

Determination of the Effect of Forest Road Construction on Existing Forest Assets with Geographic Information Systems

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Abstract: Many expectations such as benefiting from forests all year round, providing transportation for people, protecting forests, transporting wood raw materials are only possible with forest roads that provide access to forests. Today, with the increase of global warming, forest fires have affected the whole world. If the forests cannot be reached and intervened during the fire, the forests that hold carbon start to release carbon during the fire. This situation reveals the importance of forest roads, which make it possible to fight fires. In this study, the effect of forest road construction on existing forest asset will be tried to be revealed by using geographic information systems. For this purpose, analyzes were carried out on a forest road built in 2019 in Osmangolu Forest Management Directorate, which is within the borders of Kastamonu Regional Directorate of Forestry Ilgaz Operation Directorate. Controlled classification was made using SNAP software on two satellite images of 2018 and 2023 and the current forest change was revealed. By determining the differences between these two situations, the effect of this change on forest carbon, the effects of the road construction area on the surrounding stands and the condition of these stands after the road construction were evaluated. As a result, the relationship between the construction of a forest road and the existing vegetation and thus forest carbon has been tried to be revealed.

Keywords: SNAP, Forest road construction, Vegetation, Classification.

1. INTRODUCTION

As a result of the increasing levels of carbon dioxide in the atmosphere, which have led to climate change and exacerbated global warming, forest fires have become a worldwide issue. When forests cannot be accessed and intervened during a fire, carbon-storing forests begin to release carbon during the fire. This underscores the importance of forest roads that enable firefighting efforts.

Beyond their role in protection, forest roads, which are also fundamental to the opening up of forests for exploitation, are used throughout the year for the purpose of transportation and the execution of forestry services by vehicles (Erdaş, 1997). The planning, construction, and maintenance of the forest road network that will open up forest areas for exploitation are of significant importance due to their technical and economic characteristics as well as their ecological problems (Çalışkan & Çağlar, 2010). Planning routes that are as close to nature as possible is an absolute consideration. This is because there are direct or indirect effects on living areas between the starting and ending points of road construction (Lugo & Gucinski, 2000; Tunay, 2006; Gümüş et al., 2008; Eker & Coban, 2010; Boston, 2016; Gülci et al., 2017). During the construction and maintenance of forest roads, various forms of damage occur in the natural environment. The most significant of these include forest area loss, injury to trees leading to insect infestations, and preparing the ground for erosion and landslides (Acar, 1999).

In Regulation No. 292 titled "Planning, Construction, and Maintenance of Forest Roads," the adverse effects of forest roads are identified based on an improperly planned 1 km long road as follows:

- Depending on road types, a minimum of 4,000-8,000 m² of forested area is cleared, and 400-3,500 trees are cut down depending on the age of the stand.
- As a result of excavation material flowing downhill, there is breakage, injury, and damage to standing trees on the lower slope, leading to insect damage.

- c) By breaking the support structure on slopes, landslides are induced.
- d) Changes in the flow directions of shallow groundwater result in the inability to meet the water needs of natural stands, leading to negative alterations in the ecosystem.
- e) Wind corridors are created, increasing the breakage and uprooting of trees.
- f) The increase in surface runoff distance triggers erosion.
- g) With transportation comes artificial and intense pressure on pristine areas, disturbing wildlife and limiting their right to live.
- h) The construction and maintenance costs of roads burden the national economy in this manner (OGM, 2008a).

Generally speaking, infrastructure works in the construction of forest roads; It consists of cleaning the building area (cutting down trees, protecting the topsoil and removing logs), disintegrating rocks with explosives and soil leveling. (Çalışkan & Çağlar, 2010) This stage causes the most damage.

Forest roads cause the transportation of fertile topsoil, change the soil properties and microclimate, and increase erosion, resulting in a decrease in the productivity of the growing environment. (Megahan, 1987) It has been stated that the construction impact area of roads planned in forested areas in Türkiye (sum of ditch and platform width multiplied by the road length) cannot be more than one percent of the forest area (OGM, 2008b).

In this study, it was tried to determine how much the forest existence was affected after the construction of forest roads using geographical information systems. In this way, the effect of this change in the vegetation of the areas where forest roads providing access to the forests were built on forest carbon, the effects of the road construction area on the surrounding stands and the status of these stands after the road construction were evaluated.

2. MATERIALS AND METHODS

In this study, the effect of a forest road built in 2019 in Osmangözü Forest Management Directorate, which is within the borders of Kastamonu Regional Directorate of Forestry Ilgaz Operation Directorate, on the forest existence was determined (Figure 1).

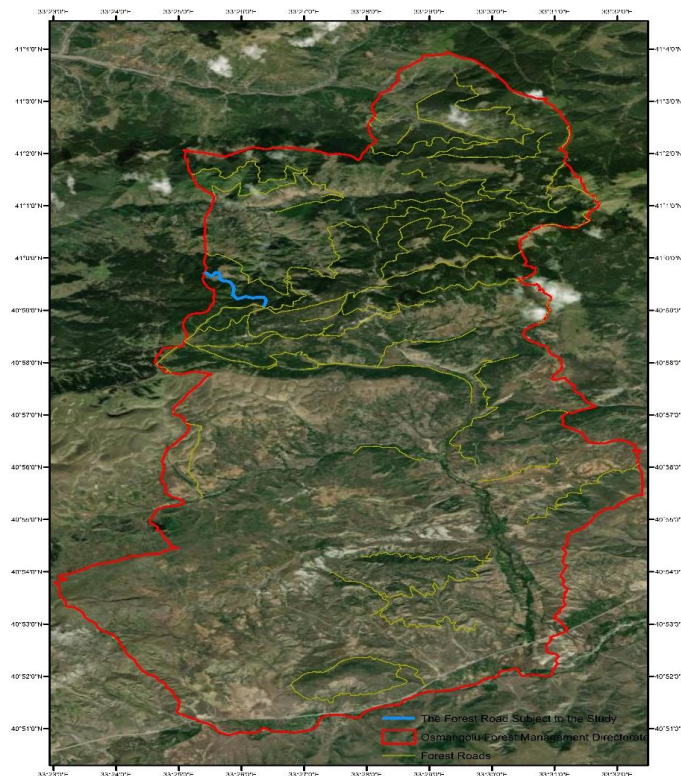


Figure 1. Study area.

For this, controlled classification was made using SNAP software on two satellite images of 2018 and 2023 and the current forest change was revealed (Figure 2).



Figure 2. Satellite images of 2018 and 2023.

In controlled classification, separate control parcels were determined for 3 classes (forest area, forest roads and bare land) (Figure 3 and Figure 4).



Figure 3. Controlled classification for 2018 satellite images (Blue: forest area, orange: bare land, light blue: forest roads).



Figure 4. Controlled classification for 2023 satellite images (Green: forest area, light green: bare land, purple: forest roads).

According to the results of these processes performed separately on the satellite images of 2018 and 2023, comments were made on the forest area change.

3. RESULTS AND DISCUSSION

3.1. Results

As a result of the controlled classification process carried out for 2018, the forest area was determined as 74.076% of the existing area, the presence of forest roads was 6.487% and the bare land was 14.437% (Figure 5).

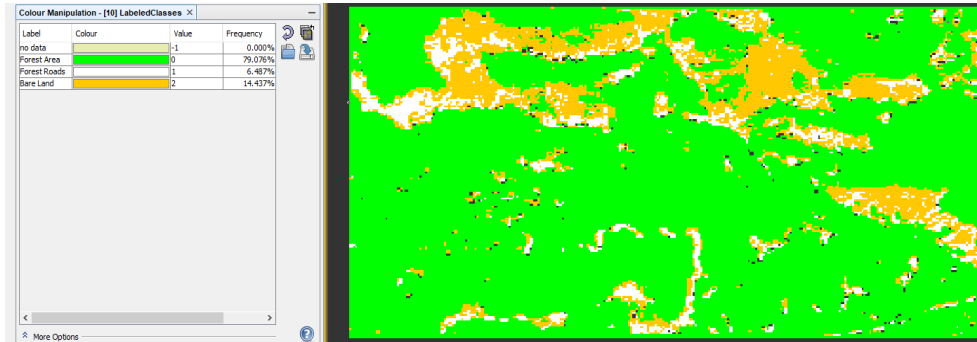


Figure 5. 2018 controlled classification result.

As a result of the controlled classification process for 2023, it was determined that 83.188% of the existing area was forest area, 10.998% was forest road presence and 5.813% was bare land (Figure 6).

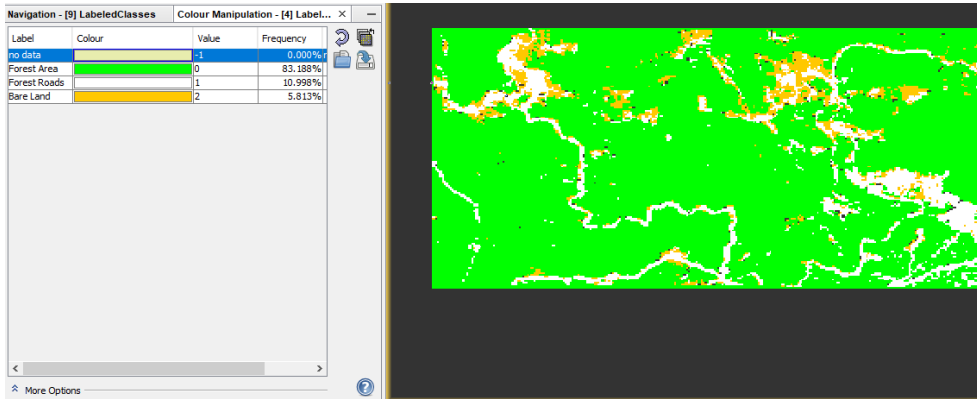


Figure 6. 2023 controlled classification result.

When looking at the 5-year forest area change in this process carried out through satellite images; There is a 4% increase in forest area. Likewise, the forest road built in 2022 affected the current situation as a 4% increase (Table 1).

Table 1. 5-year land use change.

	2018	2023
Forest Area (%)	79.076	83.188
Forest Roads (%)	6.487	10.998
Bare Land (%)	14.437	5.813

According to these results, it is understood that the most changing land use is bare land.

3.2. Discussion

Since it is known that the length of the newly built road in 2022 is 2900 meters, it is thought that a 4% increase may be normal. An increase in the forest area will be possible as the community consisting mostly of herbaceous plants and shrubs, which appeared as bare land in 2018, will create a closure within 5 years.

4. CONCLUSION

In this study, conducted on satellite images using SNAP software, the effect of a newly constructed forest road on the existing forest area was revealed using the controlled classification technique. This study, conducted on 2018 and 2023 satellite images, revealed that the ratio of forest area and forest roads increased and the bare land decreased significantly.

It is known that forest roads harm the environment. However, access to forests is only possible via forest roads. As can be seen from this study, it is understood that forest roads built with an approach close to nature and in accordance with the technique have less impact on the environment than bare land.

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