Estimation of the environmental load of mountaineering activities in the Mt.Manaslu region

***Hijiri SHIMOJIMA**, Faculty of Regional Environment Science, Tokyo University of Agriculture, Japan, h3shimoj@nodai.ac.jp*

Introduction

Manaslu is one of the 8,000-meter peaks ranking as the 8th highest peak in the world, located 130 km northwest of Kathmandu, the capital of Nepal. Since Manaslu's normal route (general climbing route) is relatively less difficult, the number of Manaslu's climbers have increased rapidly over the last 10 years. Sixty years have passed since Manaslu was first conquered by a Japanese expedition. The popularity of its scaling and the rapidly growing tourism in the Nepal Himalayas after 1970 are noticeably affecting natural, social, and cultural environments in the area. This in turn, is creating serious environmental issues at the Manaslu Base Camp (4,800 m above mean sea level), the entry point for climbing Mt. Manaslu.

In this research, we aim to develop a system that can combine high resolution imagery and Digital Surface Model (DSM) in the base camp and simple monitoring into one method in order to estimate the environmental burden associated with the climbing activities in the Manaslu Base Camp. We performed aerial photography of the base camp using Unmanned Aerial Vehicle(UAV) and created DSM from Structure from Motion (SfM) of the obtained images. At the same time, positioning data of the feature was acquired through a Differential Global Positioning System (DGPS) survey, and a 3D topographic map was created.

Method

The geographical area covered in this study is the Manaslu Base Camp in the Manaslu Conservation Area's, Gorkha District which is located in Northwest Nepal. In order to elucidate the actual usage of the Manaslu Base Camp, a field survey was carried out in August, 2016 at and around the Manaslu Base Camp using UAV. We conducted the following investigations at the Manaslu Base Camp: survey of the Base Camp, questionnaires to all the mountaineering parties at the Base Camp, survey of the water quality at the Manaslu Base Camp. We monitored the actual usage of the Manaslu Base Camp in order to clarify the number of tents and their locations by photointerpretation using high resolution satellite images.

In the survey of the Base Camp using UAV, we acquired a high resolution image using Phantom 4 of DJI. Using the obtained high resolution image, 3D terrain data and an ortho mosaic image was generated from the SfM, and a map of the Manaslu base camp was created. In the DGPS base camp survey, we recorded location information of features such as tents, toilets and routes in the Manaslu base camp. We conducted a water quality test in the Manaslu base camp using a portable multi - item water quality inspection machine.

Results

Survey of the Base Camp

A topographical survey of the Base Camp was conducted to pinpoint the location of each tent and to grasp the topographical features of the area. The Base Camp in the post-monsoon season is shown in the MANASLU BASE CAMP TOPOGRAPHIC MAP 2016 AUGUST.

We were probably the first in the world to create a topographical map of the Manaslu Base Camp that shows detailed positioning of the campsite. There were 32 kitchen tents,58 toilet tents, 42 altars (places to pray for safe climbs) in the post-monsoon season. The resolution of the obtained high-resolution image was 0.009 m. The flight time used for image acquisition was about 60 minutes. In the aerial shooting using UAV, we flew 50 to 80 m above ground and photographed a small area of about 600 m × 200 m.

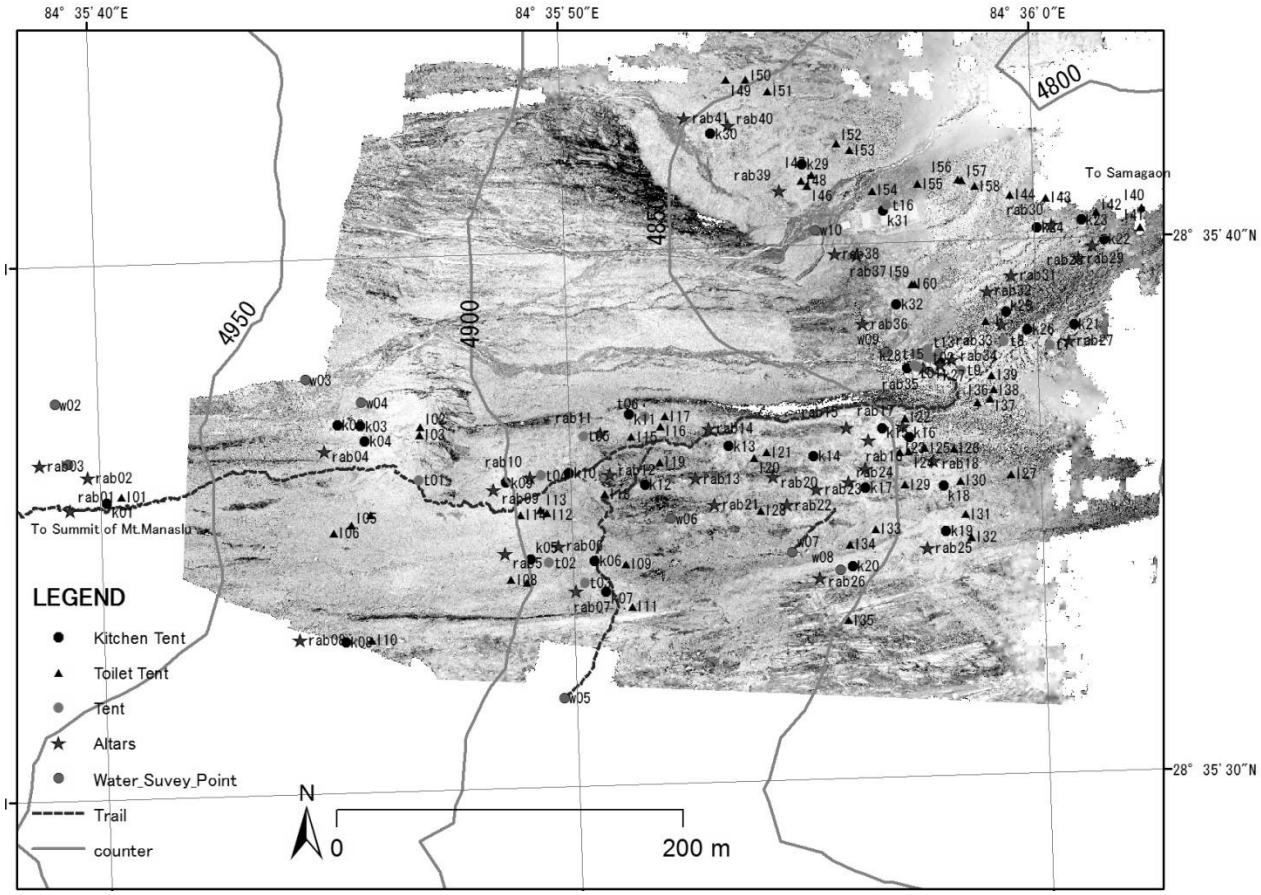

Figure 1. Manaslu base camp topographic map 2016 august

Questionnaires to all the mountaineering parties at the Base Camp

Inquiries were made to every party staying at the Manaslu Base Camp in 2016 August. The questionnaires enquired about the following information: Number of members in each party; number of belongings brought in and out; number of donkeys used to carry equipment; and environmental considerations taken by each party. Results of the questionnaire show that during the post-monsoon season, at least 46 tons of equipment was brought into the Base Camp. Furthermore, over 780 donkeys and many porters were used for transportation during the post-monsoon season. The enormous amount of excrement produced by these donkeys is one of the main sources of resource contamination.

Survey of water quality at the Manaslu Base Camp

Water quality research was conducted at 10 locations of the Base Camp: water collection points; filtering drainage; and inflow points of contaminated water. HNO_2 at the collection points were 10 mg/L, which indicated that the water was badly contaminated from the upper campsite. Drinking or cooking water is usually sterilized by boiling. However, it was

revealed from this research that the headspring itself was contaminated. We can conclude that the sources of contamination were not only from the toilets used by people, but also from the enormous amount of waste generated by the donkeys, and waste water from the kitchens, showers, and laundry areas of each party.

Conclusion

A few of the findings of this study after three surveys in August 2016 at and around the Manaslu Base Camp are as follows. (1) A topographical map of Base Camp was prepared pinpointing the location of each and every tent of the area. We are the first in the world to prepare such topographical map of the Manaslu Base Camp using UAV. (2) Inquiries were conducted with each group staying at the Base Camp regarding the number of members in each party, quantity of goods brought in and out, and number of donkeys used for transportation. The results of the questionnaires show that during the pre-monsoon period in 2016 an astounding 46 tons of goods were brought into the Base Camp. Furthermore, over 780 donkeys were used for transportation. (3) Water quality research was also conducted at water collection points of the Base Camp. The water was found to be badly contaminated because of the urine and excrement of donkeys that were found scattered over the Base Camp.