

TerraSAR-X Applications Guide

**Extract: Change Detection and Monitoring:
Geospatial / Image Intelligence**

April 2015

Change Detection and Monitoring: Geospatial / Image Intelligence

Issue

Change Detection and Monitoring related to general Geospatial / Image Intelligence requires temporal dense and reliable provision of information about continuous activities in a specific area of interest sometimes over a longer time period (e.g. progress of construction work or mobility of equipment).

Very often the area under observation is quite large and the data amount available for reconnaissance is huge. This circumstance is challenging image analysts as their capacity is restricted. As such, information for giving image analysts a focus is quite often requested by customers. This focus can be provided as delineating those areas, which have changed in between a certain time span.



Markets

Defence, Civil Engineering, Civil Institutions

Achievements

TerraSAR-X as an active SAR sensor offers preferred conditions for generating change information:

In the case of Amplitude Change Detection (ACD) a change is identified, if backscatter (grey value of pixel) changes between repeated acquisitions; thus simple overlaying of subsequent imagery is sufficient to identify changes. By generating a colour composite of a minimum of two different acquisitions, changes are easily visible as colourised areas (Figure 1). This is a very time and cost effective method.

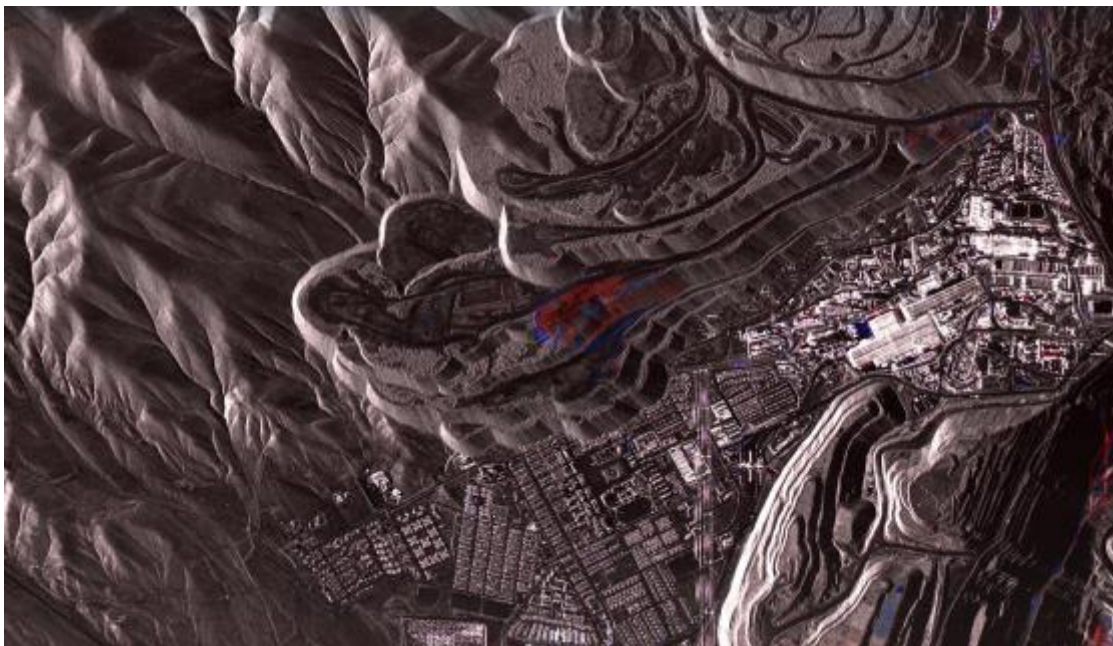


Figure 1: TerraSAR-X Sample for Amplitude Change Detection at Chuquicamata Mine, Chile; Changes in between 11/02/2014 and 11/03/2014 due to dump site activity are clearly visible.

In the case of Coherence Change Detection (CCD) under specific arid conditions is not only possible to detect tracks, but also to determine whether tracks have been used within a certain time frame between two subsequent acquisitions. The detection of changes due to the movement of a vehicle on a gravel road is definitely unique for SAR and opens the possibility to judge on the activity that has taken place in a certain area of interest (e.g. across a border). Bright pixels indicate stable objects like infrastructure or settlements, grey and dark pixels indicate changes for example active dumpsites or earthworks (Figure 2).



Figure 2: TerraSAR-X Sample for Coherence Change Detection at Iranian Heavy Water Research Reactor in Arak, Iran

Suitability of Amplitude or Coherence Change Detection depends on targeted features to be investigated, the kind of change to be detected and the location of the area of interest:

Indicator	Location	Target	Benefits	Final Product
Amplitude Change Detection	Worldwide	Ship, train, armoured vehicles, military activities	Reactive and reliable analysis	RGB product Changes in colour
Coherence Change Detection	Rocky and Arid area	Tracks activities, earthworks and dump site evolution.	Early detection of small changes down to car size	Image with changes in black

Benefits of using TerraSAR-X

TerraSAR-X offers precise geo-location for change detection results.

Furthermore, the Staring SpotLight mode with its very high resolution provides the potential for also detecting smaller changes.

Change Detection results are quickly available due to cloud and day-light independence of TerraSAR-X as well as (semi-) automatic processing.

Furthermore, the high acquisition frequency provides a good temporal sampling for change detection. With the availability of TerraSAR-X / PAZ constellation a daily revisit will be available for most latitudes.

Relevant Data Specifications

Table 1: Recommended Image Specification

Image Modes:	StripMap, SpotLight, High Resolution SpotLight, Staring SpotLight	
Number of datasets:	Two (acquired with exactly the same acquisition parameters, i.e. repeat pass)	
Assumed Analysis Approach:	<ul style="list-style-type: none"> Amplitude Change Detection (ACD) utilizing colour composite for two acquisitions, Coherence Change Detection (CCD) utilizing a calculation of coherence between acquisitions. 	
System Settings:	Polarization:	HH; HH/VV
	Incidence Angle [Degree]:	Any
	Orbit	Ascending or Descending
TerraSAR- Image Product	Basic Image Product:	MGD, EEC, GEC (if ACD is applied), SSC (if CCD is applied)
	Resolution Mode:	<ul style="list-style-type: none"> SSC: N/A, MGD, EEC, GEC: Radiometrically Enhanced (RE)
	File Format:	COSAR

Note: Recommended image specification is an indication only. It may vary depending on the software used. Airbus Defence and Space, Geo-Intelligence does not guarantee relevant capability.

Relevant Products and Services available from Airbus Defence and Space, Geo-Intelligence

- Change Indicator Product

Available Case Studies

- “Reliable Construction Monitoring with TerraSAR-X” (Belo Monte Dam, Brazil)

Related Publications

- None

Related Sample Datasets

- 3 x High Resolution SpotLight Qom, Iran (SSC, HH)

Change Detection

Reliable Construction Monitoring with TerraSAR-X

Challenge

In 2011, the construction of Belo Monte Dam (Lyon completion) will be the third largest dam in the world, comparable in the state of Pará in Brazil. The dam is intended to be complex of three dams retaining the water of the Xingú River in two large water reservoirs covering nearly 100km².

In the case of such a construction project located in a difficult area, and if a significant amount of monitoring can be challenging. Interferometric and co-polarization SAR imagery can be utilized to monitor the ground area and deliver information on the construction progress and changes such as forest clearance, leveling works, construction of access roads, storage and housing facilities. This comparison on-site observations. Due to the location of the construction site in the Amazon rainforest, monitoring with optical satellite imagery can frequently be hindered by cloud coverage particularly in the rainy season.

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AIRBUS DEFENCE & SPACE

Suitable Software

Application	Company Name								
	BAE Systems	Exelis	GAMMA Remote Sensing AG	Hexagon Geospatial/ GEOSYSTEMS GmbH	Joanneum Research	PCI Geomatics	Racurs	Textron Geospatial Solutions	Trimble
	Provided Software								
	SOCET GXP	ENVI SARscape	GAMMA MSP, ISP, DIFF&GE O, LAT, IPTA	ERDAS IMAGINE	RSG - Remote Sensing Software Package Graz	Geomatca and GXL	Photomod Radar	RemoteView, ELT5500, and Global ImageViewer	eCognition
Change Detection									
• Interferometric Coherence Change Detection		X	X	X	X	X	X	X	
• Amplitude Change Detection		X	X	X	X	X	X	X	X

Note: Information provided by Software Providers, Airbus Defence and Space, Geo-Intelligence does not guarantee relevant capability.

Contact

For feedback or further inquiry please contact the Airbus Defence and Space Customer Service Centre via telephone at +49 7545 8 4344 / eMail: terrasar@astrium-geo.com or visit <http://www.geo-airbusds.com/terrasar-x/>

List of Abbreviations

ACD	Amplitude Change Detection
CCD	Coherence Change Detection
DEM	Digital Elevation Model
DInSAR	Differential Interferometry
DSM	Digital Surface Model
DTM	Digital Terrain Model
EEC	Enhanced Ellipsoid Corrected (Basic Image Product)
EGR	Enhanced Gas Recovery
EMSA	European Maritime Safety Agency
EOR	Enhanced Oil Recovery
EU	European Union
EEZ	Exclusive Economic Zone
GCP	Ground Control Points
GEC	Geocoded Ellipsoid Corrected (Basic Image Product)
GEO	Airbus Defence & Space, Geo-Intelligence
HS	High Resolution SpotLight (imaging mode)
IMINT	Image Intelligence
InSAR	Interferometric SAR
IWS	Interferometric Wide Swath (Sentinel-1 imaging mode)
MGD	Multi Look Ground Range Detected (Basic Image Product)
NRT	Near-Real-Time
PSI	Persistent Scatterer Interferometry (PSI)
RE	Radiometrically Enhanced
REED+	Reducing Emissions from Deforestation and Forest Degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries
SAR	Synthetic Aperture Radar
SBAS	Small Baseline Subset Interferometry
SC	ScanSAR (imaging mode, 4-beam ScanSAR)
SE	Spatially Enhanced
SL	SpotLight (imaging mode)
SM	StripMap (imaging mode)
SSC	Single Look Slant Range Complex (Basic Image Product)

SRTM	Shuttle Radar Topography Mission
ST	Staring SpotLight (imaging mode)
WS	Wide ScanSAR (imaging mode, 6-beam Scan SAR)