GEO0606 & GEO1856

Landslide Monitoring with High-Resolution TerraSAR-X Data in the Three Gorges Area

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Outlines

• Background
• Monitoring Landslide with medium-resolution SAR interferometry
• Monitoring landslide movements using high-resolution SAR data
• Evaluation of InSAR deformation measurements
• Conclusion
Part I

Background
Geohazards in the Three Gorges area

- **Landslide**: 3830 occurrences, 67% of total
- **Rockfall**: 549 occurrences
- **Debris flow**: 90 occurrences
- **Collapse**: 85 occurrences
- **Ground fissure**: 45 occurrences
- **Unstable slope**: 1107 occurrences
Landslide hazards in the Three Gorges area
Typical landslides in the Three Gorges area
Difficulties for landslide studies with InSAR/D-InSAR

- Steep terrain
- Dense vegetation cover
- Complicated geological and atmospheric condition
Part II

Monitoring landslide with medium-resolution InSAR
Monitoring landslides in Three Gorges Area
ERS-1/2 before Dam construction

ENVISAT ASAR after Dam construction
Time series InSAR analyses over Badong Town

Deformation trends from different methods applied to C-band ENVISAT ASAR data stack
Results from ASAR data

- Two active deformation zones in the south river bank of Badong city are identified.
  - One is in the west part of the city, about 400m above the Yangtze River.
  - Another is in the east part near the old city of Badong county.
Preliminary experiment with L-band ALOS/PALSAR data

Differential interferogram from ALOS/PALSAR data

$B_n = 192m$

19th Feb, 2010 vs. 6th Apr, 2010

Water level: 161.81 m → 153.81 m
Part III

Monitoring landslide movements using high-resolution SAR data
Landslides monitoring around Zigui with TerraSAR-X data

A great landslide appeared here on Aug 30th, 2008.

<table>
<thead>
<tr>
<th>Image Acquisiton Time</th>
<th>Perpendicular Baseline (m)</th>
<th>Water Level (m)</th>
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<td>07-21-2008</td>
<td>94.7</td>
<td>145.1</td>
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<td>08-12-2008</td>
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<td>170.87</td>
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</table>
Amplitude images before the Landslide event

21st Jul, 2008  
145.1 m

12th Aug, 2008  
145.9 m

23rd Aug, 2008  
145.8 m

Reservoir water level at the Three Gorges Dam
Amplitude images after the Landslide event

3rd Sep, 2008
145.8 m

14th Sep, 2008
145.8 m

17th Oct, 2008
155.1 m

19th Nov, 2008
171.8 m
Differential Phase after the Landslide
(a) the landslide happened; (b) and (c) are two moving landslide bodies.

Using the high resolution TerraSAR-X data, near the Shazhenxi town in this area, one landslide happened in the end of August 2008 can be identified. As reported by the official media, the heavy rain caused the landslide.
Part IV

Evaluation of InSAR deformation measurements
Landslide monitoring at Shuping village

- Period I, the rapidly changing water level caused obvious deformation.
- Period II, the deformation became smooth with relatively stable water level.
- Period III, the scouring force from the decreasing water reduced the river bank uplifting pressure, thus significant deformation can be observed with a time lag.
Georeferenced PSI results from TerraSAR-X data stack

Mean velocity of deformation at Shuping landslide
derived from 15 TSX scenes between 12/09/2009 and 01/05/2010
Validation of TSX PSI results using GPS measurements

- Overall good consistency in temporal trend between PSI and GPS measurements
- RMS errors of PSI results w.r.t GPS measurements are 2~4 cm/y
Conclusion & Discussion (1)

• D-InSAR & PS-InSAR are powerful tools for wide-area surveillance of landslide movements.

• However, it is still difficult to use them in the Three Gorges area, and advanced PS-InSAR techniques like QPS or DS-InSAR can improve the results by relaxing the constrain on PS selection.
Conclusion & Discussion (2)

• TerraSAR-X data shows unique capability of detecting more details of landslide movement with high-resolution and more frequent observation.

• Deformation measurement accuracy for TSX PSI at fast-moving landslide is at cm level according to validation with GPS.
Thanks !