学 位 論 文 内 容 の 要 旨

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学 位 論 文 題 名

Recreational impacts on unmanaged campsites in Daisetsuzan National Park and suitable management strategy to enhance site sustainability
（大雪山国立公園の野営指定地におけるレクリエーションの影響と持続可能性を高めるための適切な管理戦略）

In mountain regions where the constructions of cabins and huts are difficult, campsites usually play important roles in accommodating overnight users. Camping activities have several negative impacts, including the expansion of and proliferation of bare grounds, soil erosion, conflicts, and crowding problems in the sites. In national parks, to avoid serious resource degradation and social conflicts caused by camping, efforts to monitor and maintain campsite conditions are widely practiced. However, in many national parks, efforts to monitor and manage soil erosion are still insufficient or even lacking. Owing to the lack of implementation of formal management practices, some campsites in Daisetsuzan National Park (DNP), northern Japan, have suffered serious soil erosion, bare ground expansion, and crowding problems, which may deteriorate the site's sustainability.

This study aims to identify the variety of recreational impacts and use levels in unmanaged campsites, gain more insights into campsite soil erosion, assess the effectiveness and applicability of the management actions for minimizing camping impacts, propose an appropriate management system to mitigate the problems observed in unmanaged campsites, and further promote sustainable use of campsites in mountain national parks. This study was mainly conducted in DNP, the largest mountain national park in Japan. In addition, another two mountain natural parks in Japan (Chubusangaku National Park and Yatsugatake-Chushin Kogen Quasi-National Park), and three mountain national parks in Taiwan (Yushan National Park, Shei-Pa National Park, and Taroko National Park) were selected as targets to study about their advanced campsite management. The bare grounds and informal trails in 12 unmanaged campsites in DNP were mapped using georeferenced aerial photographs taken in 2017. The use level and site occupancy of three representative campsites were monitored using lapse cameras in the camping season of 2019. Structure-from-motion (SfM) photogrammetry surveys with ground control points (GCPs) were conducted three times consecutively in the current (2017, 2018, and 2019) and former Kuro-dake campsites (2018, 2019, and 2020) in DNP for short-term monitoring of soil erosion. The effectiveness and applicability of the advanced campsite management including reservation system and installation of tent pads/platforms in the target national parks were studied by structured interview surveys with the corresponding managers during the period 2018–2020. Additionally, the perspectives of campsite users (n = 189) and stakeholders (n = 19) on the necessity and possibility of introducing management actions to the unmanaged campsites in DNP were identified through questionnaire surveys and focused group discussions, respectively.

The results show that problems related to the spatial distribution of campsites, bare ground expansion, and unbalanced use level all exist in DNP. The informal camping spaces (n = 15) identified in the long-distance trail section (between Minami-numa

campsite and Futago-ike campsite) indicated that reconsideration of the current site distribution is necessary. Currently, the 12 campsites have contributed a total of 9470 m^2 of bare grounds in DNP. Informal trails were mainly observed in eight campsites with separated bare grounds. Over-expansion of bare grounds was identified in the less-visited Ura-Asahi campsite (mean use level = 2 tents/night), which holds an area of 1898 m^2 bare grounds. On the most crowded day during the study period, the average area occupied by each tent was 146.0 m^2 and 8.8 m^2 in the Ura-Asahi campsite and the Kuro-dake campsite, respectively. In contrast to the Ura-Asahi campsite, an overcrowding condition in the Kuro-dake campsite could be imagined. Both over-expansion of bare grounds and overcrowding problems might deteriorate the site's sustainability.

In the monitoring of soil erosion, elevation change that exceeded 3–4 cm was successfully detected by using the DEMs of Difference (DoDs) maps. Considerable soil losses were detected in the current campsite (2.20 m^3) and former Kuro-dake campsite (22.27 m^3) in the periods of 2017–2018 and 2019–2020, respectively. In the case of the current campsite, the vertical and horizontal development of the deep gully running through the site contributes most to the soil loss. Terminating the connection between the current campsite and the downstream slope was suggested for preventing gully development. Significant soil erosion was still detected both on the bottoms and walls of deep gullies even after long-term closure. Meanwhile, considerable elevation changes (>10 cm) were also identified in the areas without gullies, indicating the development of new gullies. To effectively reduce the camping impacts on the former campsite, rehabilitation efforts that promote the recovery of vegetation cover and mitigate soil loss should be considered.

Due to the small density of cabins (0.07–0.09 facilities/km), campsites are considered necessary for overnight users to complete their trips in the three surveyed Taiwan's national parks. In Yushan National Park and Shei-Pa National Park, the number of campers to stay at each campsite is limited based on its capacity. In Taroko National Park, the number of trekkers to enter different trail sections is limited by corresponding trailhead quotas. The managers of the three national parks believed that the introduction of a reservation system has not only reduced the crowding problem in campsites but also improved the quality of the camping experience. However, there is still a crowding problem caused by unauthorized camping in some campsites. Further improvement of the reservation system is needed. In the three surveyed campsites in Japan, different types of tent pads/platforms were mainly introduced as an option to accommodate more campers in unideal terrains. Only the tent pads at Enzanso campsite were recognized as effective in reducing soil erosion. Different levels of maintenance were conducted for the tent pads/platforms in the three campsites.

In DNP, more than 60% of the respondents recognize the necessity of limiting the number of users in the campsite, especially on crowded days. In addition, better availability of toilets at campsites and a larger number of campsites were expected mostly by users. Both the users and stakeholders showed positive attitudes to introducing a reservation system for campsites. Most users were positive about introducing different types of tent pads/platforms to campsites in DNP. On the other hand, introducing tent pads/platforms to increase the capacity of the campsite where necessary was more positively considered by stakeholders. It indicated that introducing tent pads/platforms was one possible option for improving the camping environment in DNP.

This study demonstrated that the use level and site occupancy data collected by lapse cameras and the 3D data of the campsites collected through SfM surveys could become powerful tools for future monitoring of campsites. These monitoring methods were included in the campsite management framework proposed by this study. The findings will help identify different kinds of problems related to use level, the extent of bare ground, and development of soil erosion, which are closely related to the sustainability of campsites in DNP and other mountain national parks. In addition, the applicable management responses to improve site sustainability under different conditions were also suggested by this framework.