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学 位 論 文 審 査 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)

Camping activities have several negative impacts, including the expansion and proliferation of bare grounds, soil erosion, conflicts, and crowding problems in the sites. In many national parks, efforts to monitor and mitigate soil erosion at campsites are still insufficient or lacking.

This study aims to identify the recreational impacts and use levels in unmanaged campsites, monitor campsite soil erosion, assess the effectiveness and applicability of the management actions for minimizing camping impacts, propose an appropriate management framework 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 Daisetsuzan National Park (DNP), Japan's largest mountain national park. In addition, other 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 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. Three representative campsites' use level and site occupancy were monitored using lapse cameras in 2019. Structure-from-motion (SfM) photogrammetry surveys with ground control points (GCPs) were conducted three times in the current (2017, 2018, and 2019) and former Kuro-dake campsites (2018, 2019, and 2020) in DNP to monitor soil erosion. The effectiveness and applicability of the reservation system and the tent pads/platforms utilized in the target national parks were studied by structured interview surveys with the managers from 2018–2020. Additionally, the perspectives of users (n = 189) and stakeholders (n = 19) on the necessity and possibility of introducing management actions to 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 sites ($n = 15$) identified around the long-distance trail section (between Minami-numa campsite and Futago-ike campsite) indicated that reconsidering the distribution of campsites is necessary. Informal trails were mainly observed in eight campsites with separated bare grounds. On the most crowded day, 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. Both over-expansion of bare grounds and overcrowding problems might deteriorate the site's sustainability.

Considerable soil losses were detected in the current (2.20 m^3) and former Kuro-dake campsite (22.27 m^3) in 2017–2018 and 2019–2020, respectively. Soil erosion was detected on the bottoms and walls of deep gullies at the former campsite, even after long-term closure. Maintenance efforts and rehabilitation efforts after site closure should be considered to mitigate the soil loss from the current and former campsites.

Two different methods to limit use in reservable campsites were identified in three Taiwan's national parks. The managers believed that introducing a reservation system has reduced the crowding problem in campsites and 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, the utilization of different types of tent pads/platforms helped the managers to accommodate more campers in unideal terrains. The tent pads at the Enzanso campsite were recognized as effective in reducing soil erosion. Different levels of maintenance were conducted for the tent pads/platforms to sustain their effect.

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, users expected to increase the number of campsites and maintain the undulating grounds at campsites. All these expected improvements indicated a necessity to introduce formal management to change the current camping condition in DNP. The users and stakeholders showed positive attitudes toward introducing a reservation system for campsites. Introducing tent pads/platforms to the campsites with unideal terrain to improve the camping environment in DNP was possible. Some stakeholders agreed to recognize part of the informal sites in the long-distance trail section as campsites to meet user demands.

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 the future monitoring of campsites. These monitoring methods were included in the campsite management framework proposed by this study. The findings will help identify problems related to use level, bare ground extent, and soil erosion development, which are essential for enhancing the sustainability of campsites in DNP and other mountain national parks. In addition, the appropriate management responses to improve site sustainability under different conditions were also suggested by this framework.

In addition to the excellent academic knowledge in the research, her academic records throughout the Ph.D. course are outstanding. Based on these pieces of evidence, the committee concluded that Ting Wang deserves to become a Doctor of Environmental Science.