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Displacement analysis of aftershocks occurred after 6 February 2023 Kahramanmaraş Earthquakes

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Abstract

The phenomenon of shaking the environments through which the shakings that occur due to the fractures in the earth's crust spread as waves and pass through is called an earthquake. Shakings that occur during an earthquake cause displacement in their locations. Many remote sensing methods are applied to detect deformations. Turkey is located on the North Anatolian Fault Line, the West Anatolian Fault Line and the East Anatolian Fault Line, and these fault lines cause earthquakes from the past to the present. On February 6, 2023, 7.7 (Pazarcık) and 7.6 (Elbistan) earthquakes occurred in Kahramanmaraş. After these earthquakes, there were many aftershocks. In this study, in which aftershocks were examined with PSI and SBAS methods, the data obtained from the Sentinel-1 satellite was used.

1. Introduction

Earthquakes, which occur as a result of fractures in the earth's crust, are one of the natural disasters that cause loss of life and property and affect the economy. Earthquakes also cause deformation on the earth. Surface rupture, regional collapse, slope movements, volumetric compression, liquefaction, settlement and bedding failures, flow slides, lateral spreading and sand volcanoes are some of the deformations that may occur (Onur, 2007).

Since Turkey is located along the North Anatolian Fault Line, East Anatolian Fault Line and West Anatolian Fault zones, it has been under the risk of earthquakes since ages (Karslıoğlu, 2021). The seismic activities in Turkey and its surroundings have been technically monitored since the 1900s. T.R. The Disaster and Emergency Management Presidency (AFAD) of the Ministry of Interior and Boğaziçi University Kandilli Observatory and Earthquake Research Institute are the two main seismic network operators in Turkey (Kadirioğlu et al., 2018).

On February 6, 2023, 7.7 M earthquakes occurred at 4.17 in Pazarcık district of Kahramanmaraş province and 7.6 magnitude earthquakes occurred at 13.24 in Elbistan district. These earthquakes caused huge destruction in 11 provinces, including Kahramanmaraş, Gaziantep, Kilis, Adıyaman, Hatay, Malatya, Osmaniye, Şanlıurfa, Adana, Elazığ and Diyarbakır. More than 50 thousand people died in this earthquake where more than 37 thousand buildings were destroyed (AFAD, 2023).

AFAD recorded those 294 aftershocks greater than M4 occurred from 6 February 2023 to 13 April 2023 in and around Kahramanmaraş.

In this study, InSAR analysis has been used to calculate the surface displacement during the aftershocks period.

2. Method

2.1. Study area

The 7.7M earthquake that occurred at 04:17 in Kahramanmaraş's Pazarcık district on February 6, 2023, recorded by AFAD, lasted for approximately 1 minute. Then, the earthquake that occurred in the district of Elbistan at 13:24 lasted for about 45 seconds. Many aftershocks occurred after these earthquakes and are shown in Figure 1.

Between February 6, 2023 and April 13, 2023, 294 aftershocks with magnitudes greater than 4M occurred.

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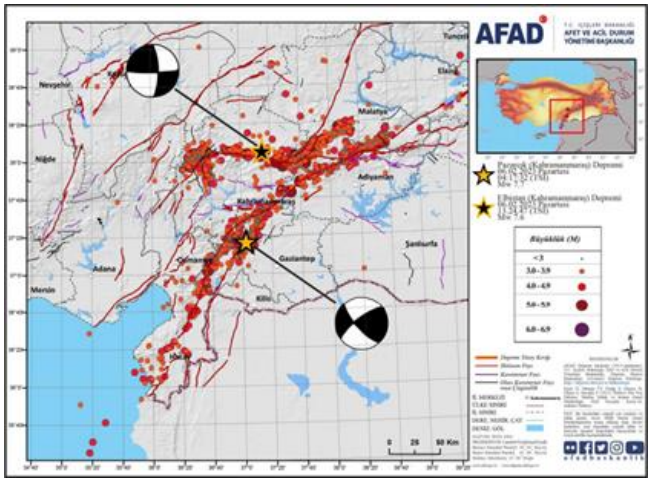

Figure 1. Kahramanmaraş earthquake location map (AFAD,2023)

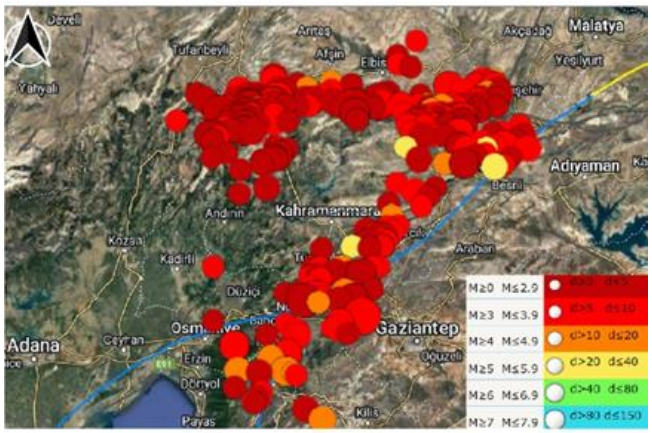

Figure 2. Kahramanmaraş aftershock's location map

2.2. SBAS

The SBAS method achieves displacement over time by stacking conventional D-InSAR interferograms (Berardino et al., 2002).

The SBAS approach has two distinct features. Multiple SAR images taken at different times in the same area are required to get started. the end is only the removal of targeted scattering.

2.3. PSI (Persistent Scatterer Interferometry)

Interferometry based on permanent scatters is an interferometry technique that studies surface movements with the help of fixed surfaces. This technique is based on the series of interferogram approach. Unlike InSAR, which detects deformations occurring on the surface with a single pair of interferograms, it makes use of multiple interferograms.

This technique was developed in 1999 by the Sar team at the Polytechnic University of Milan (POLIMI). This method, which is used to detect landslides or landslides, collapse and uplift areas, is also used to monitor urban activities such as pipelines, transportation lines, highways and railways, and to monitor seismic faults, volcanic areas and analyze their structures (Çomut, 2016).

For SBAS, we have used NASA ASF HYP3 data processing system for ascending and descending modes both.

3. Results

Between 6 February and 13 April 2023, SBAS and PSI analyzes were made using the data received from the Sentinel-1 satellite, and the displacements created by the aftershocks on the surface were obtained by two methods. The displacement results obtained and the fault line data were overlapped and the relationship between the deformation caused by the aftershocks and the ground was obtained.

4. Conclusion

According to the results of the SBAS analysis, the displacement values vary between -55.9 cm and 414,5 for the ascending satellite data, while the result of descending mode is between -26,0 cm and 34,6 cm.

Regarding PSI methodology, for the descending mode, the displacement has the values between -26,3 cm and 31 cm.

The results show that the displacement still occur with high values during the aftershocks which have been happening after the main EQs.

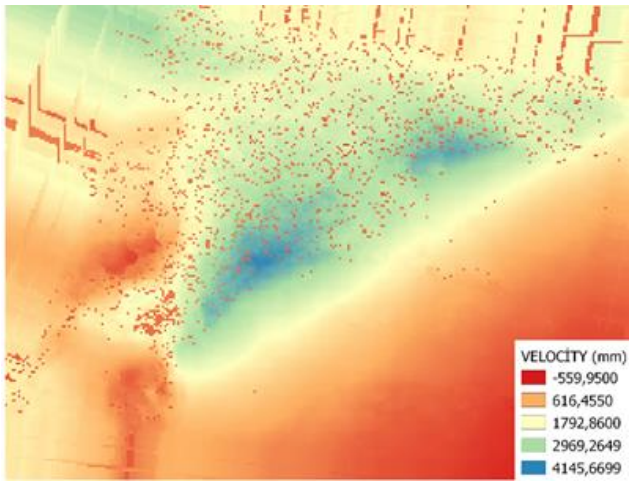

Figure 3. Displacement result from SBAS- ascending mode (mm)

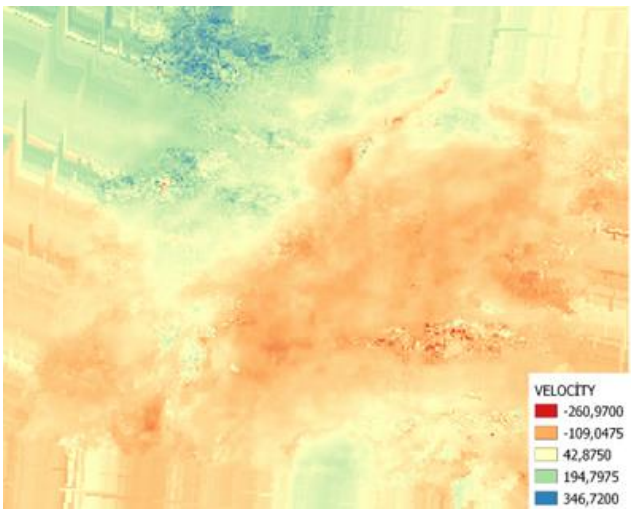

Figure 4. Displacement result from SBAS- descending mode (mm)

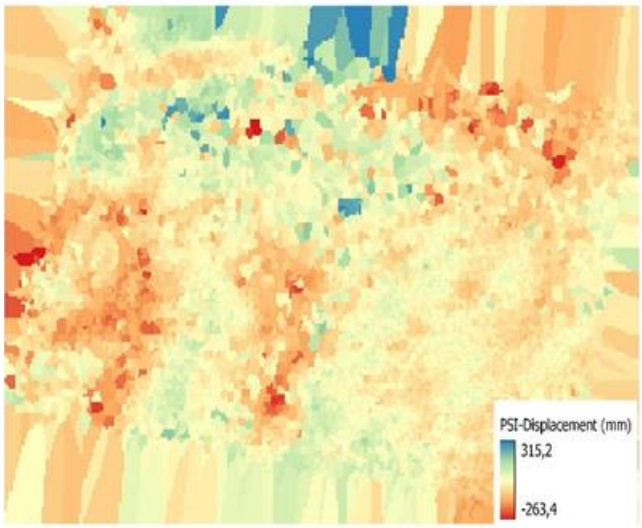

Figure 5. Displacement result from PSI - descending mode (mm)

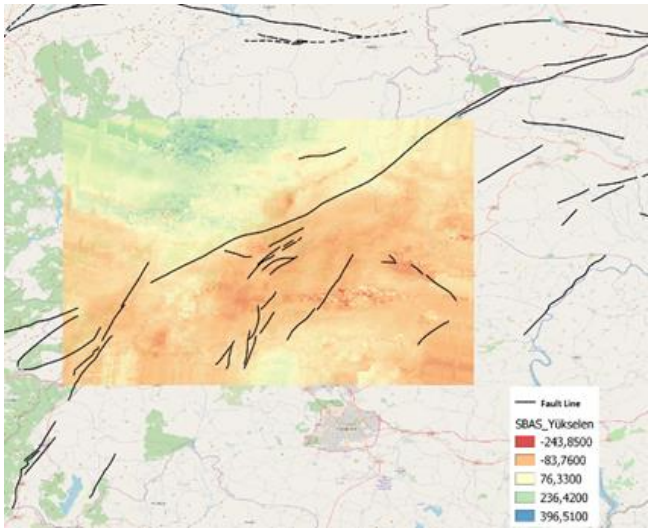

Figure 6. SBAS- descending - fault line, mm

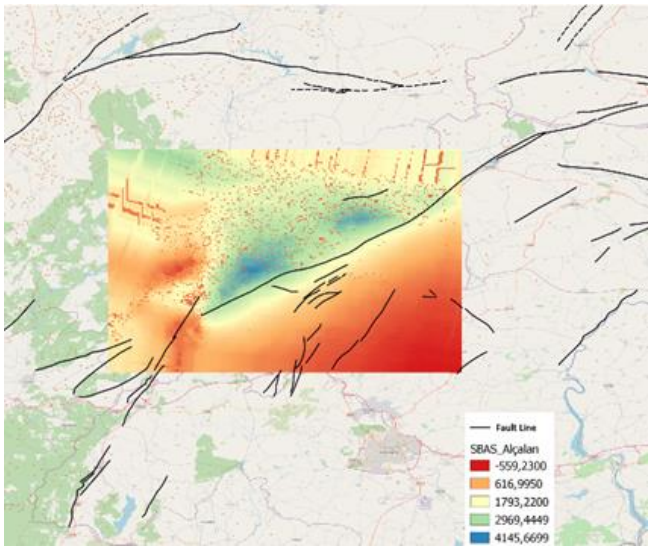

Figure 7. SBAS- ascending - fault line

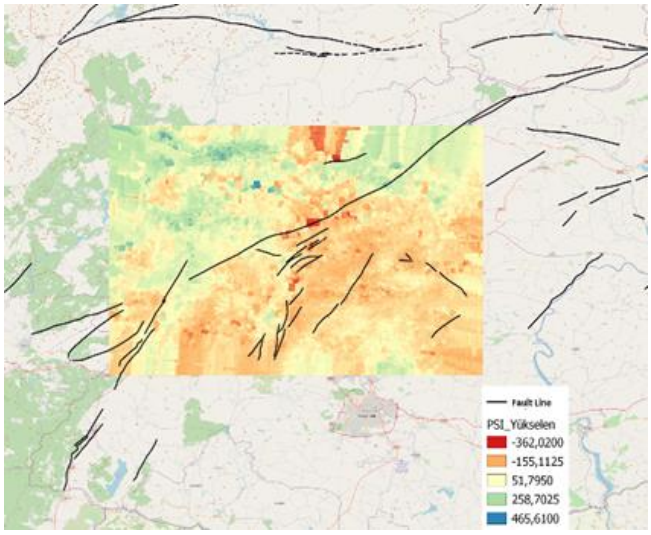

Figure 8. PSI- ascending - fault line

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