

Noise and Soundscape Mapping in a Mountainous National Park of South Korea

Kyong Seok KI¹; Ji Su YOO²; Hunjae RYU³; Seo Il JANG⁴

¹ Dept. Of Environmental Science and Landscape Architecture, Sangji University, Rep.of Korea

² Dept. of Energy and Environmental System Engineering, University of Seoul, Rep.of Korea

³ Korea Educational Protection Agency, Rep.of Korea

⁴ School of Environmental Engineering, University of Seoul, Rep.of Korea

ABSTRACT

National parks require conservation of the sound environment in order to secure the environment and habitat quality. However, many national parks in Korea are exposed to various noise sources such as roads, airplanes, and cities. Therefore, it is necessary to improve the sound environment in order to preserve the habitat and the environment of national parks. The purpose of this study is to establish management plan through analysis of noise and sound environment for Taebaeksan National park. The noise map modeling result of Taebaeksan National Park showed 91.5% of the total area less than 40dB (A). As a result of aircraft noise analysis, daily average aircraft noise frequency was 54 times and 16 times per hour. Airplane noises occurred on Monday and Friday by day of the week. As a result of soundscape mapping, the frequency of the biophony such as various birds and insects was high in the valley. High altitudes were less frequent in wild animals. For the noise management of Taebaeksan National Park, it was considered necessary to manage aircraft noise and road noise.

Keywords: road-traffic noise, aircraft noise, biophony, geophony, anthrophony

1. INTRODUCTION

Nature sound in quiet environment is one of the most important reasons for the existence of national parks(Haas and Wakefield, 1998). In order to maximize the experience of visitors in national parks, conservation of sound environment is necessary(Newman & Dawson, 1998). Noise increases the risk of accidents by interfering with the communication between the rangers and visitors in dangerous activities in national parks(Lynch et al., 2011).

Most of the national parks in Korea are geographically adjacent to the city. and the density of infrastructure such as highway, railway, and airport is so high that the national parks are exposed to road-traffic noise, railway noise, and aircraft noise. There are many large facilities such as military bases or broadcast towers in the ecologically sensitive highlands inside the national parks.

The purpose of this study is quantifying the anthropogenic noise in the national park in Korea through the noise mapping and find out the noise impact on ecosystem. And Developing soundscape mapping and noise analysis methods in the national park trails to investigate the impact on visitors and wildlife. This study can be used as basic data for sound environmental management in national park.

¹ gf@aaa.com

² gf@bbb.co.jp

³ gf@ccc.go.jp [Please note: It is optional to provide the email address(es) of the author(s). Please make sure that your co-authors concur with the mention of their email address in this paper.]

⁴ gf@bbb.co.jp

2. Methods

The study area is Taebaeksan National Park (70.1km²) of Korea. The study period is from May to December 2018. Noise mapping program is SoundPLAN(ver. 7.4.). Road-traffic estimation model (road-traffic noise, parking lot) is RLS90. Attenuation of sound during propagation outdoors is ISO 9613-2(1996). Grid size for calculation is 50m × 50m. Spatial background is district of Taebaeksan national park. Temporal background is day-time (06:00 ~ 22:00). A-weighted equivalent noise level is LAeq [dB(A)]. Input variable is field measurement value. The number of field measurement points is 20 roads, 11 parking lots, 1 commercial district, 1 park village and 2 wind farms.

Aircraft Noise mapping program is INM. Aircraft noise was measured in June 2018. The flight path of the aircraft was visually identified from the field. Aircraft noise field measurement points were three flight paths. The INM model application environment is temperature 70.9F, humidity 50.4%, wind speed 1.9kt, air pressure 29.73 in-Hg, no precipitation (mm), weather clear. F16GE and A10A models were applied to aircraft noise modeling. The average number of flight training events was 60 times a day.

The sound environment survey method is Soundwalk. Sound recording equipment is Idampro digital recorder. Noise measurement equipment is Sound Level Meter GM156. GPS device is rambler. Spatial background is Taebaeksan national park trails. The number of trail sounding is 111 points. The survey parameters were dB (A), sound intensity, preference, and satisfaction. Trail sound grade classification was used for factor analysis and cluster analysis.

Soundscape analysis used sound files recorded in the national park(111 points). The types of sound landscape analysis were biophony, geophony, and anthrophony. Biophony is divided into birds, mammals, and insects, geophony is wind and rain, anthrophony is people, cars, music, airplanes, and machine sounds. The soundscape analysis program is Adobe Audition CC (version 6.0), Microsoft Excel 2010, and IBM SPSS (version 23).

3. Results

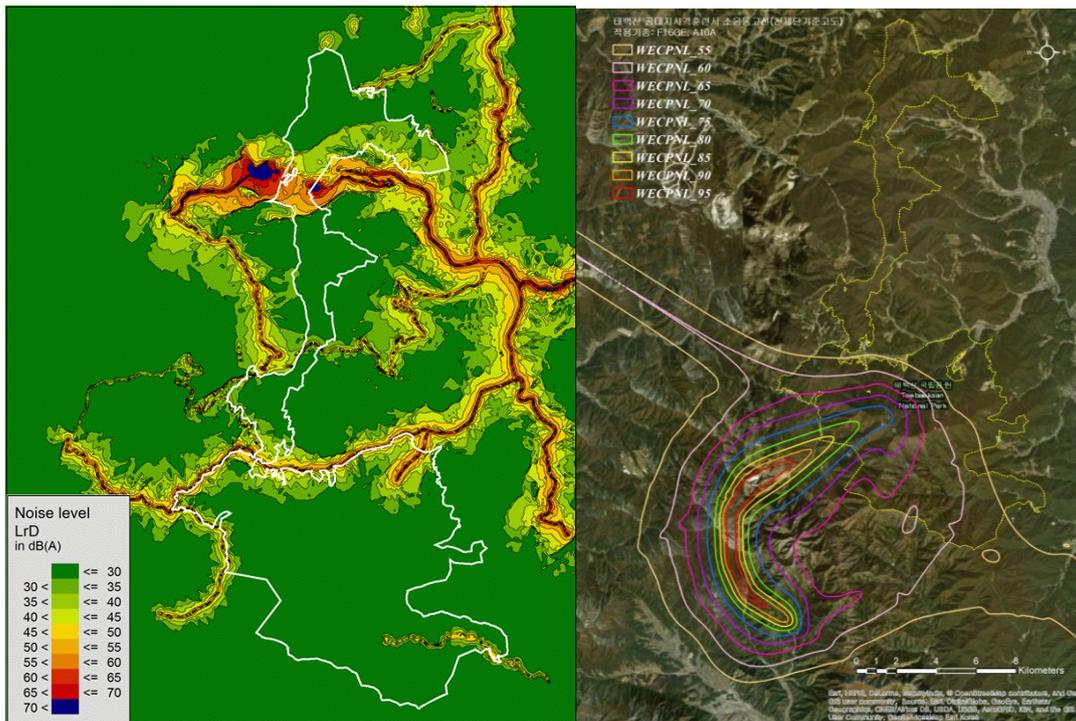
3.1 Noise mapping

The noise map modeling result of Taebaeksan National Park shows that 91.5% of the total noise is less than 40dB (A), 5.4% is 40 ~ 50dB (A), and 3.0% is more than 50dB (A). In Taebaeksan National Park, less than 50dB (A) accounted for 96.9% of the total. If there is no aircraft noise, it means a very quiet environment. The Taebaeksan National Park was spreading to the inside of the park by the penetrating roads in the north and south. Especially, the noise around tunnel entrance was high.

As a result of analyzing the aircraft noise, daily average aircraft noise frequency was 54 times and 16 times per hour. Aircraft noise was particularly common on Mondays and Fridays. As a result of the analysis of the aircraft noise map, the area over 50WEPCNL was 52.4% based on the whole park. The aircraft noise intensity at the top of Taebaeksan peak, which is the most visited, is 70 ~ 75WEPCNL. Aircraft noise is expected to have a negative impact on visitors and creatures over the long term.

Table 1. Area and ratio of road-traffic noise level in Taebaeksan nationalpark

dB(A)	area(m ²)	ratio(%)	
less 35	58,866,668	83.8	91.5
35-40	5,436,378	7.7	
40-45	2,301,273	3.3	
45-50	1,520,945	2.2	5.4
50-55	1,254,046	1.8	
55-60	667,945	1.0	
60-65	144,469	0.2	
65-70	49,615	0.1	
70-75	20,078	0.0	3.0
over 75	4,876	0.0	
Sum	70,266,294	100.0	



a. Road-traffic noise map

b. aircraft noise map

(c) OpenStreetMap contributors

Figure 1. Noise map of Taebaeksan nationalpark

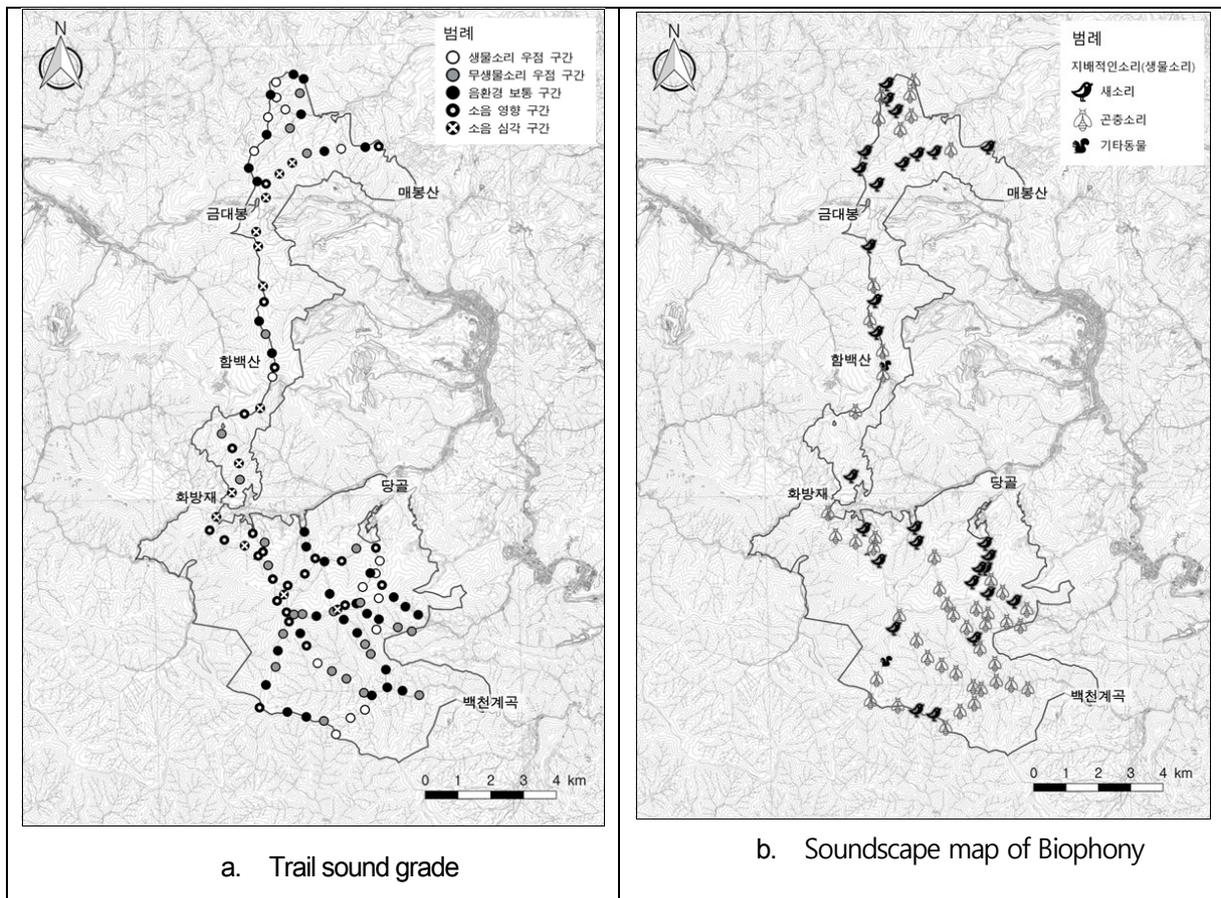
3.2 Trail sound environment

As a result of the sound grade classification, the average sound grade (30.7%) was the most widely distributed. The geophony dominant grade and noise impact grade were 21.6%. The biophony dominant grade was 14.4% and the noise severity grade was 11.7%.

As for the spatial distribution of the sound grade, the Daedeok Mountain Valley in the northern part of Taebaeksan National Park and the Baekcheon Valley in the southern part have good sound environment. On the other hand, the bad sound environment was near the road and air force training area.

3.3 Soundscape

As a result of soundscape analysis, Insect sound (60.8%) was the most widely distributed, followed by birds (36.7%) and other animals (2.5%). There was a lot of insect sound around the valley part of the southeast side of Taebaeksan. And The northern forests of Taebaeksan mountain had a lot of wild bird sounds. Geophony was dominated by wind sound(67.8%), followed by water sound(24.7%). The ridge of the Taebaeksan National Park was dominated by wind sound and the valley was dominated by water sound. Among the anthrophony, airplane sound (40.8%) was the most widely distributed. The people sound was 28.6%, road traffic sound was 20.4%.



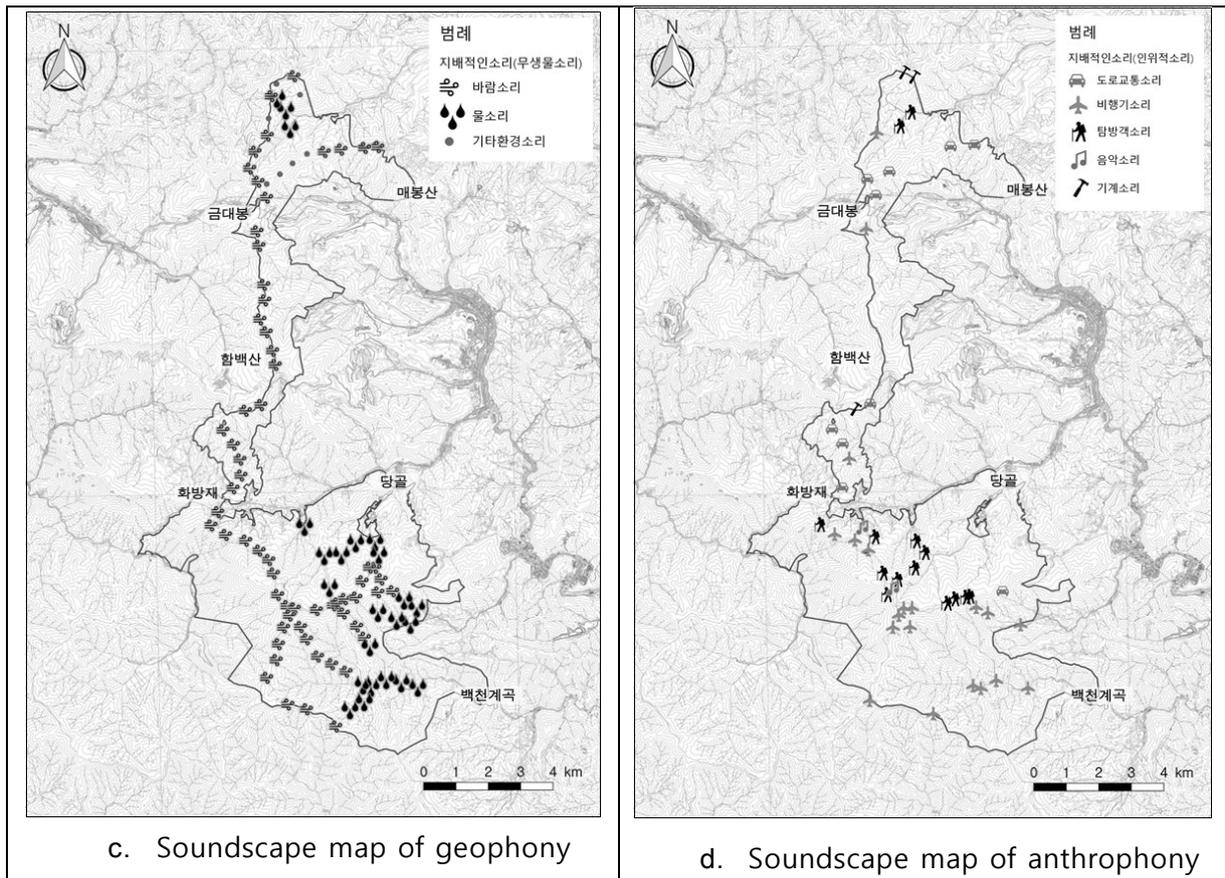


Figure 2. Trail sound grade map and soundscape map of Taebaeksan nationalpark

4. CONCLUSIONS

We introduced the noise and soundscape mapping method of the mountainous national park in Korea. The results show that Taebaeksan nationalpark is affected by road and aircraft noise. Such noise is expected to lower the quality of the natural experience and adversely affect wildlife habitat. Therefore, we need to recognize the need for management of noise in national parks. The results of this study will be used as basic data for noise management in national park.

ACKNOWLEDGEMENTS

This study was conducted with the support of Korea Research Foundation (NRF-2017R1C1B1008457) and Korea National Park Service.

REFERENCES

1. Haas, G. E., & Wakefield, T. J. (1998). National parks and the American public: a national public opinion survey on the National Park System: a summary report. The Association.
2. Lynch, E., Joyce, D., & Fristrup, K. (2011). An assessment of noise audibility and sound levels in US National Parks. *Landscape ecology*, 26(9), 1297.
3. Newman, P., & Dawson, C. P. (1998). The human dimensions of the wilderness experience in the High Peaks Wilderness Area(Master's thesis, State University of New York. College of Environmental Science and Forestry, Syracuse, NY).