addition to 25 watersheds areas construction building of 14 circular cross-section pipe, 8 basket handled pipe or hamp and 3 large culvert or pipe hamp in appropriate locations. Furthermore, the types of probable hydraulic constructions were selected according to the results of calculations in determined crossing points.
It was determined that the existing hydraulic constructions were quantitatively and qualitatively inadequate. The research method was developed and used for the first time in Turkey. It was observed that the method is capable for these operations.

1. Introduction

Forestry activities in Turkey are performed on 20.7 million ha forested areas. Road networks are needed to study on mountainous lands covered with forests (Erdaş et al., 1995).

Forest productions transport from production area to market make necessity the development of factory and transporting technology. Development of forest technology also became effective in constructing building and forest road. The concept of constructing building takes importance in today forestry related to technological development at the time to time.

Hydraulic construction building include hamp, ditch, relying wall, culvert, pipe bridge, that protect road from harmful effects of rain and snow water in order to pass roads easily (Bayoglu, 1997).

Today of Turkey the forest roads of construction building are executed according to 202 number of announcement and type projects. In recent years, there were huge developments at the vehicle of main road. This shows themselves at the transporter of productions of forest. For this reason the construction buildings are taken attention and they taken importance. The expenditure and good working of construction building related to selection of the suitable type, greatness of area and construction. They all so need well repair. When we take attention at these four points we can decrease the expensive of repair and drain of construction building (OGM, 1984).

Most important expensive increase the cost of forest road is construction building of forest road. Along the roads, the alternatives provide most short distance of river passage is accepted optimal road route. In this stage, the analyzing ability related to geographical information systems take importance in the planning of road and utilizing of road route and all so it give possibility for one new techniques which is not done with classical methods (Acar and Gümüş, 2003).

There are studies, about the effecting factors of defined forest roads of construction building how defined in the situation of computer and making technical operation of classical map how done with computer. For this aim, Yeşiltepe Forest District (Maçka, Trabzon) is selected as a researching object. The construction buildings of forest roads are taken hand in this area and their appropriate, necessities were investigated then, lands are needed construction building, but they are not do all so determined. Which type, dimension of construction building is necessary for these all so determined.

2. Materials and method

2.1. Material

The investigation areas exist in the border of Yeşiltepe Forest District (Maçka, Trabzon). Total area is 643.01 ha, total forest roads length 14496 m. and total stream length 16722 m. The investigation area is being at 40° 47’ 56’’- 40° 54’ 52’’ northern latitude to 39° 27’ 38’’ –39° 43’ 11’’ eastern longitude (Anonim, 1984)].

In this investigation, the datum of planning of forest management in 1984, 1/25000 scale topography map (Trabzon G43a1, G43a2, G42b3, G43a4, G43a3) of Yeşiltepe Forest District was used. Digital map was handed with way of numbering taken photograph explained the subject.

2.2. Methods

2.2.1. Land Studies

In the working process of land, topographic map and planning network of road aerial photographs were handed. Then, map and land were compared with each other in this way to make control on the disharmony.

The land needed construction building was determined with taken photograph and get coordinate of land value of coordinate taken with Global Position Systems (GPS) were transferred to Excel program. In this way, one paintaning was designed. After this, these data were recorded as dbf file. In this way, they were transferred to ArcView the geographical information system.

2.2.2. The Design of Working Model of Geographical Information System

The model of geographical information system were formed as following:
In the entering of datum, the data of graphic were entered with using the program of AutoCad R14. The design of datum the forming of floor of datum and decreasing of mistake of datum graphic were done with Raster to Vektor to formed topology for establishing relation between graphical datum and situation. For this aim, Arc module was used. The establishing questioning relation between datum table being in forming floor datum and establishing relation of forming datum were made with info module, topographic analyzing were made for assurance of datum about land of forest.

For these analyzing, numerical model of land (SAM) was formed. These works weremade with using Tin (Triangular Irregular Network) module. For demonstration, Arc/Info programming of ArcView module were utilized.

2.2.3. Separation of Watershed Area

Forest network road and digitalizing of stream system were constructed with the data base of geographical information system in order to determine construction building in working point with using road stream on numerical model of water were transformed numerical situation. Class polygon was formed for every stream. In this way, the areas of watershed were handed with using topology.

2.2.4. Selecting and Calculating Dimensions of Hydraulic Construction Building

Determination of type and dimension of bridges, pipes, and culverts is very important in terms of safety and economical perspectives. The fist criteria in determination of construction buildings in whether there is deposition or not in the area. Some of these constructions can be used under deposition while the others are not. While pipes, box and arch culverts can be used under deposition, small culverts, culverts with cemented ground part and bridges cannot be used under deposition (Table 1 and 2)

Table 1: Drainage structures can be built under deposition

Construction Buildings Name	Free Space	Deposition Height	
		Min.	Max.
Concrete Pipes	(∅ 60, 80 cm)	30 cm	3,0 m
Basket handled Pipes	(∅ 60, 80 cm)	3,0 m	6,0 m
Box Culverts	(1,0-1,5 m)	-	15,0 m
	(2,0-3,0 m)	-	9,0 m
Arch Culverts	(1,0-1,5 m)	-	15,0 m
	(2,0-3,0 m)	-	9,0 m

Table 2: Drainage structures can not be built under deposition

Construction Buildings Name	Free Space
Small Culverts	(60 – 120 cm)
Cemented Ground Part Culverts	(6,0 m)
Bridges	(> 6 m)

We used Talbot formula to determine dimensions of pipes, culverts and bridges in forest roads. We preferred this formula due to lack of hydrological data in the area. Talbot's formula considers only the topographical data and ignores precipitation data.

Cross-section areas of construction buildings were determined according to Talbot's formula. Determination of type of construction building was done according to Table 3. Both functional and economical perspectives were considered in deciding.

Table 3: Construction building types selected

Cross-section Area	Construction Buildings Type
$<1m^2$	Circular cross-section pipe or small culvert
$1\text{-}2m^2$	Basket handled pipe or hamp
$2\text{-}8m^2$	Large culvert or pipe hamp
$>8m^2$	Bridge

Formula of Talbot is:

S = 5.791*C*4.A3 where;
S = Cross-section area of construction building (m^2)
A = Watershed area (km^2)
C = Coefficient depending on topography of watershed

Table 4: Talbot coefficient values for different topographic sites (Tavşanoglu, 1973)

Topography of Area	C (Talbot Coefficient)
Flat	0,2
Close to flat	0,3
Slightly waved surface	0,4
Waved surface	0,5
Slightly hill	0,6
Hill	0,7
Mountainous	0,9

In this study, we used Talbot value of 0,9 due to high average slope, high surface run off, and mountainous topography of area. Hamps were preferred to pipes and culverts in these areas with high sediment deposition risk.

3. Results and discussion

3.1. The Situation of Construction Building in Land

3.1.1. The Properties of Existed Construction Building Investigated on Land

It is determined that the three of the existed construction building are pipes and their properties are given in Table 5.

Table 5: The properties of existed pipe in Yesiltepe forest district

Nu.	Pipes Name	Pipes Diame. (cm)	Mem. Cour. (cm)	Pipes Leng. (m)	Slope (%)	Const. Deep (cm)	Cons. Year	Road Code	Funct.	Aspect
1	Circular Pipe	40	5	5,00	2	50	1984	165	n.f.	North
2	Circular Pipe	60	7	5,00	6	45	1984	188	n.f.	North
3	Basket Handled	80	12	5,00	6	45	1984	186	n.f.	South

n.f.: nonfunctional. Diame.: Diameter Mem.: Membrance Cour.: Course
Cons.: Construction Funct.: Function

Two Circular Pipe and one Basket Handled Pipe were determined in Yesiltepe Forest district as shown in Table 5. The number of Circular Pipe is 40 cm diameter, other is 60 cm and Basket Handled Pipe is 80 cm diameter. Two of pipes are located northern aspect and the other is located on south aspect. The slopes of pipes were between 2-6 % and construction deep was 45-50 cm. Also all of the pipes were nonfunctional.
According to literature on forest roads pipe diameter should be at least 60 cm. Our results support this statement, because 40 cm diameter pipes observed in this study were either broken or clogged. It was also observed that pipes were not applied appropriately. According to literature pipe slope should be between 2 and 15 %.

Destruction in pipes occurred partly due to the use of insufficient amount of cement to concrete dose and to improper dimensioning. In addition, at some locations it was seen that the pipes were not located deep enough.

Because soil under the pipe were carried by water and hence the pipe was brought up the surface. It was seen that there were not enough deposite materials between the pipe and the road platform, also the plate on which the pipe was lied on was not supported by enough material. Therefore, these factors resulted to break the pipe (Figure 1).

Figure 1: The destruction occurred on the end of a pipe due to improper building

3.1.2. The Cross-section Areas of Planning of Construction Building

Watershed areas that required hydraulic construction building and their locations are given Figure 2. According to this map appropriate hydraulic construction building are formed as in Table 6.

Table 6: Selection of appropriate hydraulic construction buildings for the field

Area Num.	A (km^2)	$\sqrt[4]{A^3}$	C	Constant (5,791)	$S=5,791*C*\sqrt[4]{A^3}$ 4*3*2 (m^2)	*Planned Construction Building Type
	1	2	3	4	5	6
1	0,04	0,31021	0,9	5,791	0,4661	Basket Handled Pipe,Hamp
2	0,14	0,15042	0,9	5,791	1,1928	Circular Pipe, Small Culvert
3	0,01	0,20388	0,9	5,791	0,1648	Basket Handled Pipe, Hamp
4	0,04	1,17507	0,9	5,791	0,4661	Large Culvert, Pipe Hamp
5	0,08	0,28778	0,9	5,791	0,7839	Basket Handled Pipe, Hamp
6	0,11	0,07208	0,9	5,791	0,9954	Circular Pipe, Small Culvert
7	0,05	0,08944	0,9	5,791	0,5510	Circular Pipe, Small Culvert
8	0,26	0,15042	0,9	5,791	1,8976	Circular Pipe, Small Culvert
9	0,24	0,05318	0,9	5,791	1,7871	Circular Pipe, Small Culvert
10	0,09	0,16431	0,9	5,791	0,8564	Circular Pipe, Small Culvert
11	0,55	0,17782	0,9	5,791	3,3286	Circular Pipe, Small Culvert
12	0,24	0,41545	0,9	5,791	1,7871	Large Culvert, Pipe Hamp
13	0,14	0,21649	0,9	5,791	1,1928	Basket Handled Pipe, Hamp
14	1,26	0,10573	0,9	5,791	6,1983	Circular Pipe, Small Culvert
15	0,86	0,26475	0,9	5,791	4,6544	Basket Handled Pipe, Hamp
16	0,11	0,37456	0,9	5,791	0,9954	Basket Handled Pipe, Hamp
17	0,09	0,24102	0,9	5,791	0,8564	Basket Handled Pipe, Hamp
18	0,15	0,20388	0,9	5,791	1,2562	Basket Handled Pipe, Hamp
19	0,13	0,16431	0,9	5,791	1,1283	Circular Pipe, Small Culvert
20	0,46	0,13608	0,9	5,791	2,9111	Circular Pipe, Small Culvert
21	0,09	0,38491	0,9	5,791	0,8564	Large Culvert, Pipe Hamp
22	0,03	0,12123	0,9	5,791	0,3756	Circular Pipe, Small Culvert
23	0,08	0,08944	0,9	5,791	0,7839	Circular Pipe, Small Culvert
24	0,02	0,08944	0,9	5,791	0,2771	Circular Pipe, Small Culvert
25	0,05	0,07208	0,9	5,791	0,5510	Circular Pipe, Small Culvert

* Planned Construction Building Type: Cross-section area due hydraulic construction building type

According to this table, as a result of this study over 25 watersheds areas construction building of 14 circular cross-section pipe, 8 basket handled pipe or hamp and 3 large culvert or pipe hamp in appropriate locations.

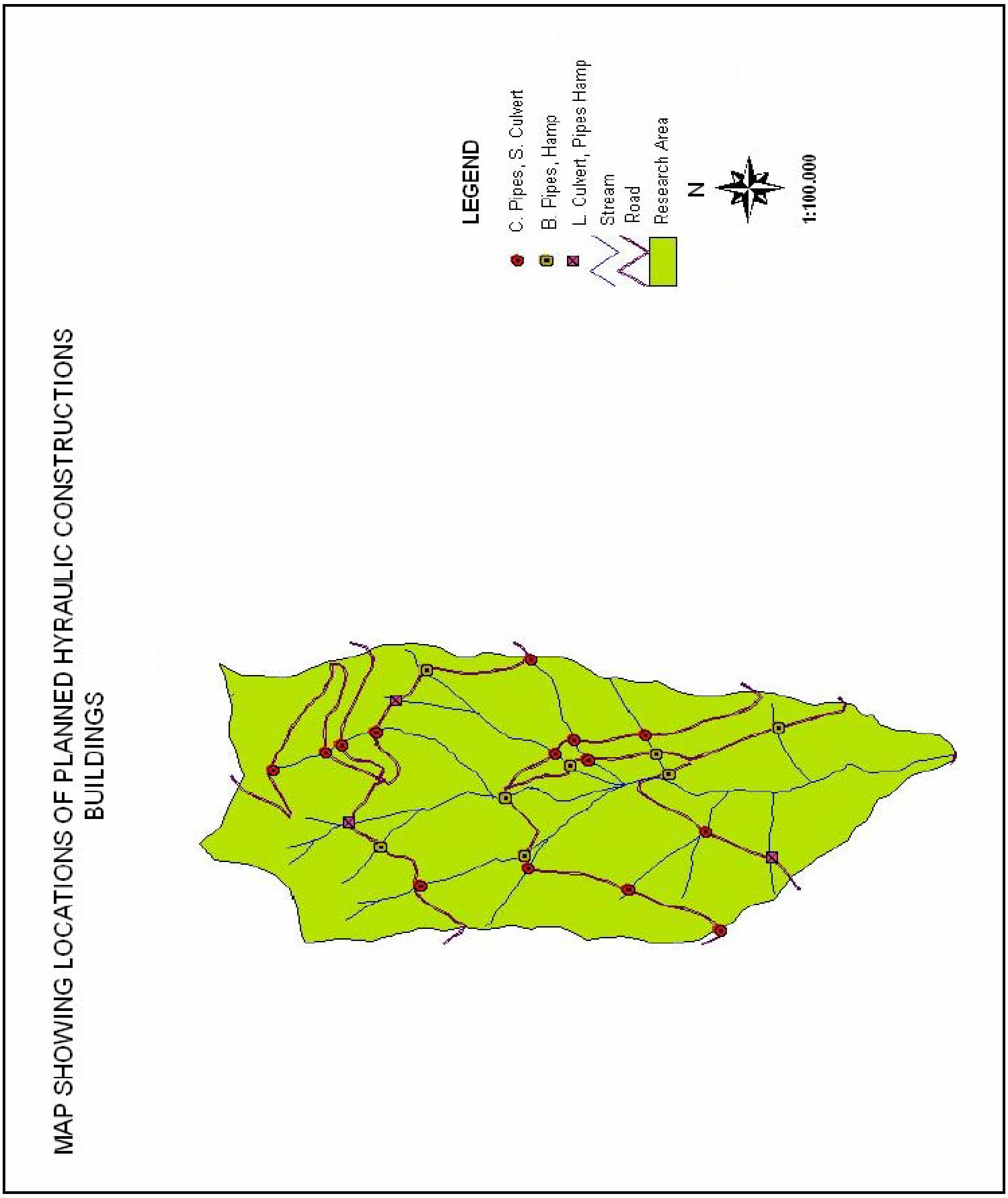

Figure 2: Map showing locations of hydraulic construction buildings

Construction building costs are generally high in riparian areas. According to a study done in the region, cost of building a bridge in 1 m. Length was equal to cost of building a 150 m length forest road (Erdaş, 1981).

Because of these reasons, when the forest roads are planned we should keep out the areas which have got drainage problems. In these areas the required construction building and types were determined.

4. Conclusions and suggestions

Dimension and selection of the type of constructing building will be used on forest road carrying most importance for helping these roads in long time. Forest network road can be out of using when constructing building is constructed with mistake type and dimension.

In order not to face these kinds of negative things, location and quality of constructing building is necessary for infrastructure and planning of the network road should be determined.

In addition to 25 watersheds areas construction building of 14 circular cross-section pipe, 8 basket handled pipe or hamp and 3 large culvert or pipe hamp in appropriate locations. Firstly, we must have knowledge about functions, dimension of the type of constructing building. Constructing building should be determined for every one watershed in forest road.

We should give importance at the standardization of construction building to help them in a long term, and should be made hardware test. We should research the sources of broken down of constructing building should be restored. Than we should be care other stage of plan and build not to repeat the same mistake.

The amount of water in ground is has negative effects on carrier power of ground should be taken under the control. For this reason good system of (drainage) should be formed to for the harmful underground and surface water from the road. Additional system of drainage should be planned for the necessary area according to situation of rain.

Periodical restoring of constructing building are not hampered in order to help them for a long spring and lasting down of transporting seasons in year do not to forget; broken down of road emerged because of absence of constructing building is required more expenditure to restore.

In order to promote widespread use of geographical information systems and computer technology in all over the country, satellite data should be used and evaluated in forest information system studies and obtaining data from the field.

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