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Noise Effects of Roads on Wildlife using GIS: A case study of Bartın–Karabük Highway in Turkey

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ABSTRACT

While our forests cover 27% surface area of our country, wild areas correspond to 90% of our country together with forests and a size of 70 million hectares in Turkey. However sustainability of these sources will be possible by realizing protection and usage balance. Protection, development and sustainable management of our wildlife sources including our forests is the most basic responsibility. In this context it is necessary to minimize the human originated negative factors affecting wildlife under the scope of sustainable management principle. Most important of these structures are roads. In this context risk factors in wild life related areas should be determined by studies to be conducted on highways and necessary precautions should be taken. This study was conducted on 30 km long part of Bartın-Karabük road majority of which is located in wild life area. Noise measurements were made in totally 94 points by using CELL633A1 noise level meter tool in the time period when traffic was crowded. All collected data was transferred to GIS environment. While modeling the spatial variation of road related noise, IDW (Inverse Distance Weight) interpolation was applied. After that audio surveillance was performed in points which were away from noise effect (46.4 dBc/Hz) and accordingly a noise map was formed along the road within the region up to that limit value. On the map that was formed, suggestions were made about precautions to be taken for wild animals.

Key words: Wildlife, GIS, noise, highway

INTRODUCTION

Liveliness in wild life is a perfect demonstration of the environment health. It is because, wild life can maintain its existence and show a good improvement in environments which are not unbalanced and are away from pollution. Environments whose ecological balance have not been destroyed are the places where wild life improves the best. Therefore, abundance and variety of the wild species in a place show that this place has the healthy life and all its conditions. The wild life is a unity which has its own rules. The natural balance in this unity is formed through the competition between the animal and plant species. Mankind could disturb this balance by creating a competition which is not on the same footing. One of the conditions that ruins the ecological balance for the wild life is sound, in other words; noise [1-2-3-4]. Human activities introduce anthropogenic noise sources into the environment across many elements of the landscape, including especially roads, airports, military bases, and cities. The impacts range in effects from mild to severe. They can impact wildlife species at both the individual and population levels.

Roads form the basic infrastructure of the terrestrial transportation system by reticulating the land where they stand. Roads have bad influences on the dynamics of the ecosystem functions and the ecosystem components including the species compositions in the ecosystem (Fig. 1). Wild life (WL) biologists have observed that roads create an obstacle limiting the movements of the wild animals [5-6-7], form a death source for them [8], and cause behavior disorder in animals [9-10].

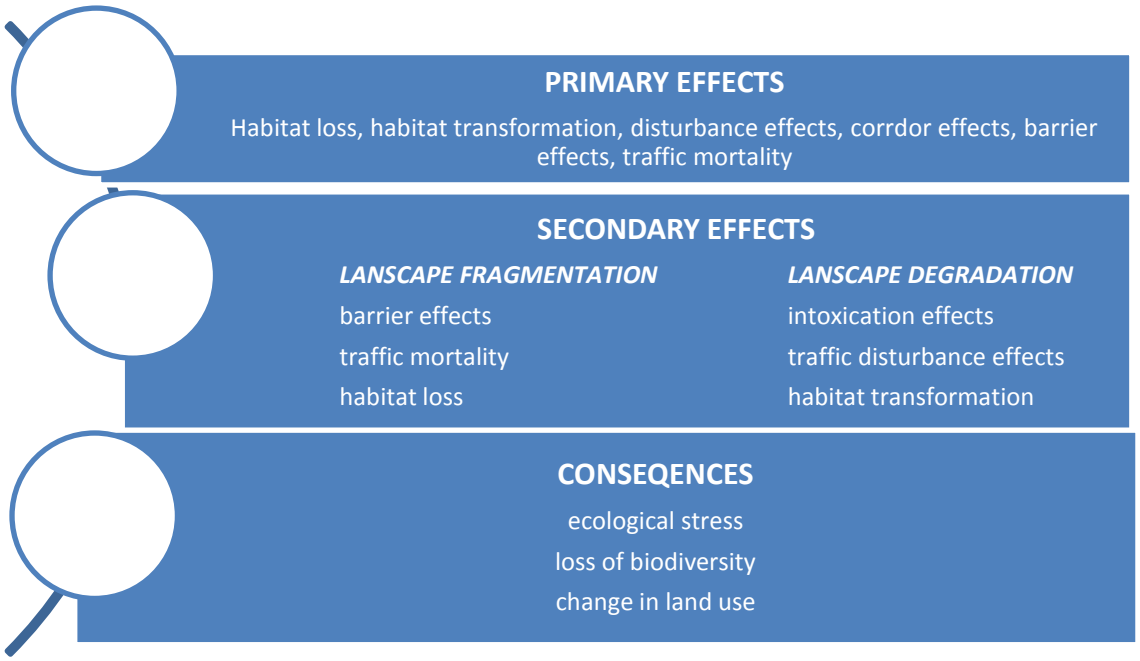

Fig. 1 Cause, effects, and consequences of road construction (Seiler and Eriksson, 1997)

Biodiversity that Turkey has is the demonstration of the delicate and natural balance in the region. Industrial development and rapid population growth taking place lately have become real threats for the natural balance of the ecosystems and the sustainable management of these. Practicing an affective WL managing mechanism for Turkey depends on making and executing WL protecting plans, especially on source inventory, WL development plans, and hunting ground plans. In this matter, it is important to detect the effects of the highways on the wild life, and making plans about the precautions that can be taken. For the plans to be made, geographical information systems and usage of remote sensing technologies offer very helpful information about data supply [11-12-13-14].

This study was carried on the 30 kilometers part of the Bartın-Karabük highway which is located in wild life in most parts. In 94 points at total, noise measurements were done by using CELL633A1 noise level meter device during the time periods when the traffic density was high. All the data gathered was transferred into GIS platform. While modeling the environmental change of the noise relating to the road, IDW (Inverse Distance Weight) interpolation was used. Later, by measuring the audio surveillance made on parts of the road away from the noise (46.4 dBc/Hz), a noise map was created within the region which reached to this level throughout the road.

MATERIAL AND METHODS

Field of study continues in the Western black sea region of the Bartın-Karabük highway (D-755), from Bartın in the north (D-010) till İstanbul-Samsun intersection (D-100) in the south. Ahmetusta passage is an important route for the cargo and passenger transportation on the highway which is affected by the different natural habitat features with its altitude reaching up to 1030 meters. Truck and rig transportation has an important place in Bartın-Karabük highway. Materials of the Karabük Iron and Steel plant and shipping from Bartın port is carried out by using this road. Besides, this road is also the route between Safranbolu-Amasra tourism centers. Study field is the route of the highway placed in the forest (Fig. 2).

Measurements for the environmental noise in the study field were carried out with a mechanism formed of CELL633 noise level meter, CELL633-A calibrator device and other equipment integrated to these. Noise measurements were carried out within the 30 kilometers part of the Bartın-Karabük highway (D-755) within and outside of the forest (Fig. 3). Measurements were done every 20 and 50 meters about 94 different points up and down gradient on both sides of the road. “Environmental noise measurements” were done at such points as especially turns, long plains and vertical curve turns where noise level would be different. Furthermore, for the average inner-woods noise level, environmental noise measurements were done during the day in different parts of a forest isolated from the highway and the city structures. In environmental noise measurements, weighting values were used in the detection of the low frequency sounds C (dbC). During summer, measurements were done during day hours between 09:30 and 19:00 at the determined points.

All the data were transferred into the GIS platform. While modeling the spatial change of the noise relating the road, IDW (Inverse Distance Weight) interpolation was used. Inverse Distance Weight technique is commonly preferred in producing grid out of the sample points with interpolation. IDW interpolation technique based on the fact that closer points weight more than the further points in the area which is to be interpolated. This technique, as it moves away from the point to be interpolated, decreases the weight and creates a surface interpolation according to the weighted average of the sample points. Weighted moving average is a method commonly used for interpolation. Different weighted forms of

functions were used, but IDW became the best common form in the GIS systems (Fig. 4). IDW is a total interpolator, such that it consolidates the value of the data [15-16-17].

Fig. 2 Study Field

Fig. 3 CEL633 Noise Level Meter and measurement process

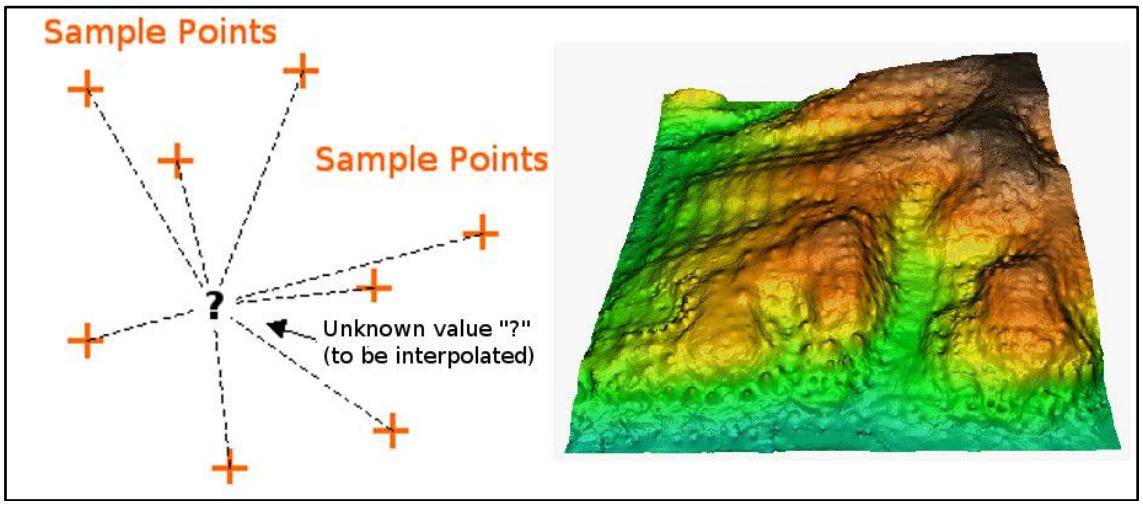

Fig. 4 Inverse Distance Weight (IDW) principle

RESULTS

In the study, measurements were done in the 30 kilometers forest part of the Bartın-Karabük highway (D-755) where wild life is found. Measurements were done every 20 and 50 meters up and down gradient on both sides of the road. Geographical or projection coordinates (UTM) of every point where measurements done were recorded as .xml according to the EUROPEAN DATUM 1950. Every point where measurements were done was transferred to Google Earth database and tested (Fig. 5). Besides, other than the road by the forest, "audio surveillance" measurements were done in the forest away from the settlements and artifacts.

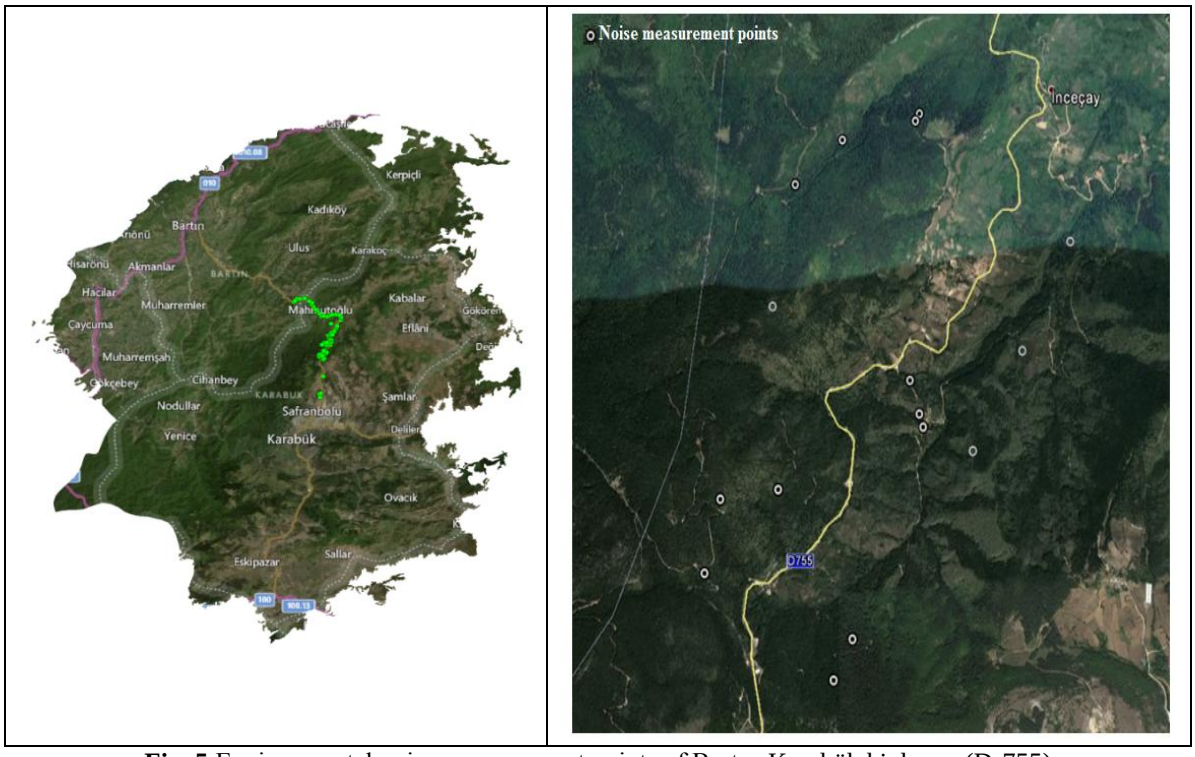

Fig. 5 Environmental noise measurement points of Bartın-Karabük highway (D-755)

Average of the inner-forest sound surveillance was calculated as 46.4 dB (C). Based on this value, measurements were done taking into consideration the measurements done by both sides of the road (up and down gradient) every 20 and 50 meters were interpolated till the threshold value 46.4 dB (C). In this measurements, when the road line is accepted as the center, it was calculated that a buffer zone which is about 350 meters down the road and 150 meters upwards have higher noise measurement values than the threshold value. This buffer zone has a higher value than the value which is accepted the inner-forest threshold value. In this area a noise map was created according to the IDW methodology (Fig. 6).

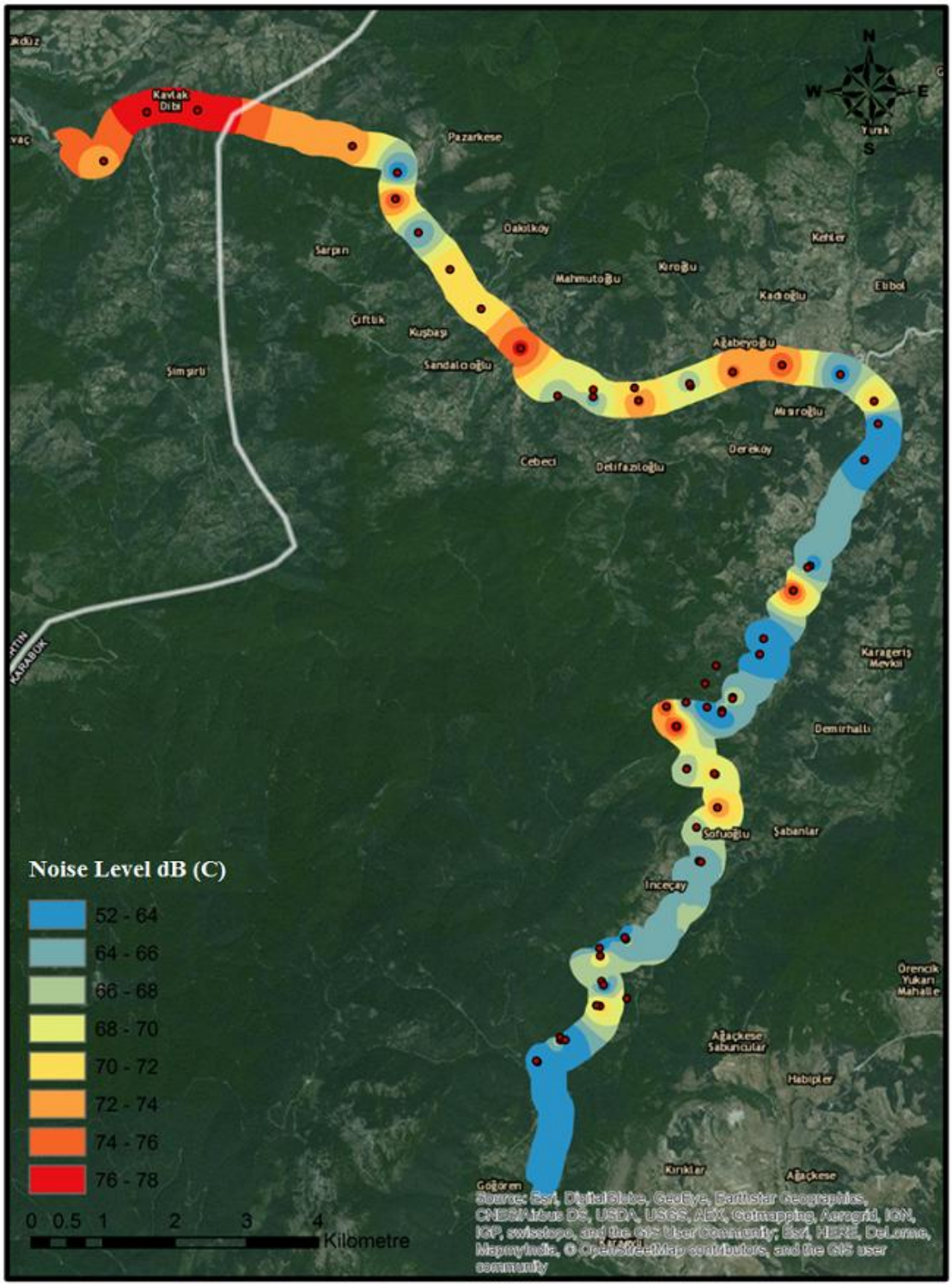

Fig. 6 Noise map of Bartın-Karabük highway (D-755)

It has been seen that in the noise map which was created for the 30 kilometers part of the Bartın-Karabük highway (D-755), the road is partially straight, and at the points which are parallel to the stream, there 76-78 dB (C) noise levels. Starting from the climbing point to the top of the road, except from a few turns, noise was measured as 52-66 dB (C). It was seen that possible transit points for the wild life might be placed in the climbing part of the road.

CONCLUSION

In this study, 30 kilometers part of the Bartın-Karabük highway most of which lies in the wild life was examined in terms of environmental noise. By taking traffic on the road into consideration, a noise map was created. With the calculated noise maps, results below were reached.

- Apart from the road, "sound observation" measurements were done in the forest away from the settlements and artifacts. Average of inner forest sound observations was calculated as 46.4 dB (C). For the buffer zone which would be created for the road, this threshold value was used.
- In the straight parts of the road, it was detected that the noise level 76-78 dB (C) as a result of cars' increasing their speed, motors and exhaust, and so on.
- As the cars ride slower at the climbing part, noise level is at 52 dB (C) which just above the threshold value.
- As the cars turn slowly at the points where vertical curves are found and increase the engine after that, and especially because of engine and exhaust, noise levels reach to 65-78 dB (C).
- The fact that the noise level is pretty high throughout the straight parts of the Bartın-Karabük highway in the forest, affects the habitat and reaching the water source found at some parts of the road.
- It has been observed that the existing trees decreases the noise at different levels depending on the down or upwards gradient.

In the light of these results, it was seen that Bartın-Karabük highway (D-755) is risky for wild life especially for access to the water supply, habitat destruction, and accidents point, and a planning was needed in terms of wild life. In this matter, the suggestions below were offered.

- To be able to prevent and reduce the ecological effects of the roads, firstly political precautions should be taken.
- In the related study field, wild life passages should be formed for the habitat integrity.
- On the straight parts of the road, both for the safety of the drivers and the prevention of the wild life accidents, precautions to reduce the speed limit should be taken.
- By checking the traffic density, at different times, for different vehicles directions to different routes should be made.

In the light of all these results and suggestions, it is important to create criteria and indication according to the ecological factors relating to the study field and handle the wild life in a sustainable Forest Management understanding. By evaluating the ecological effect and analyzing the life cycle, roads with the high negative ecological effects should be made environment friendly.

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