

## Functional Planning Criterion of Forest Road Network Systems According to Recent Forestry Development and Suggestion in Turkey

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**Abstract:** Environment of the conscious of public opinion is increase recent years. When making use of the forest ecosystem for various purposes, care must be taken not to spoil the forest structure. To achieve this, forests must be used according to forestry techniques. Forest roads planning standarts (slope, width, pavement, drainage etc.) are different in production forests, forestation, national park and protection forests. The need for total forest roads in Turkey was 201810 km and that 133693 km portion of which, corresponding to 66.25%, was constructed by the end of 2004. With a view to be capable of conducting modern forestry activities, our country's forests should be provided with a systematic roads network by completing as soon as possible the construction of the remaining portion of such roads. This study gives functional planning criterion of forest road network system in Turkey. Road spacing and road density has been inspected concerning about forest roads in production forests, reforestation, national park and protection forests in Turkey.

**Key words:** Forest Road, Functional Planning, Road Density, Road Spacing, Turkey

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### INTRODUCTION

A plan serves as a model specifying which activities need to be carried out in order to attain a defined purpose and in which order, when and where such activities are to be performed. Plans depend on the availability of various alternatives and are essentially a collection of decisions. Offering many advantages in every field of activity, the plans cover a specified period of time and are prepared in a future-oriented way. Hence, the act of planning involves a conscious process qualified as a means to choose and develop the best manner of conduct for realization of a defined purpose<sup>[1]</sup>. When considered in this way, the act of planning consists of the stages of defining the purpose desired to be attained, investigating the various alternatives that could be used to attain that purpose and choosing the best one of these alternatives. Forests, which are renewable natural assets, are formed by gathering of a large number of living and non-living creatures. However, this formation is not a random mass, but whole, a system. When making use of the forest ecosystem for various purposes, care must be taken not to spoil the forest structure. As it is the case in every engineering activity, in carrying out the road planning and construction works, the requirements regarding compatibility with nature and safety and economy must be met. The compatibility with nature, that is, the requirement that the road to be constructed as a result of the works carried out should have the characteristics enabling it to perform its expected functions is thus recognized to be of primary concern.

To meet this requirement, first the purpose of construction of planned facility must be precisely defined. Meeting the second requirement regarding safety involves the construction of planned facilities according to relevant standards within the prescribed period to enable them to serve in line with the contemplated purpose<sup>[2]</sup>. The opening of forests to exploitation is usually realized by means of well planned forest road networks. The parameters and location requirements of forest road networks vary depending on variations in land conditions and according to the technology used and administrative activities. These requirements and planning approaches may be related to economic, ecological and management characteristics<sup>[3]</sup>. In the recent years, an ever-increasing trend has been observed in public consciousness regarding environment. This has led to the creation of a medium of constant controversy between the foresters and environmentalists. The main issue of controversy is centered on the argument that the construction of forest roads destroys the natural environment to a great extent, causes soil erosion, completely destroys the habitat and impairs the integrity of landscape. As stated also in the declaration issued by UNCED (United Nations Conference on Environment and Development), the utilization of nature's renewable resources is a key component of development based on environment. It is, however, an essential requirement that access to relevant areas be provided for utilization of resources concerned. Therefore the construction of forest roads can in no case be abandoned. It follows, however, that relevant

forestry organizations are obliged to figure out new ways that could be approved by the public and would cause no harm to the environment<sup>[4,5]</sup>. It is possible to classify the functions of forests from the standpoint of various aspects. Some of the classifications that may be used to help better understand this concept are presented below<sup>[6]</sup>.

#### **Classification from the Stand-point of Time**

- \* Functions whose demand is not limited to a period of time (erosion control, hydrological, climatic and esthetic issues, protection of nature, etc.)
- \* Functions whose demand is limited to a defined period of time (scientific research, production, recreation, national defense, etc.)

#### **Classification from the Stand-point of Demand**

- \* Forest functions subject to individual demand (production of wood and forest products other than wood and recreational and sportive functions, etc.)
- \* Forest functions subject to corporate demand (national defense, hydrological issues, training, scientific research, etc.)
- \* Forest functions becoming predominant by virtue of their nature with regard to maintaining social welfare and health (protection of soil, protection against avalanches, prevention of noise, production of oxygen, reducing the greenhouse effect, filtering the polluted air, etc.)

#### **Classification from the Stand-point of Area of Scope**

- \* Forest functions subject to only local demand (recreation, esthetic and training issues, scientific research protection against avalanches, prevention of noise, etc.)
- \* Forest functions subject to regional demand (erosion control, hydrological issues, protection of nature, etc.)
- \* Forest functions subject to national demand (national defense, production of forest products, erosion control, hydrological and climatic issues, etc.)

In line with the changing priorities during the process of social development, changes have also occurred in the demands addressed to the forests. In a trend parallel to this, a change in the approaches regarding the management of forests has been experienced as well. In the classical forest planning, legal protection and obtaining high yields of wood were considered to be of essential concern. Despite these developments in the approaches regarding the management of forests, a satisfactory development with regard to an approach of planning suited to different purposes could not be achieved in the planning of forest

road networks known to constitute the most significant infrastructure facility for achieving success in planning. Since the forest road network unit was designated as a water collection basin, there is a need to reclassify the forest functions from the stand-point of preparing the plans involving the forest road networks. This is because none of the functions defined involves a magnitude in terms of area which is adequate for developing a forest road network. This points out to the need for development of forest road networks to serve different functions on the basis of different planning principles.

### **MATERIALS AND METHODS**

Turkey, with 97% of its land in Asia and 3% in Europe continents, is located between 42°06' - 35°51' N latitude and 25°40'-44°48' E longitudes. Turkey is surrounded with the Mediterranean, the Black Sea, the Marmara and the Aegean Sea, has an area of 77945200 ha and coasts of 8333 km long. This width along with large distances of over 1600 km in East-West and changing 475-650 km between North-South directions, as well properties such as location, relief and climate have caused the formation of different geographical regions within the country boundaries<sup>[7,8]</sup>. As of the end of 2004, the total forest area in Turkey is 20703122 ha. This figure is 26.6% of Turkey's area. High quality forests and coppice forests spread over 10547987 ha account for 50.9% of the total forest area, coppice forests spread over 10155135 ha account for 49.1% of the total forest area. According to 2004 figures, the percent of coniferous forest in the total forest area is 53.9 and that of deciduous forest is 46.1. Production capacities are approximately 12039718 m<sup>3</sup>/year in high quality forests and 8837705 m<sup>3</sup>/year in coppice forests, respectively<sup>[9-11]</sup>.

During the process of determining the forest road routes within a particular forest area, many factors need to be considered. The main factors that play a role in the planning of forest roads may be enumerated as follows<sup>[12-14]</sup>:

- \* Forestry activities carried out in the forests of the regions concerned (rejuvenation, forestation, etc.)
- \* Changes realized in the technologies employed in forestry activities (timber haulage using the aerial forest lines, mechanical forestation works, etc.)
- \* The stand wealth of forests open to exploitation, species of trees and their location characteristics.
- \* Environmental factors such as conditions related to forest land and geological and hydrological structure characteristics.
- \* Construction and maintenance costs of forest roads planned for opening of forests to exploitation.
- \* Agricultural, cultural and other similar activities not directly associated with forestry.

- \* Other factors such as problems related to ownership and national policies.

The examination and evaluation of factors that have an impact on the planning of forest road networks involves a somewhat complex and rather difficult study. The opening of forests to exploitation through construction of roads is the most important condition that must be satisfied in order to be able to run a forestry management compatible with nature. And to enable the running of a forestry management compatible with nature the road networks must have the following characteristics<sup>[12-14]</sup>:

- \* The forest area should be provided with inadequate road network for sawing, planting, maintenance and utilization.
- \* The trees marked with a stamp in conformity with silvicultural purposes should be dug out of the soil without causing any harm to the stand and soil.
- \* The timber utilization and haulage should be carried out by using the known techniques and the proceeds should at least meet the expenses made.

As can be seen from above information, an intensive forestry management is very closely associated with the type of road networks and the road density. In principle, the road density is determined by economic conditions. Putting briefly, once the functions of forestry management are defined, the type of forest road networks as well as the forest road density and space shall be obliged to such functions in a rational way.

Believing that how beneficial a well planned and constructed highway network is in the development of a country in all aspects, a well planned and constructed forest roads network is also a vital element in rational and sustainable forestry. Forest roads which are planned and constructed in compliance with the aims and requirement of forestry, ensure that forest products are transported economically and more extensive silvicultural applications and forestation are conducted, that, particularly, forest fires and pest disturbances are inspected and controlled, that the transport of materials, equipment and personnel to their service locations and that the needs of forest villages for roads and people's need for recreational facilities are met. The road density may be defined as the ratio of the length of existing roads to the existing forest area, or as the length of roads per unit area. Whereas, the road space refers to the average horizontal distance between two roads as measured perpendicular to the axis of road and is a more realistic measure as compared to the road density. The extent of road density depends, above all, whether or not the forestry activities are practiced at an intensive

level. Nevertheless, it cannot be considered as a concept abstracted from the general economic structure. These considerations show that the determination of road density involves an activity covering many aspects<sup>[12-14]</sup>. It is obvious that the road density may vary from forest to forest depending on the factors employed in the formulas used for this purpose. In other words, every forest will have conditions specific to that forest as well as a length of road value dictated by such conditions. A road density value obtained by means of formulas may not be justifiably considered as a mathematically final measure since there will be some other factors having an impact on road density.

The need for total forest roads in Turkey was 201810 km and that 133693 km portion of which, corresponding to 66.25%, was constructed by the end of 2004. As provided in Table 1, the construction of 66.25% of forest roads, 63.53% of fire-security roads, 47.34% of major repairs, 46.19% of pavement, 53.05% of bridges and 46.82% of forest roads structures, all of which were planned to be constructed by the end of year 2004, were completed. It is aimed that the construction of the planned forest roads and the completion of forest road structures of all forest roads will be achieved within 20 years. As a result, today, a substantial part of the forests of Turkey have been provided with forest roads constructed basing on a plan and transportation by truck on such roads has almost been the one and only choice<sup>[15-17]</sup>.

#### **Existing Forest Road Planning Criteria in Turkey:**

Type B forest service roads constitute a major part of the existing forest roads network in Turkey. There are three types of roads, i.e. Forest Highway, Type A Service Road and Type B Forest Service Road, constructed in order to have forests units managed. As given in Table 2, these roads are constructed at 7 m, 6 m and 4 m width platform respectively. The place of construction of such roads depends on the volume of load such roads are intended to carry and accordingly, the figures in Table 3-4 are taken as criteria. When the forest road planning activities carried out in other countries are examined, it is observed that every country has adopted implementations differing according to that country's geography and social conditions. The road density and road space values employed in some European countries are given in Table 5. As it can be understood from above discussion, the preparing of a forest road network plan and realizing the construction of the planned roads is never considered to involve merely a road construction technique. This is because the preparation and realization of such plans require to have knowledge of not only all the economic, technical and management

Table 1: The situation of the forest roads in Turkey as of year 2004<sup>[10]</sup>

Type	Forest roads needed	End of the year 2004		Proportion of constructed roads (%)
		Constructed	Under construction	
New forest road construction	km 201810	133693	68117	66.25
Reforestration roads	km 2820	-	2820	-
Fire roads	km 25544	16227	9317	63.53
Major repairs	km 61100	28923	32177	47.34
Pavement	km 54724	25277	29447	46.19
Bridge	m 23500	12467	11033	53.05
Forest roads structures	km 50000	23412	26588	46.82

Table 2: Forest roads standards in Turkey<sup>[10]</sup>

Technical specifications	Road types			
	Forest main road	Secondary forest roads		Skidway roads
		A-type forest roads	B-type forest roads	
Road bed wide	m 7	6	4	3,50
Maximum slope	% 8	10	9-12	18
Minimum curve radius	m 50	35	10-12	8
Number of band	Number 2	1	1	1
Band wide	m 3	3	3	3
Shoulder wide	m 0,50	0,50	0,50	-
Ditch wide	m 1	1	1	-
Pavement wide	m 6	5	3	-

Table 3: The using data of forest road density and forest road spacing in Turkey<sup>[10]</sup>

Volume of Asset (m <sup>3</sup> ha <sup>-1</sup> )	Road density (m ha <sup>-1</sup> )	Road spacing (m)
>250	20	500
<250	10	1000

Table 4: The required volume of asset to choice of forest roads types in Turkey<sup>[10]</sup>

Road type	Volume of asset (m <sup>3</sup> )
Main forest road	> 50000 m <sup>3</sup>
A-type forest road	50000 m <sup>3</sup> -25000 m <sup>3</sup>
B-type forest road	< 25000 m <sup>3</sup>

Table 5: the forest road density and forest road space values in some European countries<sup>[9]</sup>

Country	Forest road density (m ha <sup>-1</sup> )	Forest road space (m)
Austria	20-30	350-500
Germany	15-25	400-700
Italy	8-20	500-1250
France	17-20	500-600
Romania	10-20	500-1000
Turkey	10-20	500-1000

characteristics of the forest enterprise involved, but also to have information on the relationships concerning production, transport and utilization. In order that the services associated directly or indirectly with the forest

roads whose significance and functions have been summarized above can be realized in a rational way, the site of the planned facility must be provided with the standards and planning criteria in line with the contemplated purpose. Accordingly, in this study, first an emphasis is made on the concept of functional forestry and then an effort is made to take up and discuss the criteria that should receive priority in the planning of forest roads making up the infrastructure of forests established for different purposes.

## RESULTS

### Functional Planning Criterion Forest Road Network Systems in Turkey

**Production Forests:** In cases where the primary transport is carried out from the ridge toward the stream (downward), the planning should be done, as a general principle, from the stream toward the ridge. The roads serving the streams should be taken as a basis and then the hillside roads should be planned according to the length of the hillside. In locations suitable for mechanization, if the primary transport is to be made from the stream toward the ridge, then the ridge and hillside roads should be given priority in planning.

In forests where the wealth is 250 m<sup>3</sup>/ha, the planning should be done as to have a road density of 20 m ha<sup>-1</sup>, with road spaces of 500 m, while in forest areas where the wealth is under 250 m<sup>3</sup>/ha, a road density of 10 m ha<sup>-1</sup> with road spaces of 1000 m should

be tried to be realized. Besides taking the figure of wealth/ha and the distance between the stream and ridge as the main determining elements in planning, other elements such as the primary transport means in the region, any likely changes to occur in such means in later years, goodness of land general slope of the land, topographical structure and possibility of a forest fire should also be taken into consideration. In taking said elements into consideration, however; care should be taken to ensure that a gradual increase in the road density and hence an increase in the loss of forest area would be prevented in forest areas.

**Forestation Forests:** As a general principle, the planning should be done from the ridge toward the stream (downwards). The ridge roads should also be used as fire safety roads. The type of planning should be modified according to the purpose of re-forestation.

In the forestation areas aimed for production, the roads to serve the streams should be planned together with the ridge and hillside roads, but the construction of stream roads should be left to the final period of construction works, for completion one year before the commencement of production activities. The planning should be done from the ridge toward the stream. The ridge roads should also be used for the purpose of a fire safety road. First, the forest road planned to serve in the ridge area should be constructed, the construction of other roads should be carried out according to the principles adopted in the planning of roads in the production area. If a zone was left to serve as a means of protection for stream vegetation in the reforestation areas, then care should be taken to devise the planning so that said protective zone will not be entered. By taking into consideration the wealth to be possessed by these forestation areas in the future, the planning should be based on a road space of 500 m and a road density of 20 m ha<sup>-1</sup>.

In the forestation areas aimed for hydrological use, temporary hillside roads should be constructed to enable the construction of the planned road network and after completion of construction, such temporary roads should be planted to trees. Care should be taken not to plan the construction of any roads other than the ridge roads aimed to serve the production facilities and to provide protection. The construction of temporary hillside roads should be allowed only in cases where it is absolutely required by the production facility.

In the areas aimed for establishment of green belt, the planning should be done as to limit the size of green belt and any losses likely to be experienced as a result of social pressure, as well as any, external threats, particularly fire, should be prevented. The network roads and the fire safety roads on ridges should be planned by taking into consideration the size and topographical structure of such areas.

**National Park Forests:** The national park forests constitute a collection of varied and significant values.

When the functions of national parks are examined, they may be enumerated primarily as the environmental protection, environmental training, scientific activities and activities designed to provide the people with an opportunity for rest and relaxation<sup>[18]</sup>. The planning of a national park road should involve the provision of a reasonable and safe entry to facilitate the management and protection of forest resources. The duty expected from a national park road is different than that of other roads. The national park roads should be constructed only where and to the extent required. The aim should be the protection and use of the natural, historical, cultural and recreational resources making up the national park system. In the planning of national park roads should be constructed only where and to the extent required. The aim should be the protection and use of the natural, historical, cultural and recreational resources making up the national park system. In the planning of national park roads, the priority should be given to determining the type and size of vehicles that can be safely driven on those roads. In order to enable the people visiting a national park to see and make use of all the above-mentioned values, the roads planned for such areas should be such a simple type that would minimize the effect of road on the nature, instead of roads of high standard, so the plans developed for national parks should preferably involve roads provided with many curves designed for low speed driving as well as the keep the visitors for a longer period in the area. Furthermore, the national park roads should be compatible with the resources and efforts should be spent to provide them with such qualities as to offer maximum quality of sight and a pleasant and informative experience to the visitors. Such roads should be planned in agreement with the land structure involved and during the planning of roads, the descents and ascents should be provided as to allow a minimum amount of excavation. Furthermore, dozers should in no case be used during the construction of roads, instead of them, excavators should be used. The road system of national parks is designed to provide entry into the park and walking around within the park. The roads included within the forest road system of national parks may be classified as follows<sup>[19]</sup>:

**National Park Forest Roads Open to the Public:**

They are the roads used by the people visiting the national park forests, for reaching the forest areas within the park and while walking around in these areas. They may be defined as the roads providing the passing through by vehicle or reaching to the holiday resort areas, camping and picnic areas and historical and sight-seeing areas and they are divided into the following sub-groups<sup>[19]</sup>:

\* National park main roads (Roads enabling passing through, walking around and entry-exit).

- \* National park connecting roads (Roads enabling access to the areas within the park which bear significance with regard to panorama, scientific study, recreation and culture).
- \* National park forest roads of special purpose (Roads providing access to the areas open to the public such as camping and picnic places. They usually allow low-speed traffic and should be planned mostly as a one-way road).
- \* Undeveloped national park forest roads (Roads designed to visit remote areas or to enable access to the commonplace-undeveloped camping areas. They are usually planned according to low standards and can be used by vehicles provided with special equipment).

**National Park Administrative Forest Roads:** They may be defined as forest roads planned and constructed to meet the administrative purposes of national park forests. These forests roads, which may also be called as service roads, are used for administrative purposes such as labor accommodation areas, maintenance areas and other administrative facilities. These forest roads are divided into the following sub-group:

- \* Forest roads providing administrative entry (Forest roads open to the public and providing access to the administrative building, labor abode etc.).
- \* Restricted forest roads (Forest closed to the public and used only by the administrative personnel with the purpose of survey and control of the national park area).

At the planning stage of national park forest roads, the most important planning criteria seem to be the planned vehicle speed (km/hour), planned road load (number of vehicles/day) and the type of vehicle providing access to different areas within the park area.

**Protection Forests:** For such forests, the roads designed exclusively for protection should be constructed and in their planning the roads which would cause a minimum amount of damage during their construction should be preferably considered. If there are any roads already available, they should be checked and improved as required so that construction of new roads would be avoided and important consideration should be given to carry out the necessary maintenance works to maintain them in good condition for use.

#### CONCLUSION AND RECOMMENDATIONS

The concept of sustainable forest management, which may be defined as the use and regulation of forests and forest areas, at local, national and global levels, in such manner and to such extent as to protect their biological diversification, their productivity, rejuvenation capacity and survival energy as well as their potential to fulfill their ecological, economical and social functions, both

at present and in the future, while not causing any harm to other ecosystems, is well recognized by all countries in the world. The services and functions expected from our country's forests are defined in the Forest Law No. 6831. These services and functions cover the production of forestry products and the functions related to anti-erosion, climatic benefits, community health, esthetics, environmental protection, recreation, national defense and scientific aspects. Each step to be taken with respect to the functional planning of forest roads shall be meaningful only if the functions served by forests are realized fully. The Communiqué No. 202 issued by the Ministry of Forestry and entered into force in 1986 stipulates the principles concerning the planning of forest roads with emphasis on the production of forest products, but does not direct attention to the functions enumerated above except referring to them through general statements. The decisions taken at international level as well as the increased awareness experienced on the subject of environmental protection in parallel with advances in science and technology require the adoption of different approaches with regard to the planning of forest roads. It, therefore, follows that the presently used planning criteria must be revised and the modern approaches must be adopted. The main purpose in the planning of forest roads is that, when then unfavorable effects of planned and constructed forest roads on the forest ecosystem are compared with the benefit to be derived from the roads constructed as a result of planning within the concept of sustainable forest management, such benefit must be within the acceptable limits. In this context, it has become evident that the density and road space criteria presently employed to provide each piece of a forest area with a systematic forest road network in order to enable it to fulfill its planned functions shall not be equally applicable to every area. In summary, it is recommended that the purposes of management of forests should be put forth in detail and the road density and road space values to enable the realization of these purposes should be determined separately.

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