Engineering Applications of Radar Remote Sensing: Monitoring of Critical Infrastructure, and of Open and Underground Mining

Neelmeijer, Julia (1); Motagh, Mahdi (1,2); Tang, Wei (1); Haghshenas Haghighi, Mahmud (1,2); Stefanova Vassileva, Magdalena (1,2)

1: GFZ German Research Centre for Geosciences, Germany
2: Leibniz University Hannover, Germany
Mining deformation at the Hambach Mine, Germany
Mining deformation at the Hambach Mine, Germany

Sentinel-1A Ascending
- 29 images (Path 15 Frame 164)
- 19 Nov 2017 - 21 Oct 2018
- 93 interferograms

Sentinel-1A Descending
- 42 images (Path 139 Frame 424)
- 7 Jun 2017 – 24 Oct 2018
- 135 interferograms
Mining deformation at the Hambach Mine, Germany

Average deformation rates

ascending time-series
Mining deformation at the Hambach Mine, Germany

- close monitoring of surrounding area important to detect deformation related e.g. to groundwater lowering
Mining deformation in Inner Mongolia, China

- a main pit of Shendong Coal branch
- coal mine area of 61.8 square kilometers
- geological reserves of 1.23 billion tons (recoverable reserves of 830 million tons)
- established in 2000, produced 13.3 million tons of coal in 2008
Mining deformation in Inner Mongolia, China

**Sentinel-1A Ascending**
- 30 images (Path 11 Frame 126)
- 14 Oct 2017 - 21 Oct 2018
- 98 interferograms

interferogram example

(a) (b) (c)
Mining deformation in Inner Mongolia, China

average velocity (projected LOS)

better stabilization of underground mine needed?
Anthropogenic induced ground motion in Berlin

- Salt pillows used for gas storage
- \(~10 \times 10\) km\(^2\) area
- Maximum \(~5\) mm/yr uplift
  (Kampes 2005, Kuehn et al. 2009)

- Sentinel-1 dataset
  - 2014 - 2017
  - 68 ascending images
  - 63 descending images

Haghighi and Motagh 2017, ZFV
Anthropogenic induced ground motion in Berlin

Sentinel-1 ascending average velocity map

Sentinel-1 descending average velocity map

GFZ Potsdam

MMHOLTZ
Anthropogenic induced ground motion in Berlin

- for precise geolocation increase in spatial baseline needed!
Subsidence in Teheran

Haghighi and Motagh 2019, Remote Sensing of Environment
Subsidence in Teheran

Haghighi and Motagh 2019, Remote Sensing of Environment
Subsidence in Teheran

Haghighi and Motagh 2019, Remote Sensing of Environment
Masjed-Soleyman (MS) Dam, Iran

Construction period: 1995-2000
Watershed area: 60,000 km$^2$
Dam type: earth-fill dam with a vertical clay core
Crest length 500 m & Crest width: 15 m
Potency: 2000 MW
Spillway capacity: 21700 m$^3$/sec
Masjed-Soleyman (MS) Dam, Iran

Data: TerraSAR-X, Spotlight Mode

- 24 desc orbit, 03/2014 - 02/2015
- 13 asc orbit, 05/2014 - 01/2014
Masjed-Soleyman (MS) Dam, Iran

ascending interferograms

usefulness of only one orbit prevents decomposition to 3D deformation!
Masjed-Soleyman (MS) Dam, Iran

LOS-velocity from descending orbit
Masjed-Soleyman (MS) Dam, Iran

- One orbit data can provide information where a denser GPS network is needed.
Lake Urmia is one of the world’s largest salt lakes, but it is shrinking in recent years.
Bridge over Lake Urmia, NW Iran

Envisat (2003-2007)

TerraSAR-X (2012-2013)
Bridge over Lake Urmia, NW Iran

Shamshiri, Motagh, et al., JG, 2014
Questions?

neelmeijer@gfz-potsdam.de