

# SURFACE DEFORMATION DETECTED BY ALOS PALSAR SMALL BASELINE INTERFEROMETRY OVER SURABAYA CITY, INDONESIA

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**Abstract :** This paper presents the result of surface deformation by using remote sensing technique of synthetic aperture radar over Surabaya city, Indonesia. In order to investigate the impact of urban area, we applied the Interferometry Synthetic Aperture Radar (InSAR) method using ALOS PALSAR images to detect surface deformation. The research has been conducted by open source software and the method includes the process of focusing the SAR data, incorporating the precise orbit, coordinate transformation to radar systems, atmospheric correction, generating interferogram and phase unwrapping by using SNAPHU algorithms. This paper will show the displacement changes on the surface which is characterized by a phase change in the LOS (line of sight) direction of the satellite by millimeter to centimeter level.

**Keywords :** Surface deformation, Urban Area, ALOS PALSAR

## 1. Introduction

Surabaya is the second big city as urban area in Indonesia with the population more than 2,5 million. Long-term surface monitoring is needed for urban area and many other metropolitan areas worldwide. Extensive ground water pumping over the urban and industrial area has resulted in several centimeters of land subsidence in locations all around the world (Buckley et al, 2002, Chaussard, 2013). Surface deformation impacts in urban areas are quite numerous and can be categorized into infrastructural, environmental, economic and social impacts. It was natural-anthropogenic hazard affecting urban areas. This type of silent hazard is mainly caused by the combination of excessive groundwater extraction, natural consolidation of alluvium soil, load of constructions and tectonic activities (Abidin et al., 2011)

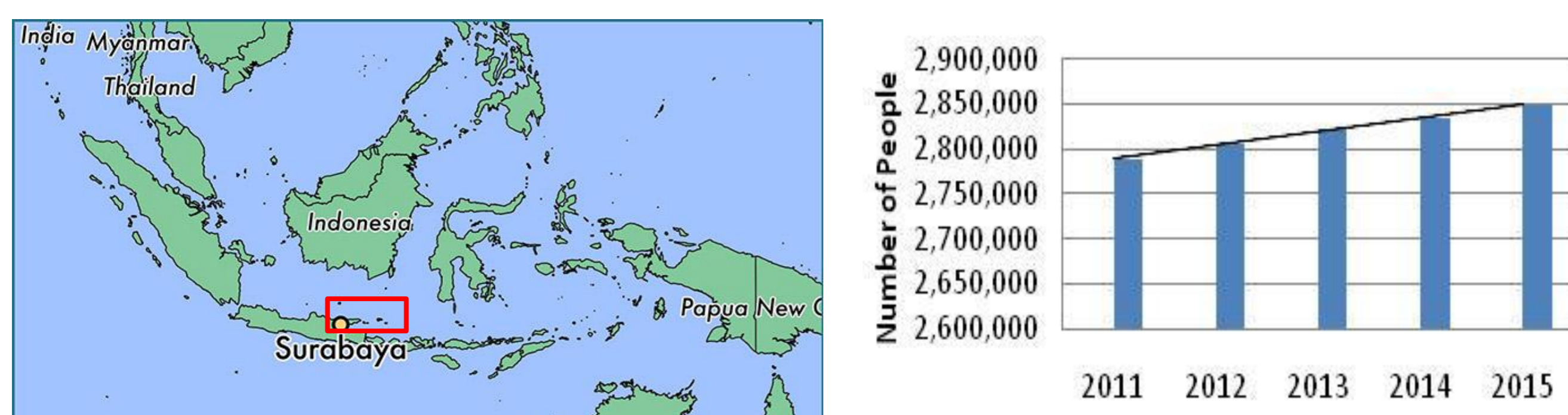
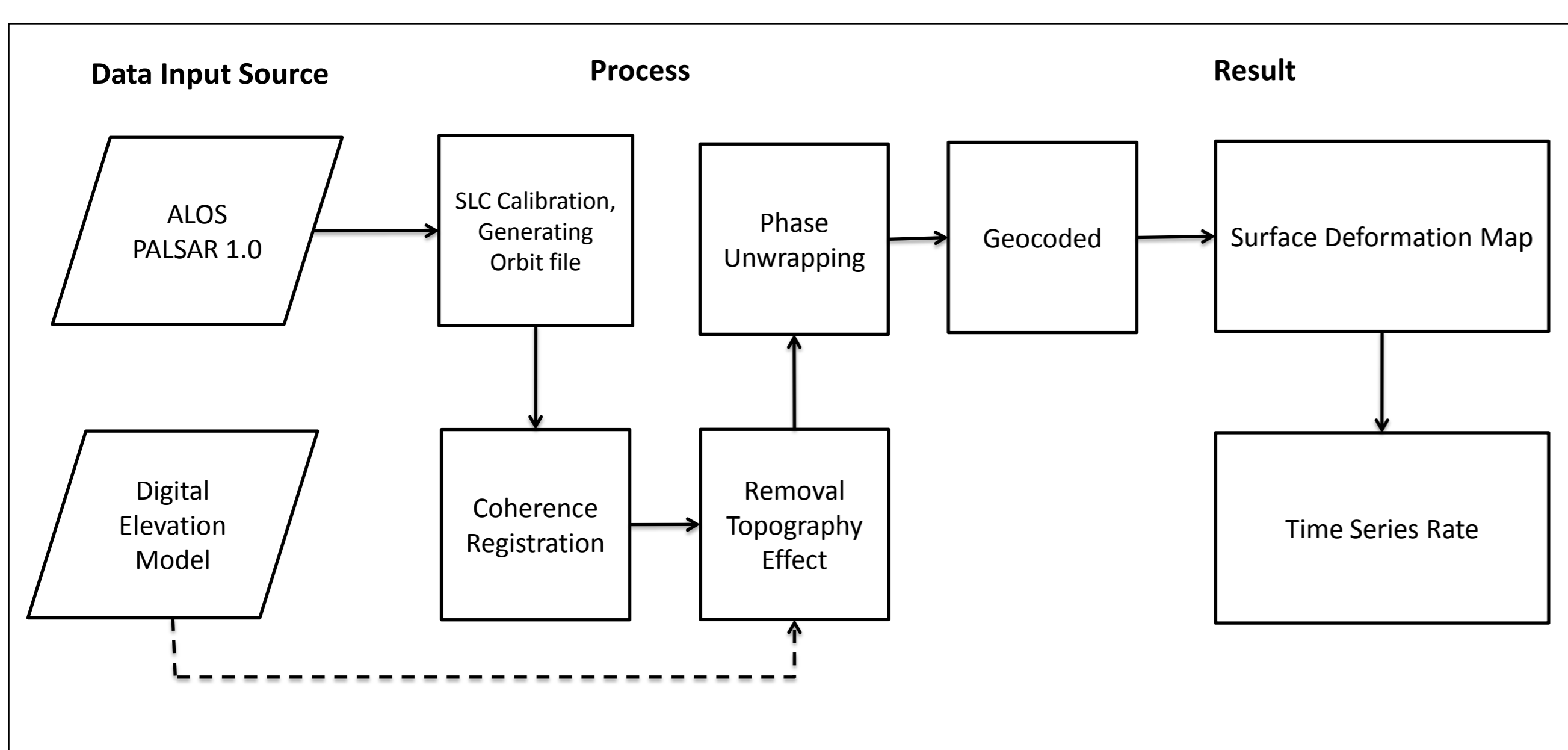


Figure 1. Surabaya and Its Population

## 2. Data and Methodology

To analysis surface deformation we used 9 FBS descending images (36 pairs) during period 2007-2008 with and 12 ascending images (66 pairs) of PALSAR for 2006-2011. SRTM3 (90 m resolution) data is used as external DEM for removing the topographic fringe. Small Baseline method is adopted to reduce spatial decorrelation (Berardino, 2002)



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## 3. Result

The interferogram result was shown surface deformation occurred over Surabaya city with average 2,1 cm per year. In industrial area (eastern Surabaya) subsidence reach up 3 cm per year. It can be caused by excessive ground water extraction.

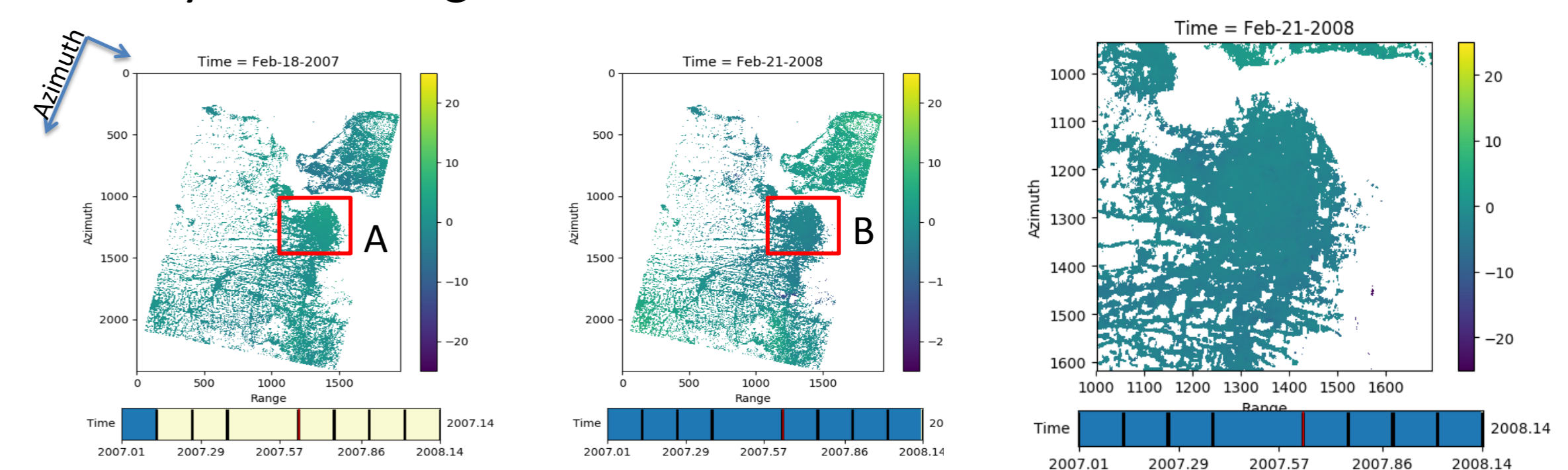


Figure 2. Descending Interferogram Images 2007 (A) and 2008 (B)

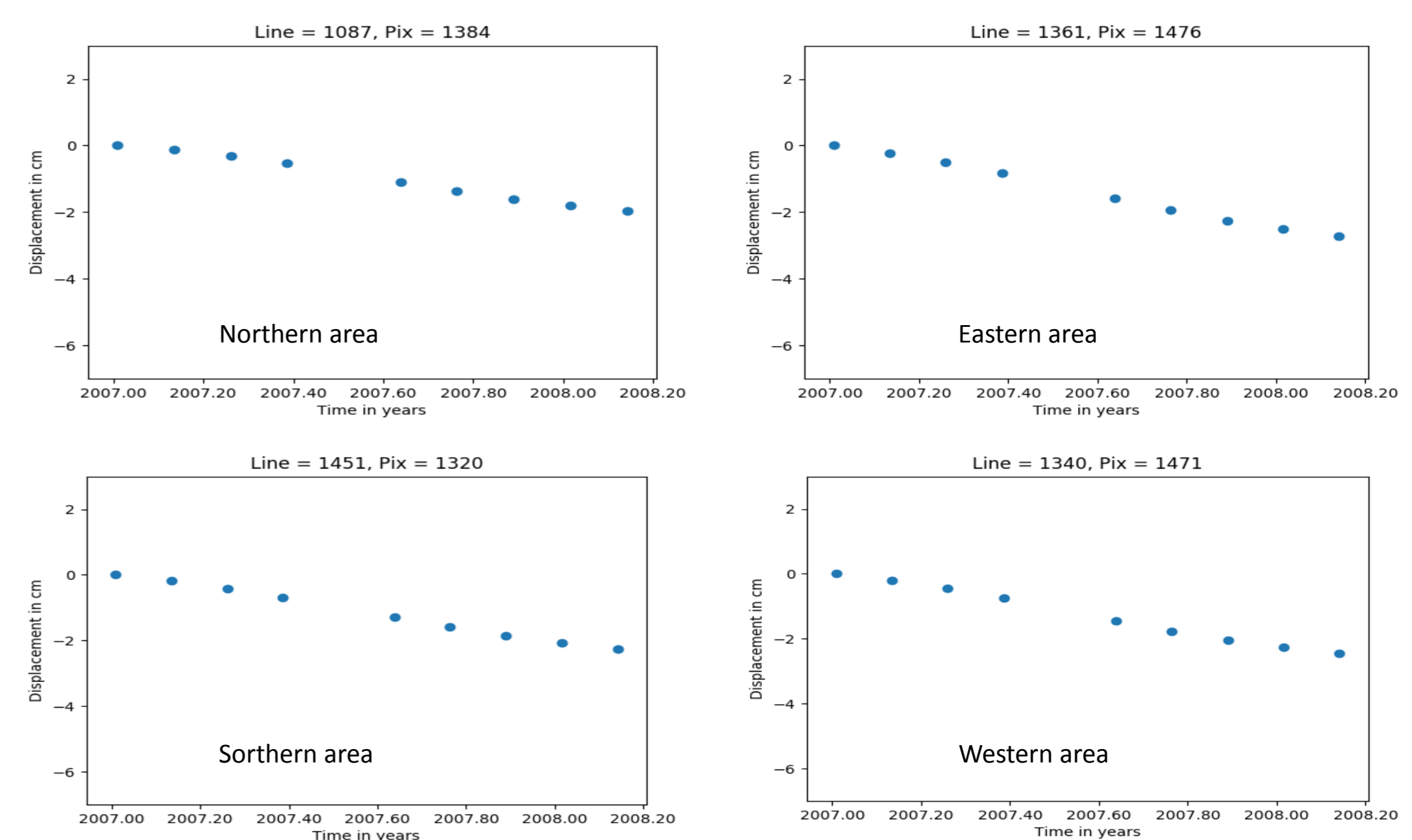


Figure 3. Time Series Diagram of Surface Deformation over Surabaya

## 4. Conclusion and Future Works

- ✓ The results of this research show that spatial pattern and rate of subsidence derived by InSAR methods are quite similar over Surabaya area. Average of subsidence rate derived by ALOS PALSAR data during the period of 2006 –2011 varies between 2 – 4 cm per year.
- ✓ Multi temporal InSAR data with Small Baseline concept yields better result to reduce spatial decorrelation characteristics.
- ✓ Furthermore, there could also be possible existence of other causes due to anthropogenic factors in almost all subsidence areas and natural factors such as tectonic processes in Southern of Surabaya.
- ✓ GPS measurement will be conducted to improve accuracy and validation for InSAR result to better understanding for surface deformation.