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Detection of OSI-Relevant Features Using Time-Series Radar Imagery

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Introduction

This poster provides a summary of the change detection results derived from RADARSAT- 2 Spotlight (SLA) imagery acquired over a 100km² area of Jordan from August to November 2014.

The study was a joint venture between the Provisional Technical Secretariat (PTS) and MDA Geospatial Services, with the latter responsible for processing the RADARSAT-2 images. The aim was to test the ability of RADARSAT-2 using its SLA beam mode to detect engineered surface features generated prior to the Integrated Field Exercise (IFE14) held in Jordan in November and December 2014.

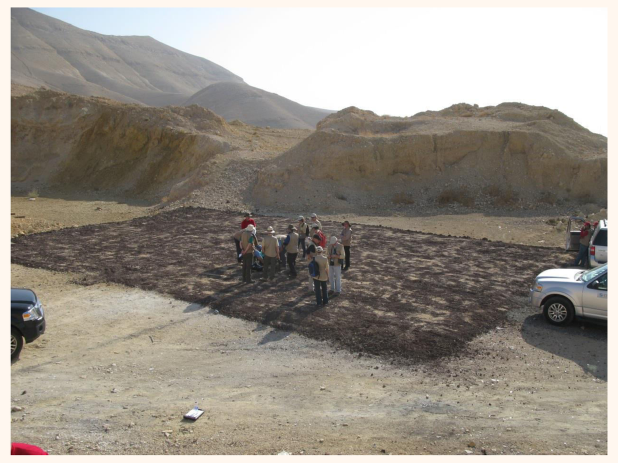
A stack of five RADARSAT-2 SLA images were acquired for a subset of the IFE14 inspection area, which were automatically processed and analysed. Positive change detections derived from the RADARSAT-2 images were then assigned a probability based on thematic information generated through object-based classification of a single high spatial resolution multispectral image.

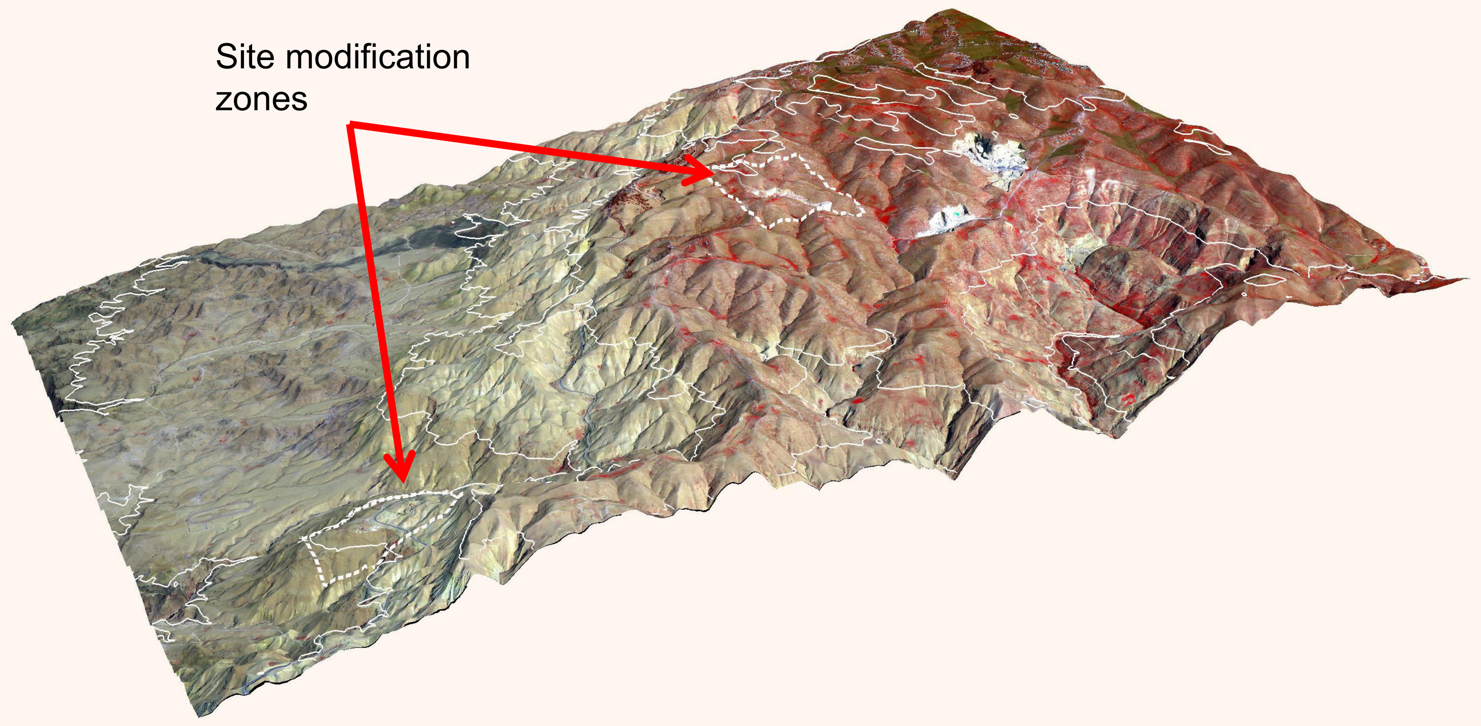
Site modifications

In preparation for IFE14, the control team engineered OSI-relevant surface features in two specific zones. For the purposes of this study, the data processing team were unaware of these locations. The relevant modifications were performed at the sites from August to October 2014, with radar imagery acquired pre, during and post site engineering.

Engineered features include ploughed bare soil, boulder fields and fresh unweathered surfaces to represent recent mass movement.

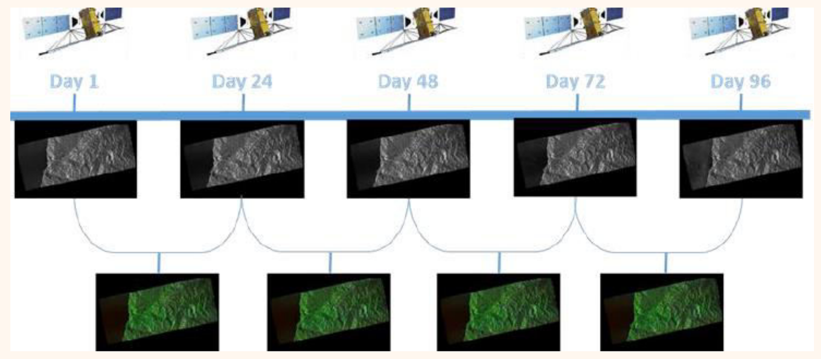
Additionally, non-local rock material was deposited over bare soil. The scale of the engineered features varied but all were in excess of 50m^2 i.e., in terms of spatial extent all were potentially detectable using RADARSAT-2 SLA beam mode (~1m spatial resolution).



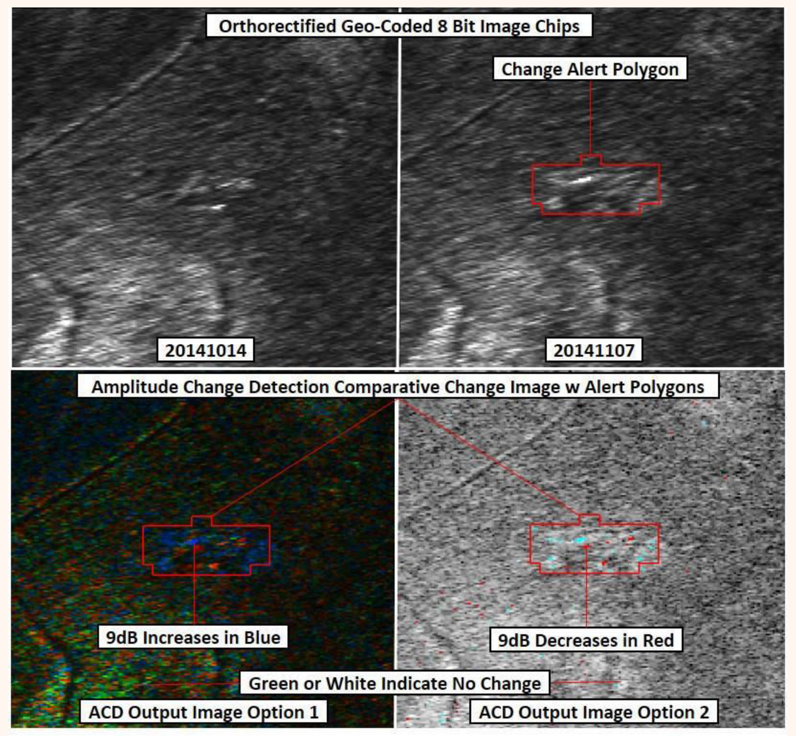


False colour image derived from the World View 2 spaceborne sensor. Image is draped over a high spatial resolution digital elevation model. The image was segmented into objects and these in turn were classified according to hierarchical rules to generate thematic layers.

Data Processing Methods

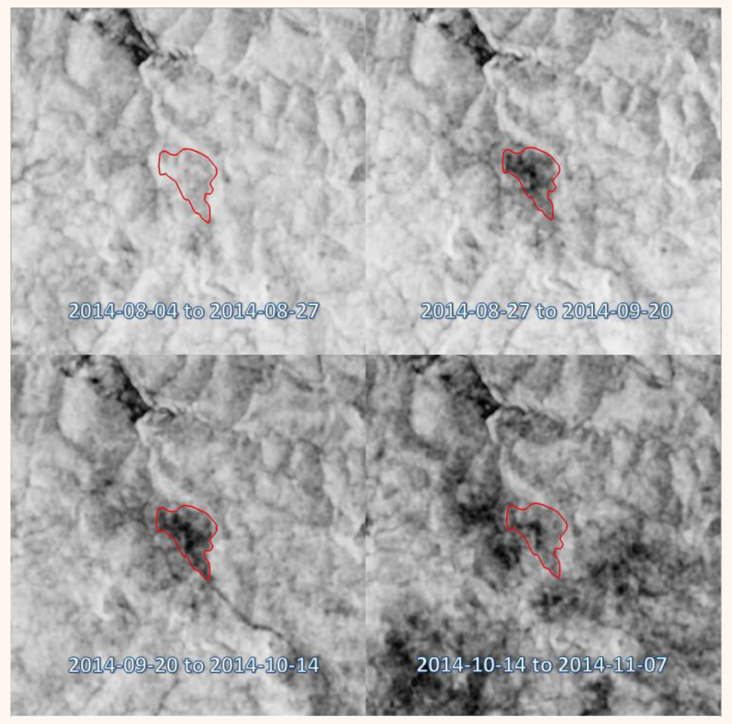


The strategy used in this analysis combined acquisitions from the same viewing geometry or "In-Stack" Analysis (*see fig to right*). This concept collects acquisitions using the repeat cycle of the satellite which in RADARSAT-2'S case is 24 days. This generates a "stack" of data in which the area on the ground is being viewed from the same SAR geometry, thus ensuring that objects and or activity on the ground are viewed in the same way for each image.



Received backscatter returns for each image were converted to amplitude values (measured in decibels, dB). As part of the process, each pixel's dB value was compared to the later image's corresponding pixel dB values (Amplitude Change Detection, ACD). When compared, an increase in dB value beyond a pre-set threshold is represented by blue pixels and a decrease in dB value beyond the same threshold represented as red.

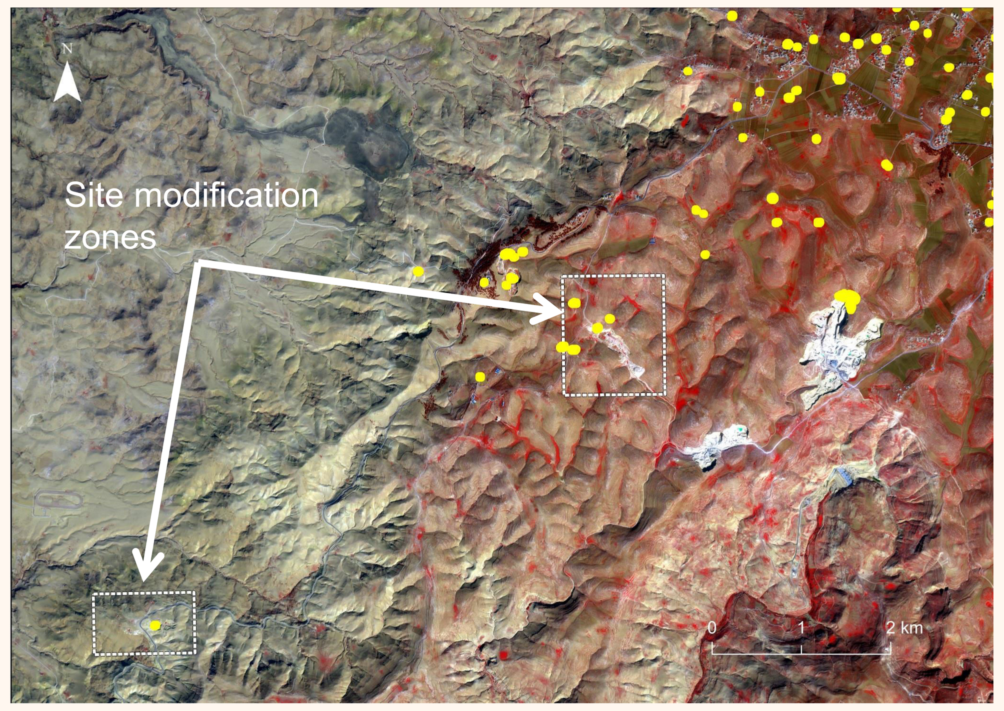
Coherence change detection (CCD) was also applied, which provides a measure of the stability of scatterers between two acquisitions, and is based on the entire complex signals of both image dates (phase and amplitude). The coherence estimate between two acquisitions quantifies the stability of the phase signal, in other words, it symbolizes the ability to correctly estimate ground motion based on phase differences.



Sequential coherograms from 2014-08-04 to 2014-11-07. White indicates high coherence, black indicates low coherence

Findings

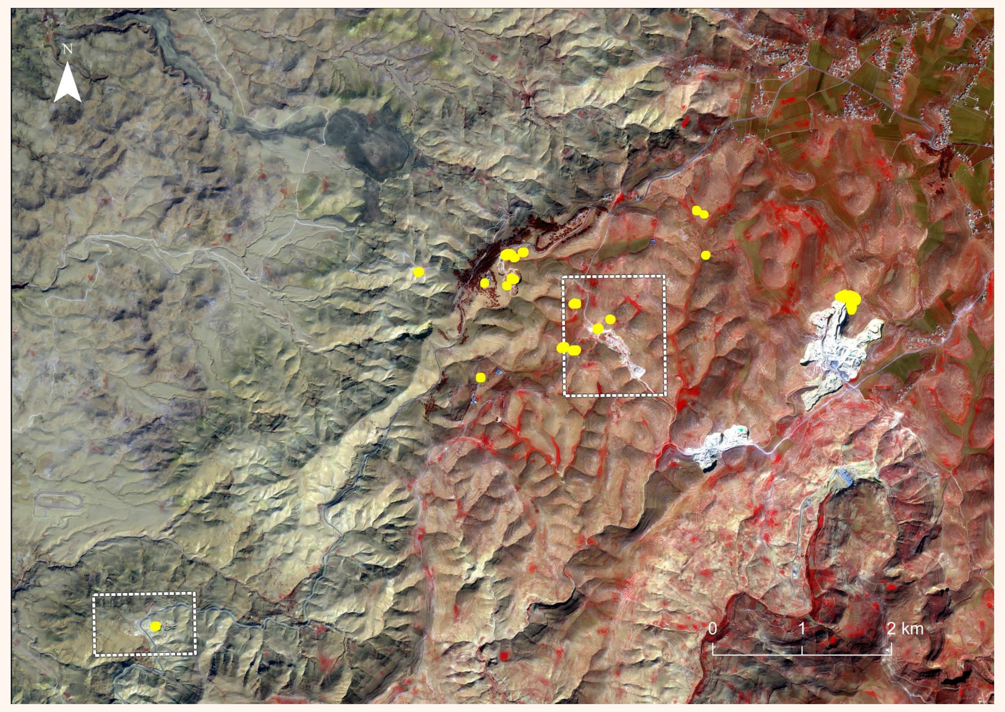
To reduce the number of possible false positives detected, the algorithm for ACD was tailored to detect only high backscatter changes (9dB) which would primarily be related to anthropogenic activity (e.g., movement of vehicles, significant ground disturbances etc.).
Detections were then filtered based on thematic information (e.g., residential properties) derived from the object based classification.



Pre filtered positive ACD detections shown in yellow (left). Site modification areas correctly identified as well as several other locations in NE of area.

For display reasons the size of the detected areas is exaggerated.

Automatically filtered positive ACD detections shown in yellow (right) with filtering based on the use of thematic information.
Activity at the quarry to the east is clearly shown as well as at both site modifications zones.



Time-series radar imagery with carefully tailored processing routines correctly identified the zones where site modifications had taken place in preparation for IFE14. Locations where activity had taken place within active quarries are also clearly registered.

Using the ACD and CCD data products in combination with thematic information limited the number of false positives, suggesting that the approach warrants further attention.