APPLICATION OF DINSAR FOR MONITORING SUBSIDENCE INDUCED BY SALT MINING IN TUZLA, BOSNIA AND HERZEGOVINA

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1. INTRODUCTION

The subsidence induced by salt mining is the major hazard in the City of Tuzla (Northeastern part of Bosnia and Herzegovina) and its surrounding area since 1950, Mancini et al. (2009). The maximum subsidence reported by Mancini et al. (2009) was about 12 meters obtained by analysis of large topographical data from 1956 to 2003. Further research of ground subsidence monitoring in Tuzla city was continued using GPS survey conducted by Stecchi et al. (2008). Stecchi et al. (2008) mentioned that the subsidence was decreased and near to the end. However, in some parts the subsidence was still on going and was measured about 100mm/year during 2006 until 2007. The authors tried to measure the current subsidence using different method with previous one. The main goal of this research is to obtain the present subsidence information in this site by means of Differential Interferometric Synthetic Aperture Radar (DInSAR) technique. The Small Baseline Subset (SBAS) time series approach proposed by Berardino et al. (2002) is used to generate the time series subsidence information.

2. DATA AND METHOD

This research used the Synthetic Aperture Radar (SAR) data from Sentinel-1 satellites provided by European Space Agency (ESA). We processed and analyzed 100 Sentinel-1 SAR data which spans from October 21, 2014 to November 28, 2017. The DInSAR technique is used to measure the surface displacement along satellite line of sight (LOS) and convert to the displacement in vertical direction (for example subsidence or uplift). DInSAR uses at least two SAR images to measure the ground displacement which taken from different time and position of the satellite. The first observation called master image and next observation called slave image, see Figure 1. One of the advantage of DInSAR is no measurement equipment is required on the ground. To achieve the precise time series subsidence monitoring, we applied SBAS time series approach.

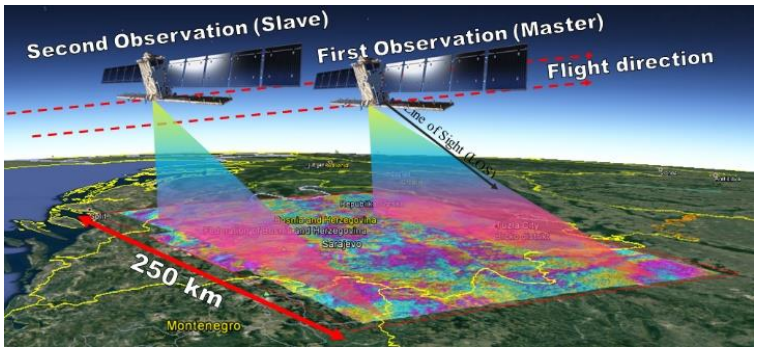

Figure 1. The illustration of DInSAR technique to measure the ground surface displacement.

3. RESULTS AND DISCUSSIONS

Figure 2 shows the subsidence distribution in the City of Tuzla obtained by SBAS-DInSAR. The blank pixel indicates the loss coherency due to high vegetated area. As seen in Figure 2, the subsidence gradually increases from October 21, 2014 until October 23, 2017 especially in the area near Pinga lake. We took several points (see Figure 3a) to know the subsidence transition, which is presented in Figure 3b. From Figure 3b we can see that the subsidence velocity is different from point to point. The GPS-16 shows the highest velocity of subsidence, which is about -40mm/year. The slowest subsidence velocity occurred at the GPS-25, which is about -3mm/year.

Figure 3b shows the subsidence seems to increase linearly during this period (from October 21, 2014 to November 28, 2017). It means there is the high possibility that the subsidence will continue for the next following years. Since Sentinel-1 satellites are operated now, we can continue monitoring the subsidence using SBAS-DInSAR technique.

Keywords : Ground Subsidence, Monitoring, DInSAR, SBAS, Salt mining
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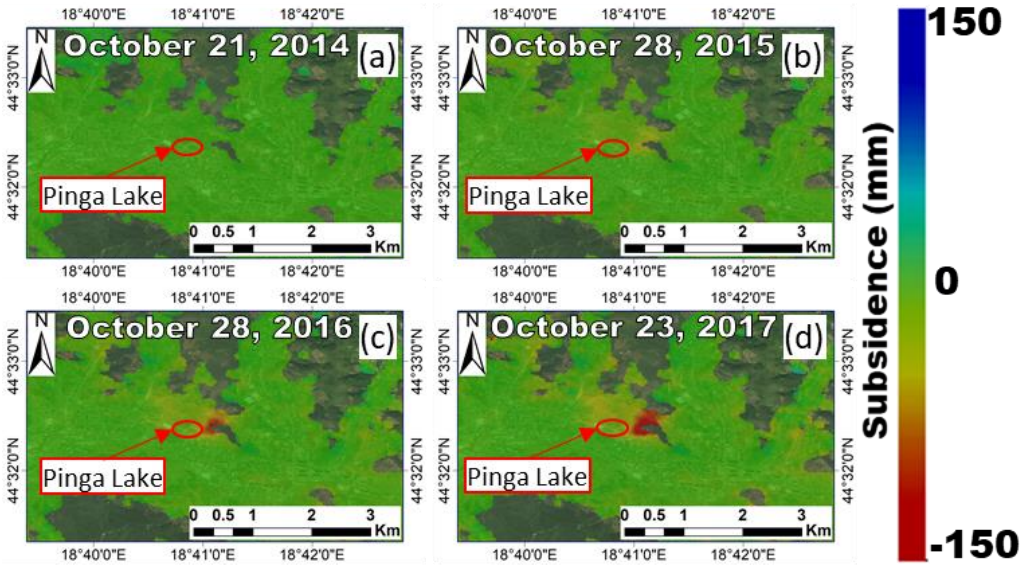

Figure 2. The subsidence distribution obtained by SBAS-DInSAR in several periods: (a) on October 21, 2014, (b) on October 28, 2015, (c) on October 28, 2016 and (d) on October 23, 2017.

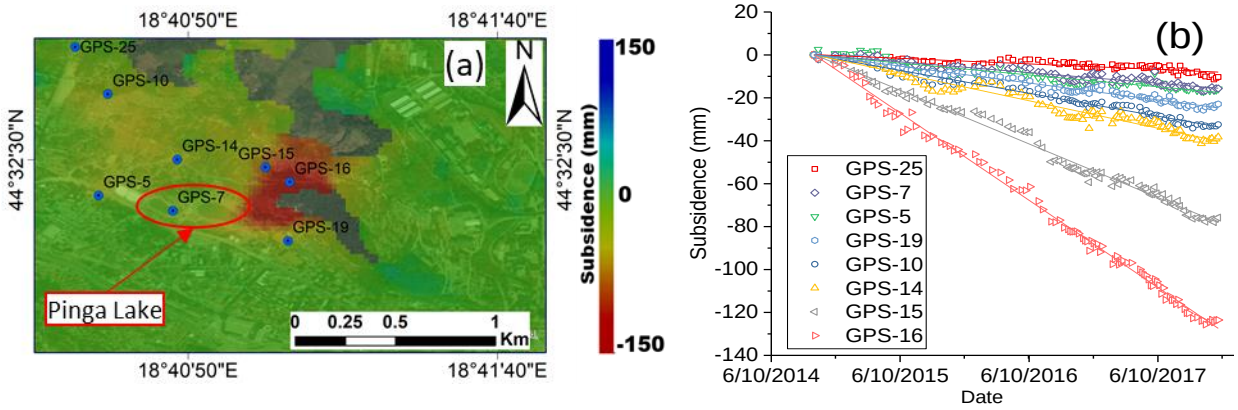

Figure 3. The subsidence transition at several points: (a) the location of points on the map and (b) subsidence in time series for each point.

4. CONCLUSION

The SBAS-DInSAR technique was successfully applied to measure the recent transition of subsidence in the City of Tuzla. The result shows that the subsidence continues and its velocity is varying depend on the area. The SBAS-DInSAR seems to provide reliable results, and it is important to continue monitoring subsidence using this technique.

ACKNOWLEDGEMENT

The authors express their gratitude to European Space Agency (ESA) for providing Sentinel-1 SAR data by free of charge. This research was partially supported by JSPS KAKENHI Grant Number 16H03153.

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