Case Study of Small Scale Surface Deformation Detection using ALOS PALSAR Differential Interferometry

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Outline

• Introduction
• Subsidence and landslide due to seismic motion in Japan
• Subsidence and landslide of surrounding of coal mine site in China
• Landslide monitoring in Shikoku district, Japan
• Conclusions
Introduction

- Advanced Land Observing Satellite, ALOS
  - Launch: 24 January 2006
  - Phased Array type L-band Synthetic Aperture Radar, PALSAR
    - Cloud-free, Day/Night observation, High vegetation penetration
  - Large scale surface deformation detection capability is well known
    - Crustal deformation due to earthquake

- Focused to small scale surface deformation detection capability
  - Subsidence, Landslide
  - Three case studies are applied

- Aim of research
  - Understanding of capability of DInSAR for small scale surface deformation detection
Small scale surface deformation in large scale deformation

• The Niigataken Chuetsu-oki Earthquake in 2007
  - 16 July 2007
  - M6.8

• Condition of DInSAR analysis
  - Data
    • Master: 16 January 2007
    • Slave: 19 July 2007
  - Software
    • SIGMA-SAR
      • Developed by Dr. Masanobu Shimada, EORC/JAXA

• Summary of DInSAR result
  - Approximately 30cm of LOS shortening
  - Approximately 15cm of LOS lengthen
Small scale surface deformation in large scale deformation

- Landslide and subsidence of surrounding of housing site

Landslide and subsidence due to liquefaction

Geological structure
- Weak ground
- Liquefiable ground (site)
- Gentle slope

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Case study of coal mine site in China

- **Aim**
  - understanding surface deformation around coal mine site
  - understanding surface deformation in open pit

- **Condition of analysis**
  - **Data**
    - Master: June 2007
    - Slave: August 2007
  - **Software**
    - PALSAR Fringe
      - Developed by RESTEC

- **Summary of DInSAR result**
  - Subsidence and landslide is detected.
  - Large subsidence is detected in the site-2
Case study of coal mine site in China (Site-1)
Case study of coal mine site in China (Site-2)
Estimation of source of subsidence: case study of site-2

• Assumption
  - Surface was deformed only to vertical direction
  - Considering ground to be elastic body

Relationship of fringe pattern and source depth (estimated)

<table>
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<th>1</th>
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<th>3</th>
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<td>Simulation</td>
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• Shikoku district, Japan is one of the landslide narrow quarters area in Japan.
  
  • Monitoring of Zentoku landslide using DInSAR from 2003.
    
    - Stable state of Zentoku landslide was confirmed.
  
  • Reactivated landslide was detected near the Zentoku landslide.
Reactivated landslide in Japan (2)

- Subside or deformation to west direction was detected.
- Two reactivated landslides, upper block and lower block, were confirmed.
- Shape of deformation area is corresponding to landslide map.

3D-view on GoogleEarth

Subside ±5.9cm

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Conclusions

- PALSAR brings excellent results of detection of small scale surface deformation as well as large scale surface deformation.
- Especially, it is effective to detect very slow landslide movement at high vegetation area.
- Reactivated landslide was detected by DInSAR analysis.
- Continuous monitoring is necessary to mitigate small scale disaster with surface deformation but also detect new risk due to small scale surface deformation.
- Combination use of DInSAR and numerical analysis is effective to small scale surface deformation detection analysis.