Mapping Urban Areas Using the Landsat-8 Image Acquired in Daegu, South Korea by Using Machine Learning and Urban Index

Yun-Jae CHOUNG, Eung-Joon LEE, and Hyeoung-Wook CHOI

Abstract: Mapping urban areas is important for monitoring urban development and preventing urban disasters. In this research, the two algorithms such as machine learning and urban index were employed for mapping the urban areas using the Landsat-8 image acquired in Daegu, South Korea through the following steps. First, the machine learning technique was employed for detecting the urban areas from the given Landsat-8 image. Next, the urban areas were also detected from the urban index image generated using the multispectral bands of the Landsat-8 satellite image. Finally, the accuracy of both urban areas was separately assessed.

Keywords: Urban areas, Landsat-8 image, Machine learning, Urban index

1. Introduction

An urban area is defined as the region surrounding a city where many people live and work close together (National Geographic, 2019). In general, mapping urban areas is significant for monitoring urban development and protecting urban areas from urban disasters (Choung and Kim, 2019). However, it is difficult to map the urban area due to the difficulty of identifying the various urban features in huge areas (Choung et al., 2019). Recently, the remote sensing datasets have been widely used for mapping urban areas through the various approaches. Choung and Kim (2019) employed the machine learning technique for mapping the urban area from the satellite imagery. Choung et al. (2019) utilized the urban index derived from the multispectral bands of the satellite imagery for mapping the urban area.

However, previous research has been limited for mapping urban areas by comparing between both approaches (the machine learning technique and the urban index) for mapping the urban areas using the high-resolution satellite image.

2. Data and Study Areas

This research selected the urban area of Daegu City, South Korea due to data availability (see Figure 1).

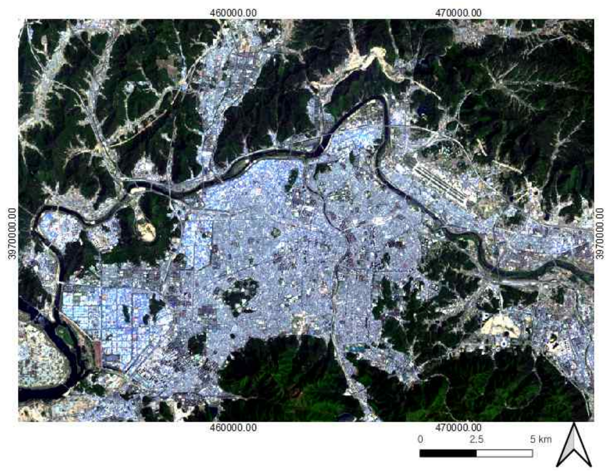

Figure 1. Urban area of Daegu City, South Korea

The Landsat satellite image was acquired on

Yun-Jae CHOUNG, Eung-Joon LEE and Hyeoung-Wook CHOI
Institute of Spatial Information Technology Research, GEO C&I Co., Ltd, 435 Hwarang-ro, dong-gu, Daegu, Republic of Korea
chyj@geocni.com, ejlee00@geocni.com, hwchoi@geocni.com

April 29, 2017 by the Landsat-8 OLI (Operational Land Imager) sensor, and the given Landsat-8 satellite image consists of the six bands (blue: 450 – 520 nm; green: 520 - 600 nm; red: 630 - 690 nm; near-infrared: 851-879 nm; short-wave infrared1: 1566-1651 nm; short wave infrared2: 2107-2294 nm) with the spatial resolution 15 m (USGS (United States Geological Survey), 2019).

3. Methodology

Figure 2 shows the flowchart of the procedure for mapping the urban areas using the Landsat satellite image acquired in Daegu City, South Korea by comparing the approaches of the machine learning technique and the urban index, respectively.

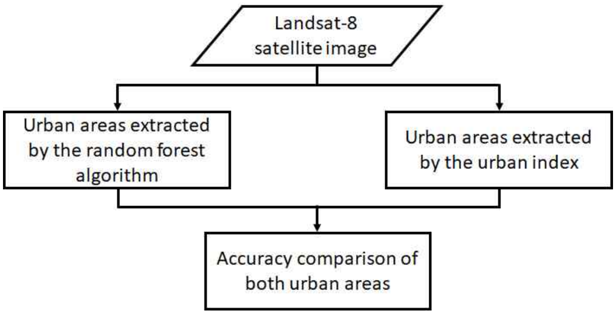

Figure 2. Flowchart of the procedure for mapping the urban areas using the Landsat satellite image acquired in Daegu City, South Korea by comparing both approaches of the machine learning technique and the urban index.

In the first step of the proposed methodology, the urban areas were extracted from the given Landsat-8 satellite image by using the random forest algorithm, a widely used machine learning technique. Figure 3 shows one section of the urban areas extracted from the given Landsat-8 satellite image by using the random forest algorithm.

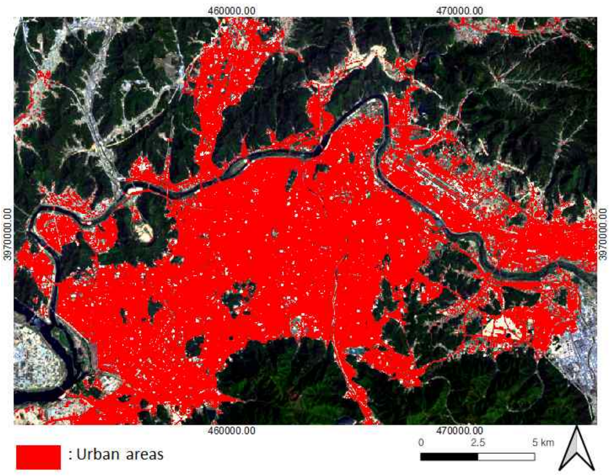

Figure 3. One section of the urban areas extracted from the given Landsat-8 satellite image by using the random forest algorithm.

The next step was to extract the urban areas from the given Landsat-8 satellite image by using the urban index that can be generated by using the below equation.

$$\text{Urban Index} = (A-B)/(A+B) \quad (1)$$

, where A represents the shortwave infrared band 2 and B represents the near infrared band. Figure 4 shows one section of the urban index image generated using the shortwave infrared band 2 and the near infrared band of the given Landsat-8 satellite image.

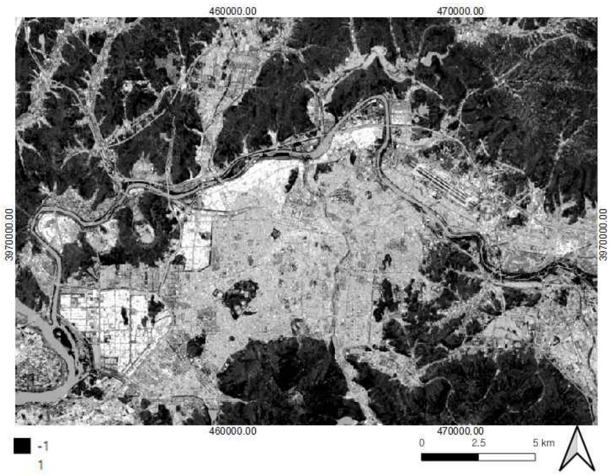

Figure 4. One section of the urban index image generated using the SWIR 2 and NIR bands of the given Landsat-8 satellite image.

As can be seen in Figure 4, the pixels representing the urban areas had the relatively high values close to 1 while the pixels representing the other areas had the relatively low values close to -1 in the generated urban index image. Then, the urban areas were extracted from the urban index image by employing the threshold -0.4, the most appropriate threshold for extracting the urban areas from the urban index image (Choung et al., 2019). Figure 5 shows one section of the urban areas extracted from the urban index image by employing the threshold -0.4.

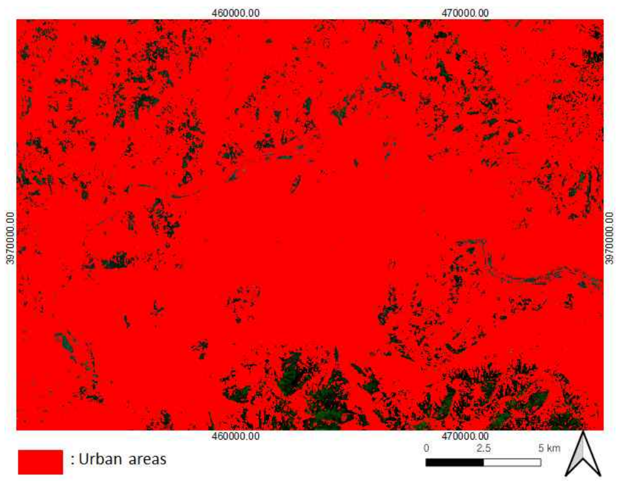

Figure 5. One section of the urban areas extracted from the urban index image by employing the threshold -0.4.

4. Results and Discussion

As can be seen in Figures 3 and 5, the urban areas extracted by the random forest algorithm had the better accuracy than the urban areas extracted from the urban index image by employing the threshold -0.4. In future research, the statistical results of the accuracy of both urban areas will be calculated using the ground truths.

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