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Determination of the conversion of the stone fields into potential agricultural lands using Sentinel-2 satellite

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Abstract

The Sentinel-2A satellite is a medium spatial resolution (10-60) multispectral instrument developed by ESA. In recent years, it has been seen that different studies have been carried out to demonstrate the competence and potential of Sentinel-2A MSI (Multispectral Instrument) satellite sensors. The aim of this study is to determine the temporal change in the acquisition of stone fields related to the rural neighborhood of Arabuk, Hilvan district of Şanlıurfa, to agricultural areas by using Sentinel-2A satellites. In this context, satellite images from the Sentinel-2A satellite of 2017 and 2022 were obtained from the data provider web address of the European Space Agency (ESA). The land cover changes for these five years were determined and the agricultural area gains were calculated. In the practice, which was carried out on an area of approximately 1925 hectares, it was determined that the lavas sprayed by Karacadağ, which is a volcanic mountain, cooled over time and turned into basalt stones. The lands that could be cultivated turned into a large stone area. As a result, the usability of Sentinel-2A satellite images, which provide free access, in the determination of the terrain pattern and determination of its use has been demonstrated.

1. Introduction

Although the agricultural activities in the world have increased over time, they cannot meet the needs and it is predicted that the increase in the world population will continue to increase in the future. On the other hand, reaching the border point of arable lands in countries that meet the demand for agricultural products and the decrease in the possibilities of increasing agricultural production further increase the importance of the issue. In parallel with these developments, the importance of developing countries with arable land and agricultural potential is increasing in terms of agricultural production. Karacadağ, which is a volcanic mountain located in the middle of the Southeastern Anatolia Region, transformed a large area into stony lands as the lavas it sprayed cooled over time and turned into basalt stones. There are dense stony areas in Şanlıurfa, especially in Siverek, Hilvan and Viranşehir districts. Since stones are scattered on fertile soils in a large part of the said lands, they can be easily cleaned and opened for agriculture.

Satellite images, which are remote sensing data, provide data with sufficient spatial resolution for many years in frequent periods (Dereli, 2019; Oğraş, 2018; Yiğit & Kaya, 2020). Determining and comparing the satellite images archived for many years with the land data belonging to the same area in repetitive periods is useful for the maps to be created in the detection of new agricultural areas (İrfanoğlu & Balçık, 2018; Aghlamand et al., 2019).

The main purpose of this study is to reveal the usability of the data obtained with Sentinel-2. For this purpose, using Sentinel-2 data, it reveals results related to the determination of the clearing of the stones on the land and opening it for agriculture in the rural neighborhood of Arabuk in Hilvan district of Şanlıurfa (Figure 1).

2. Method

Satellite images used in the detection study were obtained from the Sentinel-2A satellite. The areas covered by the stony areas of the lands determined from

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2 satellite images detected in different time periods were determined and the situation before and after the stony areas were determined.

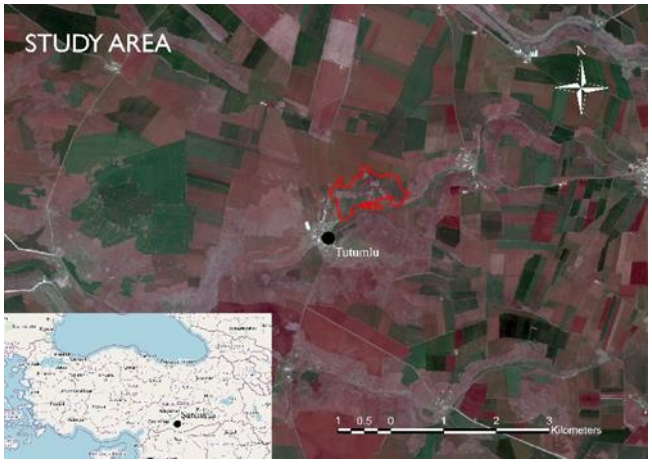

Figure 1. Study area

In the study, Sentinel-2 data from two different years was used and the changes between them were examined. First of all, a satellite image of May, 2017 was used to show the stony area before it was cleared (Figure 2). Then, a second satellite image of May, 2022 was used to show the state of the stony area after cleaning (Figure 3).

Figure 2. Map showing the study area in 2017

Figure 3. Map showing the study area in 2022

With this study, the area covered by the stony areas was determined quickly by remote sensing methods and the areas suitable for agriculture were reached instantly and accurately. On the Sentinel-2 images, the stony area and the area brought to agriculture were determined and the area brought to agriculture was determined through the image. The areas where the stony areas were cleared and collected are shown in Figure 4.

Figure 4. Areas where stony areas are cleared and collected

The accuracy assessment was made with the differences between the terrain images and the satellite images of 2017 and 2022. Evaluations of the produced maps were carried out with controls on the existing ground (Figure 5).

Figure 5. After stones are collected (up) and before stones are collected (down)

3. Results

In the study, the land cover changes for the years 2017 and 2022 were determined, and the agricultural area gains of the stony areas were calculated. In the applications performed on images with a spatial resolution of 10 m with Sentinel-2A satellites, it is seen that 740,000 m2 of stony area is cleared and brought to agricultural areas.

If the above-mentioned areas are opened to agriculture and dry wheat farming is considered to be used once a year, if we calculate the income to be obtained from 1 decare of land (for the year 2021);

Annual expense for 1 decare;

-(Seed 100 TL + Fertilizer 220 TL + Fuel expenses 50 TL + Harvest 50 TL + Agricultural Protection 160 TL) = 580 TL

-Annual income for 1 decare (Main product sales 1 decare average 400 kg = 400*2.40 TL=960 TL + By-product Straw 350*0.4=140 TL) = 1100 TL

-Annual net income for 1 decare = 520 TL

According to this calculation, it is seen that the cleaning cost of 1 decare of stony land is 1500 TL/da, and the income to be obtained from 1 decare of cleared and dry wheat farming land is 520 TL. 1 decare of land pays for itself in 2.8 years.

Fertilizer cost was also calculated in the above calculation. However, when we consider that the lands are uncultivated lands and do not require fertilizer, and we exclude that cost from the calculation, the amortization period can be reduced to 2 years for 1 decare, even in dry wheat farming that does not require only water. If different products and the second product account are added to the said calculation, it will be seen that the cleaning cost can be amortized in a very short time.

In addition, when the fact that the stones collected from the lands can also be processed and evaluated economically, it is clear that stone collection works will contribute greatly to the economy of the region.

4. Conclusion

The important point here is to determine the effectiveness of Sentinel-2 satellite images in areas such as this study. For this reason, as it is understood from the study, since Sentinel-2 satellites provide high resolution data, interpretation can be made on the resulting images. In change detection studies, satellite images of at least two different times should be used. The use of long-term data, especially in the evaluations of land change and use, yields clear results.

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