MONITORING SURFACE DEFORMATION USING SATELLITE DATA

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Overview

• Context

• Background radar satellites

• Methodology and techniques

• Product samples
  • Kuwait
  • Iceland

• Accuracy on measurements
Earth Observation Broker

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Challenge Tree linked to Subsidence Monitoring

Subsidence Monitoring

- Land motion relating to fault lines or other causes
  - OTM-001 Identifying effects of fault re-activation
  - OTM-020 Tracking groundwater tables
- Infrastructure Monitoring
  - OTM-006 Determine historical ground movement for infrastructure planning
  - OTM-008 Monitor ground movement along pipelines
  - OTM-010 Determine historical ground movement for pipeline routing
  - OTM-011 Surface infrastructure moving relative to sub-surface
- Reservoir Management
  - OTM-002 Tracking fluid migration in the sub-surface
  - OTM-003 Subsidence from reservoir drawdown
  - OTM-004 Regulatory verification relating to injection of tracking fluids
  - OTM-005 Technical verification relating to injection of tracking fluids
  - OTM-007 Identify communication between producing zones

CREDIT: EARCS, EO4OG
Example Surface Deformation product covering Stavanger

Satellite source: TerraSAR-/TanDEM-X, Airbus
Background radar Synthetic Aperture Radar (SAR) satellites 1(3)

Credit: European Space Agency (ESA)
Background radar (SAR) satellites 3(3)

Credit: Norut
Data density is related to resolution of satellite imagery

Very High resolution satellite (TerraSAR-X)

Low resolution satellite (ERS-1)
Principles of Interferometric SAR (InSAR)

\[ \Delta r = R_2 - R_1 \]

Phase shift

\[ \theta \]
Example 1: Sentinel-1, InSAR Feasibility (Coherence) Map, Kuwait

Legend

Ground conditions for InSAR

- Good
- Very Good
- Excellent
Example 2: Sentinel-1, InSAR Feasibility (Coherence) Map, Iceland

Legend
Ground conditions for InSAR

- Good
- Very Good
- Excellent
Different InSAR time-series techniques can be applied, depending on ground conditions.
Example 3: IDDP Geothermal R&D project, Reykjanes, Iceland

Iceland Deep Drilling Project (IDDP)
- Geothermal R&D project
- Initiative est. in 2000 by Icelandic energy companies
- Statoil joined in 2008
- Source: [http://iddp.is/](http://iddp.is/)
Example 3: IDDP Geothermal R&D project, Reykjanes, Iceland
Example 3: Sentinel-1, Time-series Surface Deformation data, Reykjanes, Iceland
Example 3: Sentinel-1, Time-series Surface Deformation data, Reykjaness, Iceland, 2015-2017
Example 3: Sentinel-1, Time-series Surface Deformation data, Reykjaness, Iceland, 2016-2017
Millimetre to sub-millimetre accuracy on measurements can be achieved.