TerraSAR-X Applications Guide

Extract: Change Detection and Monitoring: Emergency Management

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Airbus Defence and Space
Geo-Intelligence Programme Line

AIRBUS DEFENCE & SPACE

Change Detection and Monitoring: Emergency Management

Issue

In case of natural and man-made disasters satellite remote sensing data can become a crucial source of information for coping with catastrophic events. This involves the mapping of a disaster's spatial extent, its assessment of damages to population and infrastructure (transport, energy etc.), the identification of hot spot areas and the support of an efficient coordination of evacuation and rescue measures.

Supporting disaster management means providing solutions according to the different phases of the risk cycle: Prevention, preparedness, crisis situation and recovery. All phases require specific applications depending on type and extent of the disaster. Furthermore, for responding to a disaster just occurred, a rapid provision of satellite imagery is of utmost importance.

Markets

Disaster management, Civil protection, Spatial planning

Achievements

Natural and man-made disasters usually result in a change of the surface morphology and infrastructure. Thus, a mixture of change detection and image intelligence is the most suited way for analysing the event's impact. Change detection methods, which require the availability of pre-disaster archive imagery (ideally same sensor and geometry; alternatively optical data) and post-disaster imagery, lead to results. These quantitative results can serve as an input for image analysis for the identification or even classification of changes occurred (qualitative results).

Application examples for quantitative changes due to a flood and qualitative changes due to a volcano eruption, respectively, are given in Figure 1 and Figure 2.

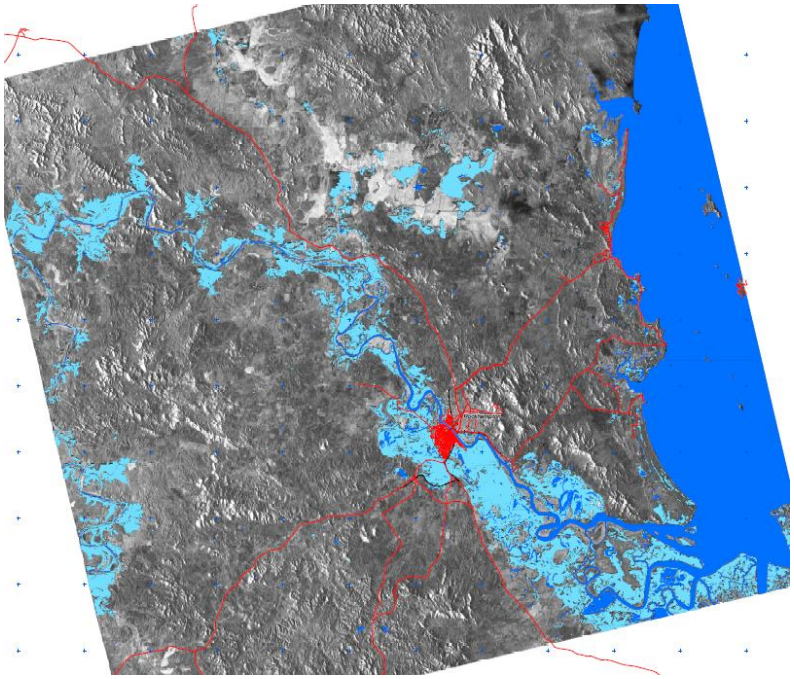

Figure 1: Mapping of flood extent in January 2011, Rockhampton

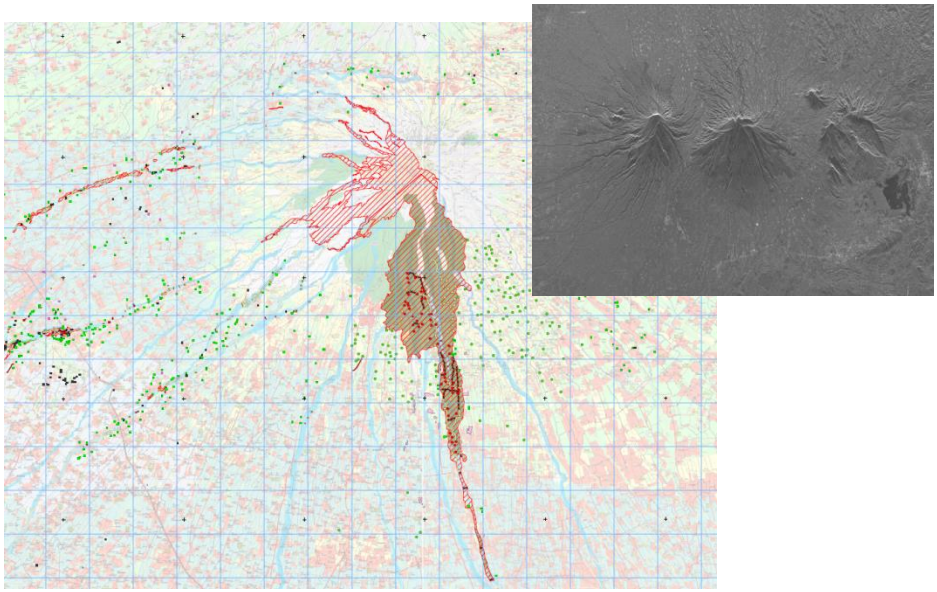

Figure 2: Sample TerraSAR-X result for damage assessment after a volcano eruption at Mt. Merapi in November 2010

Benefits of using TerraSAR-X

The all-weather capability of radar systems significantly reduces the response time for disaster mitigation activities in case disasters occur during night or under cloudy conditions. Especially the latter is typical for atmospheric disasters such as flooding and storm but also for some geophysical disasters (e.g. landslides caused by heavy rainfall).

But also at day-light and clear sky TerraSAR-X imagery provides valuable information not immediately identifiable in an optical image (e.g. collapsed roof) or the imagery can simply be used as complementary information facilitating the interpretation of the situation.

Furthermore, TerraSAR-X provides excellent radiometric stability over time, which results in comparable backscatter in repeat-pass acquisitions enabling fully automatic processing chains for emergency related change detection.

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

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

Relevant Data Specifications

Recommended image specification for emergency response varies with the targeted result:

Table 1: Recommended Image Specification for change detection

Image Modes:	StripMap, SpotLight, High Resolution SpotLight, Staring SpotLight	
Number of datasets:	Two (one prior, the second after the disaster event; same acquisition parameters).	
Assumed Analysis Approach:	• Amplitude Change Detection utilizing colour composite for two acquisitions, • Coherence Change Detection utilizing a calculation of coherence between acquisitions (if applicable)	
System Settings:	Polarization:	HH; HH/VV [a]
	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:	• SSC: N.A. • MGD, EEC, GEC: Radiometrically Enhanced (RE)
	File Format:	COSAR

[a] HH or HH/VV polarization recommended; depending on archive data set availability also other polarizations need to be considered; data set prior and after emergency need to have same polarization

Table 2: Recommended Image Specification for image analysis

Image Modes:	StripMap, High Resolution SpotLight, Staring SpotLight	
Assumed Analysis Approach:	• Visual Interpretation	
System Settings:	Polarization	HH
	Incidence Angle [Degree]	40 – 50 [b]
	Orbit	Either Ascending or Descending
TerraSAR- Image Product	**Basic Image Product:**	**GEC**
	Resolution Mode:	Spatially Enhanced (SE)
	File Format:	GEOTIFF

Table 3: Recommended Image Specification for flood mapping

Image Modes:	ScanSAR, StripMap, High Resolution SpotLight,	
Number of datasets:	Two (one prior, the second after the disaster event; same acquisition parameters).	
System Settings:	Polarization	HH
	Incidence Angle [Degree]	> 30 [h]
	Orbit	Either Ascending or Descending
TerraSAR- Image Product	Basic Image Product:	EEC (alternatively SSC if required expert knowledge available)
	Resolution Mode:	• SSC: N/A • EEC: Radiometrically Enhanced (RE)
	File Format:	GEOTIFF (EEC); COSAR (SSC)

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.

[b] depending on availability within next possible TerraSAR-X pass during emergency

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

- IMINT Training
- Change Indicator Product
- Flood Mapping Product

Related Publications

Virginia Herrera Cruz, Müller, M. & Weise, C. (2010): Flood extent mapping based on TerraSAR-X data. PFG 2010 / 6, pp. 475-488.

Related Sample Datasets

Flood Mapping

- 2 x ScanSAR Rockhampton, Australia (EEC, RE, HH)
- 2 x ScanSAR región Bijeljina, Serbia (EEC, RE, HH)
- 2 x SpotLight, Caprivi, Namibia (SSC, HH)
- 1 x StripMap, Elbe, Germany (EEC, RE, HH)

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&GEO,LAT, IPTA	ERDAS IMAGINE	RSG - Remote Sensing Software Package Graz	Geomatica and GXL	Photomod Radar	RemoteView, ELT5500, and Global ImageViewer	eCognition
Change Detection									
•Interferometric Coherence Change Detection		x	x	x	x	x	x		
•Amplitude Change Detection		x	x	x	x	x	x	x	x
•Flood Mapping (Semi- or Full Automatic Analysis)				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)