Monitoring of Land Deformation around Active Fault in the Metro Manila

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Outline

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1. Study Area
2. InSAR time series analysis using ENVISAT data
3. DInSAR analysis using TerraSAR-X data
   ⇒ preliminary study
4. Summary

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Study Area

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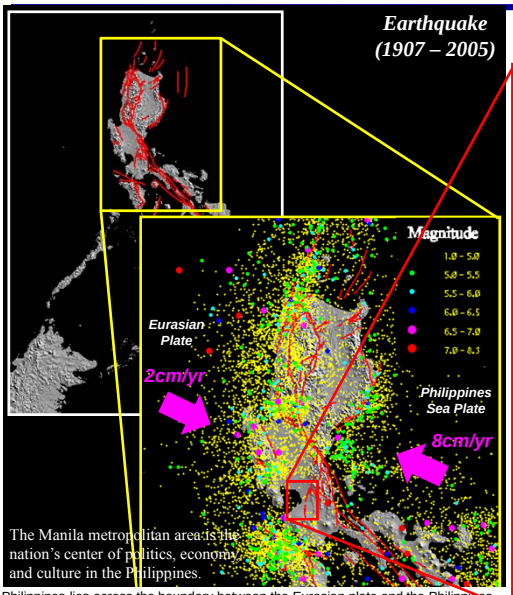
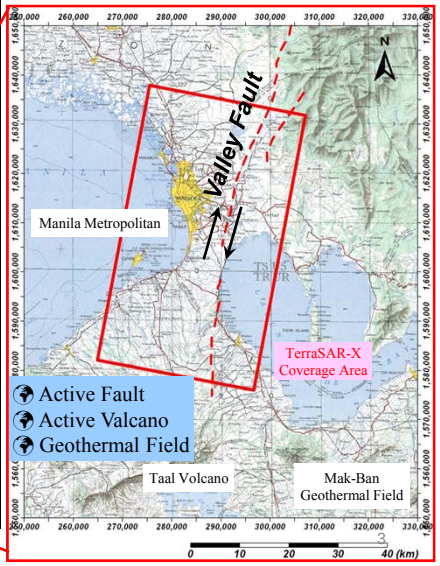


Philippines lies across the boundary between the Eurasian plate and the Philippines Sea plate, an area ridden with active faults and frequent earthquakes.

The valley fault run in north-south direction along the eastern edge of Manila Metropolitan, which is the capital of Philippine.



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Study Area

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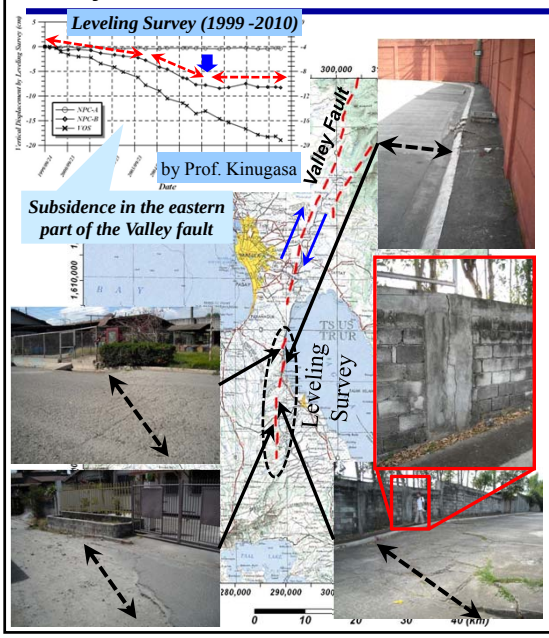

- ✓ *The Valley fault is a right-lateral fault with two to four activities recorded over the past 1,400 years.*
- ✓ *The estimated earthquake cycle translates to about 400 years.*
- ✓ *According to recent studies, the last activity of the fault took place on August 19, 1658.*
- ✓ *In consideration of the estimated earthquake cycle, the region now faces a high risk of an earthquake with a magnitude of 7 or higher.*
- ✓ *Creep deformation along the southern part of the fault has produced some cracking and vertical displacement on roads and ground structures above the fault.*
- ✓ *Prof. Kinugasa and Associate Prof. Kurita had detected the tendency by using leveling survey that areas in the eastern part of the Valley fault had subsided and its subsiding had stopped after 2007.*

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Objective

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☹ Some researchers say that this region faces a high risk of a devastating earthquake with a magnitude of 7 or higher...

Main task of this study is

☞ To investigate a spatial and temporal distribution of ground deformation around the Valley fault using DInSAR technique

In the future,

☞ To establish the monitoring system for the Valley fault using DInSAR & other measuring methods

☞ To contribute to disaster management in the Metro Manila

☞ To construct the disaster education and alert system

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Utilized Data

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【Data】
ENVISAT/ASAR (33 scenes)
TerraSAR-X (3 scenes)

【Observation Date】
ENVISAT/ASAR : 2003/01/08 to 2009/12/02
→ InSAR time series analysis
TerraSAR-X : 2008/07/08, 2009/12/29, 2010/03/27
→ DInSAR

【DEM】
SRTM3

【Software】
Personal software

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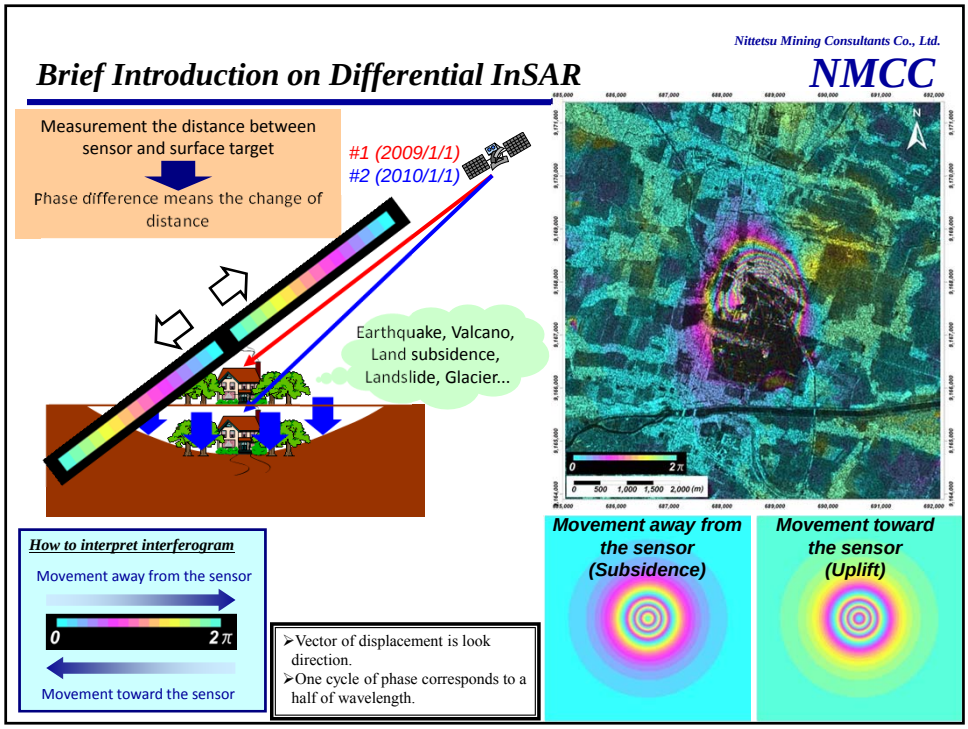

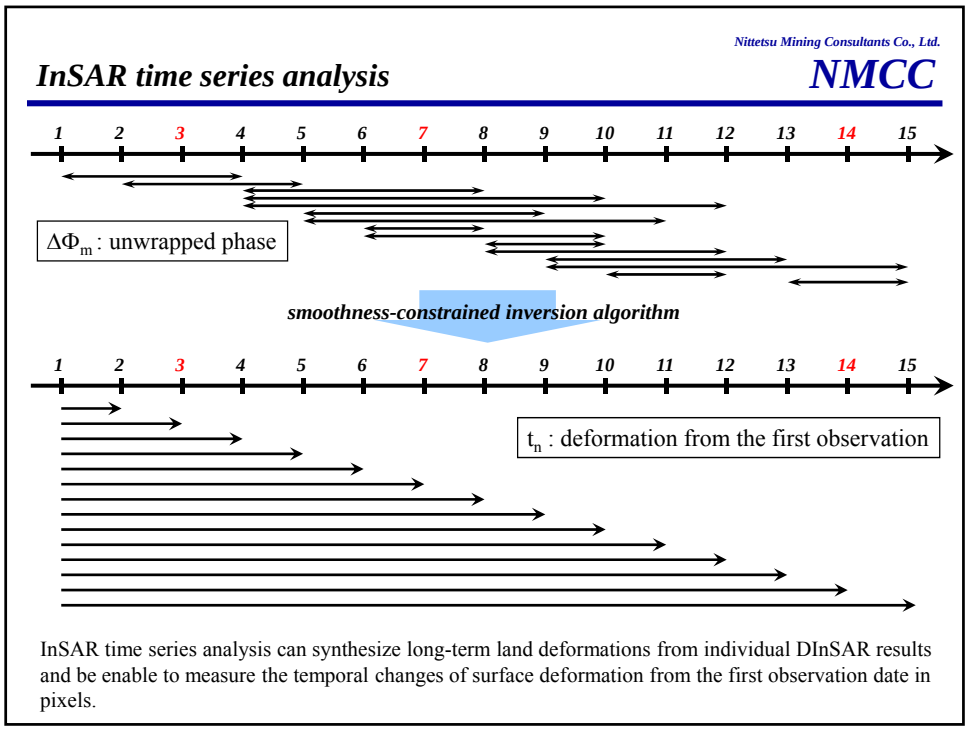

InSAR time series analysis can synthesize long-term land deformations from individual DInSAR results and be enable to measure the temporal changes of surface deformation from the first observation date in pixels.

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InSAR time series analysis using ENVISAT data

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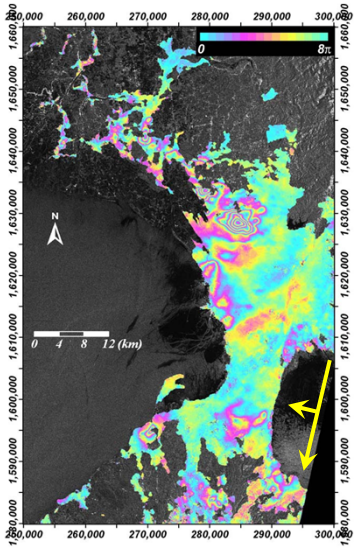
2003/01/08 2003/12/24 2005/01/12 2005/12/28 2007/01/17 2008/01/02 2009/01/21 2009/12/02



7 years

2003/01/08-2009/12/02

This movie visually shows the increase in the number of fringes and the extent to which the deformation has expanded over time

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InSAR time series analysis using ENVISAT data

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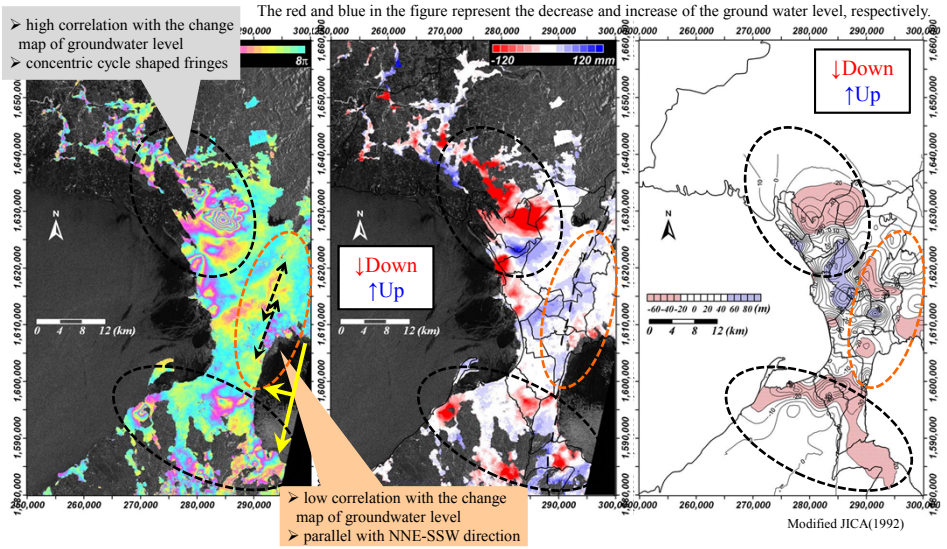
The red and blue in the figure represent the decrease and increase of the ground water level, respectively.



2003/01/08-2009/12/02

Vertical Displacement 2003/01/08-2009/01/21

Change of Groundwater Level 1981-1990

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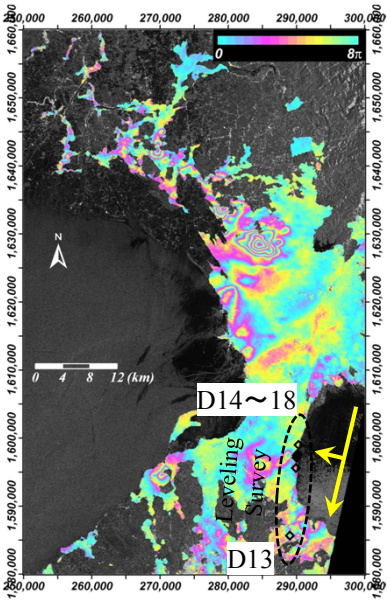
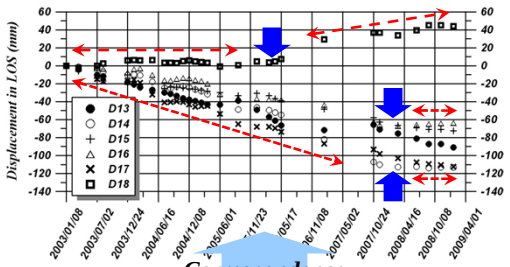
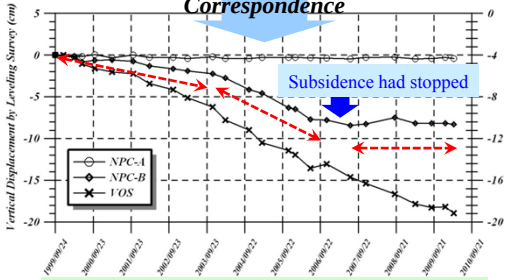
Creep deformation …

- ♣ D13 : subsiding
- ♣ D18 : "No deformation" to "Uplift"
- ♣ others : "Subsiding " to "no deformation"





Correspondence



Subsidence had stopped

Leveling survey by Kinugasa & Kurita

As regards land subsidence …

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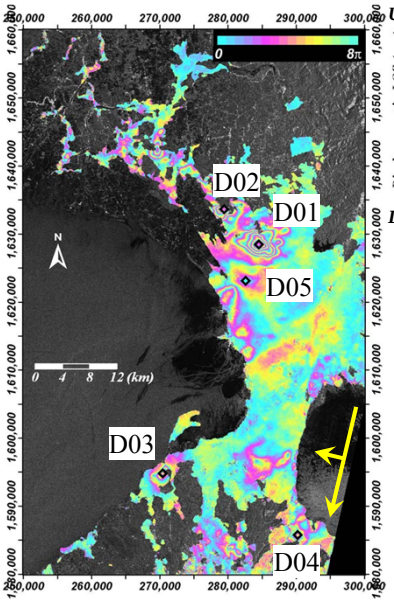

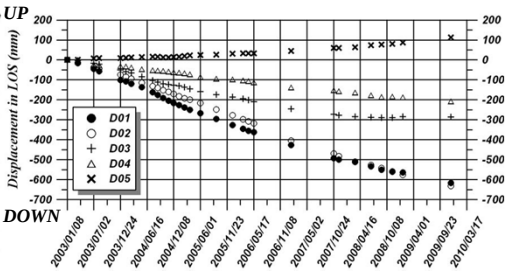

- ♣ Maximum velocity is -91mm/yr on D02.
- ♣ The average uplift velocity on D05 is 16mm/yr.
- ♣ Land subsidence and uplift is going monotonously.
- ♣ Land subsidence on D03 has already converged.

Average deformation velocity (mm/yr)

D01	D02	D03	D04	D05
-89	-91	-41	-30	+16

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Comparison of sensor specification

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	ENVISAT	PALSAR	TerraSAR-X
Observation mode	IS2	Fine beam FBS/FBD	StripMap (011)
Launch	***December 2002***	January 2006	***June 2007***
Orbit height	800 km	692 km	514 km
Periodical cycle	***35 days***	46 days	***11 days***
Frequency	5.3 GHz	1.26 GHz	9.6 GHz
Band	C	L	X
Wavelength	***5.66 cm***	23.6 cm	***3.1 cm***
Polarization	VV	HH/HH+HV	HH
Off-nadia angle	20.3 deg.	34.3 deg.	35.8 deg.
Coverage	100 km × 100 km	70 km × 70 km	30 km × 50 km
Spatial resolution	30 m	10 m/20 m	***3.3 m***
Critical baseline	1,250 m	16,500 m	2,400 m
Status	***Orbit adjustment on October 2010***	***Power generation anomaly on 22nd April, 2011***	Going well

JAXA reported all the onboard observation devices of ALOS were turned off due to power generation reduction.

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DInSAR using TerraSAR-X data

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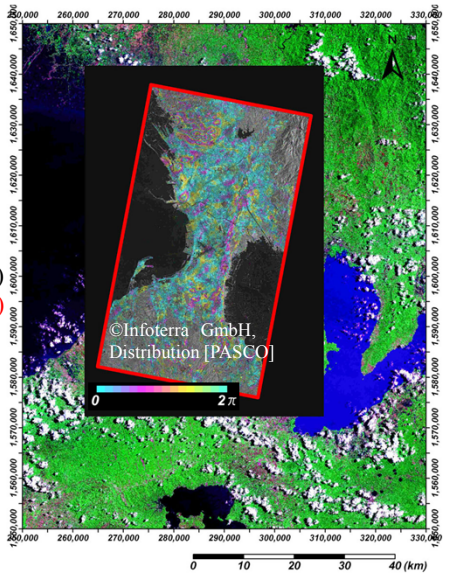
【Data】
TerraSAR-X (3 scenes)

【Observation Date】
(1) 2008/07/08
(2) 2009/12/29
(3) 2010/03/27

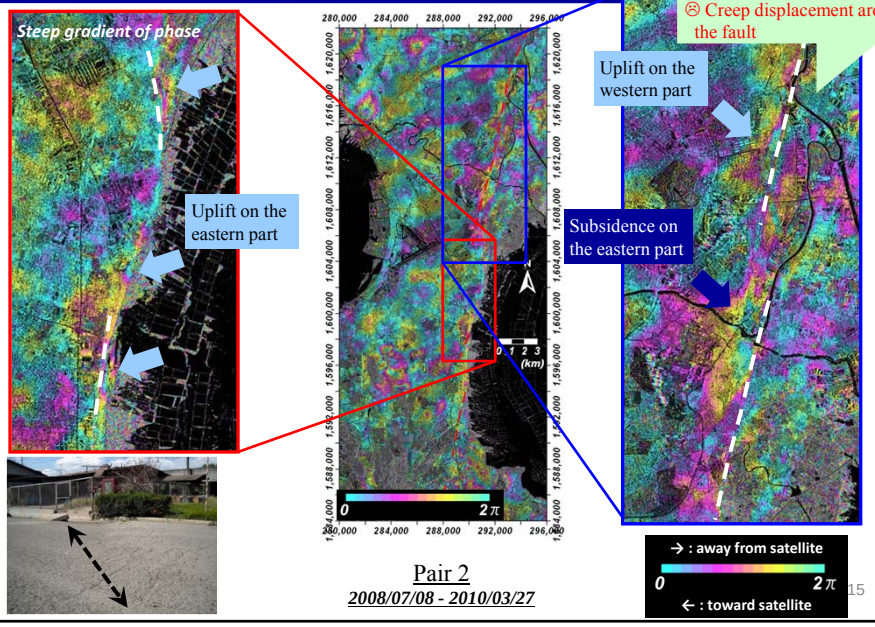
『Interferometric Pair』
2008/07/08 – 2009/12/29 (Pair 1, B_{perp}=70.0m)
2008/07/08 – 2010/03/27 (Pair 2 ,B_{perp}=71.2m)
2009/12/29 – 2010/03/27 (Pair 3 ,B_{perp}=0.8m)

【DEM】
SRTM3

【Software】
Personal software



Deformation around Valley Fault



Pair 2
2008/07/08 - 2010/03/27

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Summary

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1. InSAR time series analysis using ENVISAT data (2003-2009)
   → Sites in the eastern part of the Valley fault had subsided until 2007, but subsidence had stopped in around 2007 (correspond to leveling survey). In some areas, uplift began.
2. DInSAR using TerraSAR-X data (2008-2010)
   → In the southern area of the Valley fault, sites in the eastern part had been moving upward (correspond to InSAR time series analysis)

➪ What does the change of displacement direction mean?? Does it have any relations with earthquake??

3. The first differentiation and DInSAR using TerraSAR-X data
   → Steep gradient parallel to the Valley fault was clearly detected in the interferogram.

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Thank you very much
for your attention!!
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