LONG-TERM MONITORING OF SUBSIDENCE IN SEMARANG BY USING SBAS DINSAR

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1. INTRODUCTION

Semarang is a big city in Indonesia which has been exposed by the severe land subsidence for decades (Marfai and King, 2007). The monitoring of land subsidence is vital for predicting and managing the risks that might occur. This study monitors land subsidence monitoring in Semarang by using Small Baseline Subset Differential Interferometry Synthetic Aperture Radar (SBAS DInSAR) method (Berardino et al, 2002) for up to 14-years. Firstly, the SBAS method is performed for each time series SAR dataset. Secondly, the hyperbolic method (HM) (Tan et al, 1991) is applied to estimate real values from the results of each dataset. Finally, the hyperbolic curve is used to connect the results of the unlinked time series dataset.

2. STUDY AREA and DATA COLECCTIONS

The study area is Semarang city that is located at 6° 58′ 0″ S, 110° 25′ 0″ E. Fig. 1 shows the location of the Semarang including its geological condition and four photos showing the subsidence impacts in North-east area. There are three kinds of SAR data in Semarang that was acquired in three periods from 2003-2017 by three satellites namely ENVISAT, ALOS and Sentinel-1A. The footprint and data acquisitions date of each satellite is shown in Fig. 2. The ENVISAT, ALOS and Sentinel-1A data are available from 2003 to 2007 (period I), from 2007 to 2011 period (II), and from 2015 to 2017 (period III), respectively. However, no SAR data are available for the period between 2011 and 2014. The ENVISAT and the Sentinel data were provided by the European Space Agency (ESA), while the ALOS data were provided by the Japan Exploration Agency (JAXA).

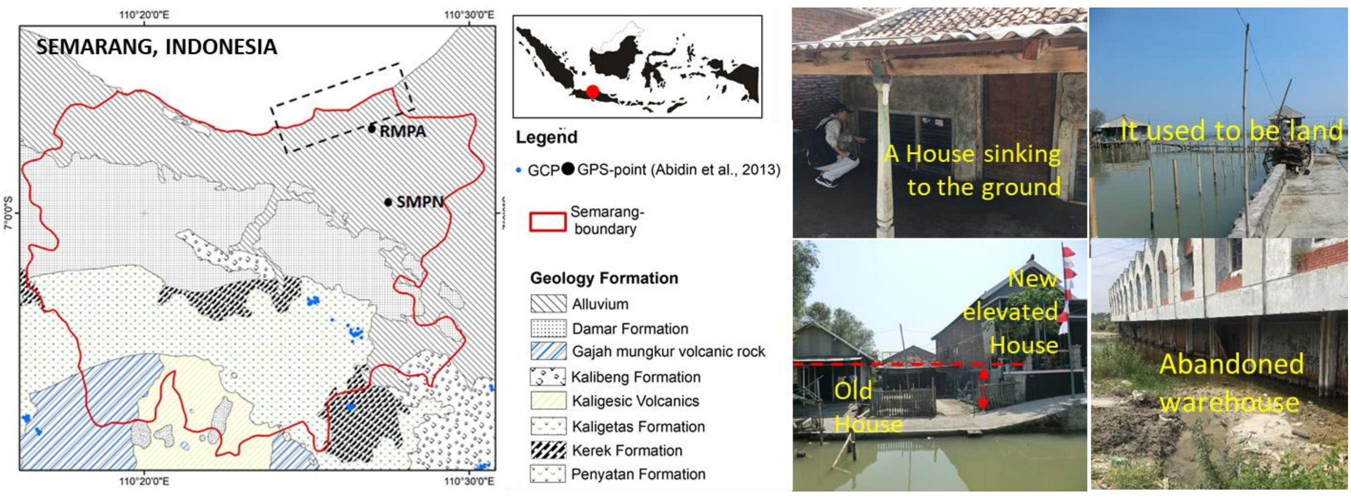

Fig. 1 The geological condition of Semarang and its surrounding area (modified from the geological map by a geological survey of Indonesia, 1975) and photos taken by the authors showing the impact of the subsidence in North-east area (dashed box) which taken during field observation on August 2017.

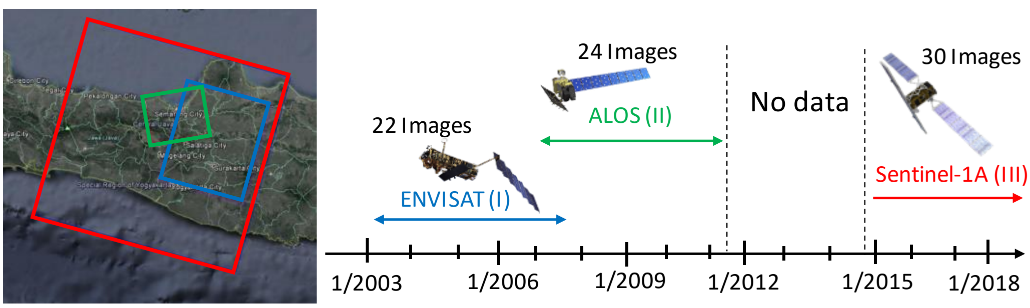

Fig.2 The footprint and data acquisition date of each SAR satellite over Semarang.

Keywords: Semarang, Land subsidence, Monitoring, SBAS DInSAR, Hyperbolic method
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3. RESULTS and DISCUSSIONS

As the results, the time-series subsidence maps with spatial resolution of about 25 m by 25 m are generated. Fig. 3 shows the cumulative subsidence map for each data set; for example, Fig. 3a was obtained using the Envisat dataset. It represents the cumulative subsidence during the period I. As shown in Fig. 3 (a) – (c), the spatial distribution of subsidence in Semarang depends on the geology and ground water extraction. The largest subsidence mainly occurs in the Northern part.

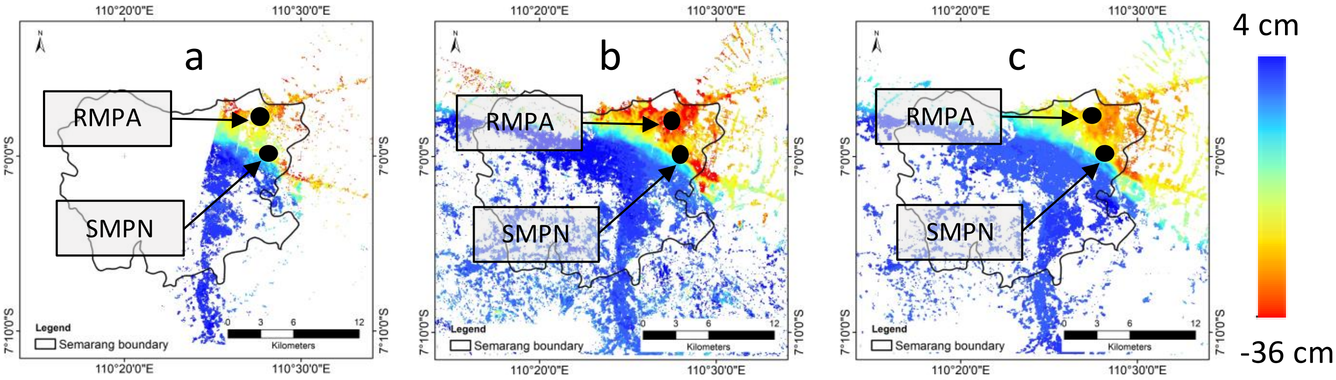

Fig. 3 Cumulative subsidence maps obtained using data sets for (a) Envisat, (b) ALOS, and (c) Sentinel-1A.

In order to smooth the results of SBAS and to link the results of each data set, the hyperbolic method (HM) (Tan et al, 1991) is adopted. Fig.4 shows the time transition of the subsidence at point SMPN and RMPA. It is clearly shown that we can connect all of the SBAS results by applying the HM. It is also found that the subsidence behavior in those points is changed as shown by the different hyperbolic curve in each period. In addition, the SBAS results and GPS measurement results by Abidin et al. (2013) also shows the good agreement each other.

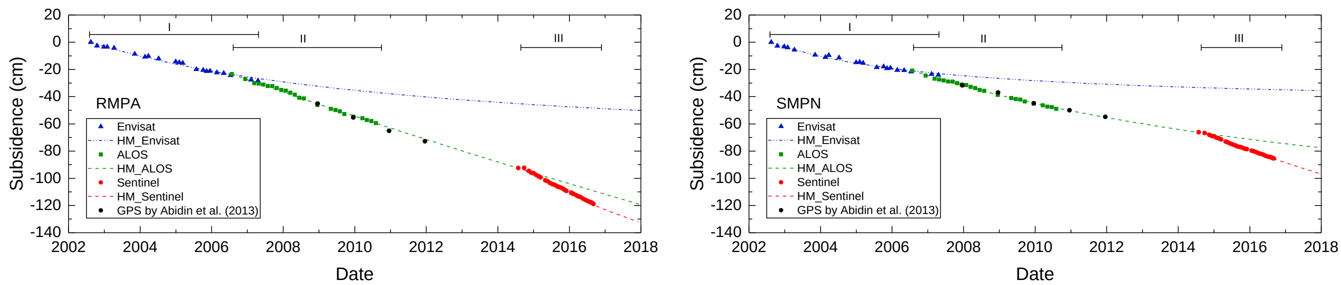

Fig.4 The long-term subsidence using the hyperbolic method.

4. CONCLUSIONS

In this study, the long-term monitoring of subsidence in Semarang has been carried out by applying an SBAS DInSAR analysis using multiple satellites. Application of the HM to SBAS results can fill in the gaps of the satellite missing periods and connecting the unlinked data.

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