Investigation for Rice Terrace with UAV through IR Filters

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1. Introduction

Recently, UAV (Unmanned Aerial Vehicle) technology are developed rapidly. UAV may work at lower cost than satellite or aerial photos. The expansion of research for UAV is expected. However, the number of bands for UAV is less than satellite images. In this study, UAV, a digital camera, aerial photos, and satellite data were used in multiple types.

In paddy cultivation, an irrigation system is more important than flat rice fields. Terraced paddy fields have been abandoned for an acreage-reduction policy since 1970s. Now, 40% of terraced paddy fields are abandoned. Abandoned rice fields are a serious problem. After 1990, some activities are done to protect paddy fields. In 1992, "Rice terrace order system", the resident of a city experience rural lives with farmers, started. In 1995, “Rice terrace summit” started to inform necessity for preservation of rice fields and to obtain understanding and agreements. In 1999, the Ministry of Agriculture, Forestry and Fisheries evaluated rice fields to preserve. Onigi terraced rice fields was developed in the Edo era and had some functions: flood disaster prevention, water retention, and landslide prevention.

The objectives of study were: (1) to get RGB, near infrared, and short infrared images with high resolution in multiple types by UAV and a digital camera, (2) to obtain NDVI and NDWI (normalized difference water index) images with UAV and a digital camera, and (3) to monitor vegetation covers and to make a land-use map with UAV and a digital camera.

2. Methods

2-1. Photographing methods with UAV

Phantom 4.0 Professional was used in this research. First, UAV was flown in the survey field. Next, a filter, IR72 was set on UAV camera to obtain NDVI. Finally, a list of bands in this study is shown in Table 1.

Table 1 List of bands

Band	Wave length(nm)	Electric Magnetic Wave
1	450-520	Blue
2	520-600	Green
3	630-690	Red
4	760-900	Near Infrared
5	900-	Short Infrared

2-2. Calculation of NDVI and NDWI with Photoshop

NDVI was calculated with Adobe, Photoshop CS6 by subtracting orthogonal photos in Band 3 from orthogonal photos in Band 4 at the same position. NDVI is shown as next.

$$\mathrm{NDVI} = \frac{Band4 - Band3}{Band4 + Band3} \quad (1)$$

NDWI was calculated with Photoshop CS6 by subtracting orthogonal photos in Band 3 from orthogonal photos in Band 5 at the same position. NDWI is shown as next.

$$\mathrm{NDWI} = \frac{Band3 - Band5}{Band3 + Band5} \quad (2)$$

2-3. Methods for calculating a catchment area

Surfaces were smoothed from DEM (Digital Elevation Model) in a 3D model with ESRI, ArcGIS. Furthermore, flow direction raster and cumulative-flow-rate value raster were made from DEM (Digital Elevation Model). Finally, catchments were calculated with flow-direction raster and cumulative flow-rate-value raster with ArcGIS.

2-4. Methods for detecting land-use maps

Band 3 distributions were calculated in the survey field with PhotoScan. Band 3 distribution could make land-use maps because vegetation absorbed Band 3, red.

3. Results and Discussion

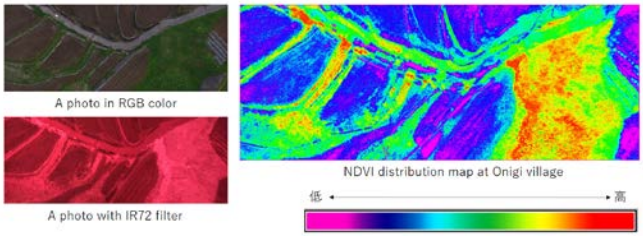

Fig. 1 NDVI at Onigi village (UAV)

Fig. 1 shows NDVI distributions in Onigi Village with 3 cm resolution using UAV in April 17, 2016. NDVI indicated equally low in paddy fields because rice planting did not start. NDVI was high in paddy fields that have been abandoned and are no longer cultivated.

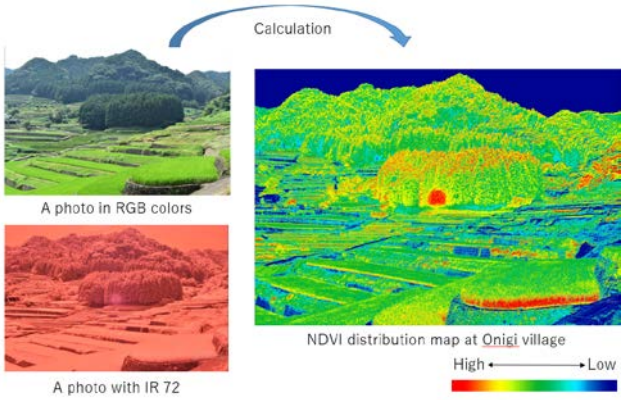

Fig. 2(a) NDVI at Onigi village (Digital camera)

Fig. 2(a) shows NDVI distributions in Onigi Village. NDVI indicated equally medium in paddy fields. NDVI was low in paddy fields that have been abandoned and are no longer cultivated. NDVI became medium or high in tea plantations.

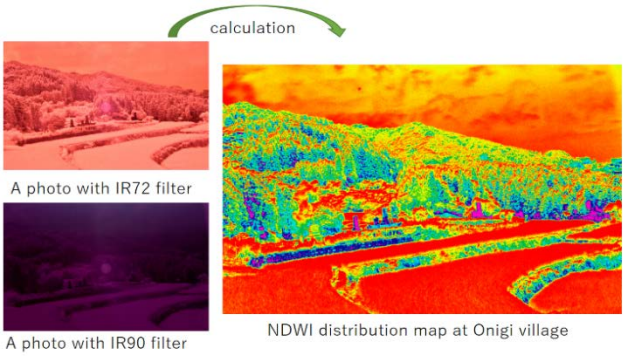

Fig. 2(b) NDWI at Onigi village (Digital camera)

Fig. 2(b) shows NDWI distributions in Onigi Village in July 30, 2016. NDWI was equally high in paddy fields because vegetation evaporated vapor. NDWI showed medium in paddy fields that have been abandoned and are no longer cultivated. NDWI became low in at the stone walls.

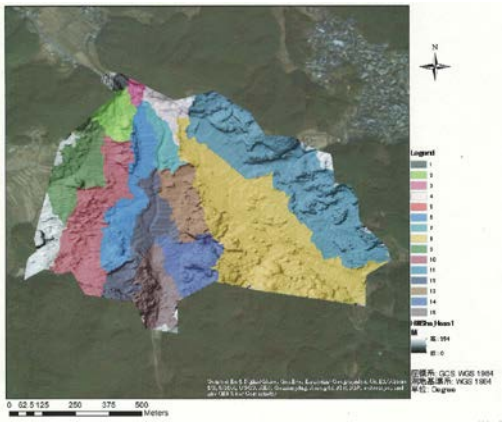

Fig. 3 Shaded-relief map and watershed at Onigi village

Fig. 3(a) shows a shaded-relief map and watershed in Onigi Village. Watershed at Onigi village was obtained from DEM with 15 cm resolution.

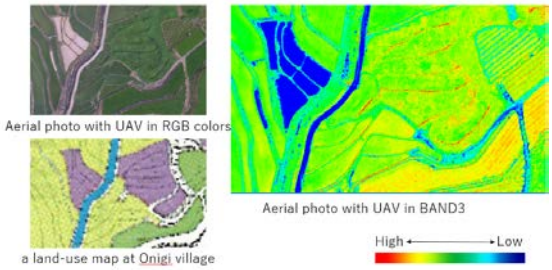

Fig. 4 Making a land use map at Onigi village

Figs. 4 shows making a referenced land-use map. According to Figs. 4, rice fields showed green or yellow equally in Band 3 photo, paddy fields that have been abandoned and are no longer cultivated were blue or scattered green, red and yellow, and also tea plantations became red or yellow linearly.

4. Conclusions

RGB, near infrared, and short infrared images were obtained by a digital camera with band pass filters, while RGB and near infrared were inquired by UAV with 6 cm resolution. NDVI images were obtained by a digital camera and UAV with IR72, while NDWI images were estimated by a digital camera with IR72 and IR90, which estimates water contents and permeability in soils. Vegetation cover was monitored in any time and also land use map was obtained from DEM with 15 cm resolution.

References

1) T. Nagahuchi, Y. Imamura, A study on the landscape characteristic of Onigi rice terraces in Hasami Town, pp. 32-44, 2016
2) S. Otsubo, S. Ogawa, H. Hidaka, G. Yamada, Present State of UAV and Applications for Civil Engineering, *NAOSITE*, 46(87), pp. 43-49, 2016.