

GMES services for Management of
Operations, Situation Awareness and
Intelligence for regional Crisis
(GMOSAIC)

Marc Mueller, Infoterra GmbH

- **GMOSAIC Project**
 - Overview and concept
 - Partners and users
 - Services chains and service cases
- **Activities of Infoterra GmbH in GMOSAIC**
 - Monitoring of borders, critical assets and migration routes using TerraSAR-X imagery
 - Demonstrations for Burgas, Gdansk, Lviv and In-Salah

- GMOSAIC
 - GMES Security Pilot Project under the 7th Framework Programme
 - Aims to provide support to the definition and implementation of security related core services

- **Facts**
 - Project duration: 36 months (Jan09-Dec11)
 - Consortium: 36 partners (Coordination: e-Geos)
 - EC contribution: 9,6 M. €
- **Objectives**
 - Identify and develop products, methodologies and pilot services for the provision of geo-spatial information in support of the EU's security related issues
 - Contribute to the definition of and demonstrate the sustainability of GMES' global security perspective



Involved players of GMES security services in Europe:

- Industrial service providers
- Institutional stakeholders and space agencies
- Leading European academic institutions and specialised small and medium size enterprises

Addressed user community

- AT-Austrian Foreign Ministry (BmEIA)
- BE-Belgian military intelligence
- BG-ASDE
- Colombia-Geographic Institute of Colombia and its Research Center - CIAF
- Columbia-IGAC (Instituto Geográfico Agustín Codazzi)
- DE-AGeoBw; BKA; Bonn International Centre for C. (BICC)
- EU-DG-DEVELOPMENT; DG-RELEX; EMSA; EU Council (Secretariat General, EUMS, SITCEN) (via EUSC)
- EU-FRONTEx; The 27 EU Ministry of Defence; The 27 EU Ministry of Foreign Affairs
- FR-Bureau Géographique InterArmée (BGI); Ministère de la Défense , including military intelligence (DRM)
- GB-Global Witness
- Intern.-AMI (Assistência Médica Internacional – International Medical Assistance); MSF (Médecins Sans Frontières)
- Intern.-IAEA; NATO; International Peace Information Service (IPIS)
- Intern.-RCMRD (Regional Center for Mapping of Resources for Development) (UN, AU)
- Intern.-Spanish Red Cross
- Intern.-UN Department for Field Support – Specialist Support Service (Cartographic Section)
- Intern.-UN OCHA; UNEP-PCDMB; UNODC
- IT-Italian MoD; Ministero Affari Esteri (Unità Crisi)
- Mozambique-ARA-Sul – Regional Water authority for Southern Mozambique
- PE-Cuerpo de Asistencia para el Desarrollo Alternativo (CADA)
- PL-Akademia Obrony Narodowej National Defence University
- PL-Ministerstwo Spraw Wewnętrznych i Administracji Ministry of Interior and Administration
- PL-Ministerstwo Spraw Zagranicznych Ministry of Foreign Affairs
- PL-P2 of the Polish Armed Forces General Staff; Polish Armed Forces Topographic Service
- PL-Służba Wywiadu Wojskowego Military Intelligence Service
- PT-Aguas de Portugal – Águas de Moçambique; IDN
- PT-INAC (Instituto Nacional de Aviação Civil); MAI (Ministério da Administração Interna) PALOP Security Office; Ministerio de Negocios Extranjeros; SIS (Serviço de Informações de Segurança)



- GMOSAIC develops services in order to support EU interventions for crisis management:
- Intelligence and early warning
 - With the objective to deploy and validate those information services that contribute to the analysis of reasons leading to regional crises
- Crisis management operations
 - With the objective to deploy and validate those information services that contribute to support the planning for EU intervention during crises, the citizen repatriation, the adverse consequences management, reconstruction and resilience

<i>Crisis Phases</i>	<i>Thematic information</i>	<i>Service chain</i>
Intelligence & Early Warning	Proliferation & treaties	• Monitoring of nuclear decommissioning sites
		• Continuous surveillance of nuclear facility
		• Peace accords and human rights
	Crisis indicators	• Exploitation of natural resources (ENR)
		• Population pressure (PP)
		• Land degradation (LD)
	Critical assets	• Critical assets monitoring
		• Critical assets event assessment
	Illegal activities	• Illegal mining
		• Illegal timber logging
		• Illicit crops
	Routes & borders	• Monitoring of military activities, border crossing and related infrastructure along the border
		• Long range migration routes & temporary settlements along the routes
Preparedness for crisis	Contingency planning	• Contingency plan preparation
Crisis	Emergency mapping	• Terrain analysis and mobility assessment (non permanent tasks)
		• Logistic and deployment operations
Post-crisis & reconstruction	Damage assessment	• Damage assessment for post-conflict situations, post conflict environmental assessment (jointly with UNEP DEWA)
		• Support reconstruction mission after conflicts

Intelligence and Early Warning

Geographic

SC#1 Eastern Europe

SC#2 Southern Africa

SC#3 DR of the Congo

Focussing on “critical” world areas

Involving heterogeneous users

Applying different service chains

Thematic

SC#5 Illicit crops

SC#6 Nuclear and NP monitoring

SC#7 Migration

SC#8 Critical Assets

Built around specific issues addressed by EU security policies

Very specialized users

1 or 2 service chain(s)

Crisis Management

SC#8 Planning and Preparedness

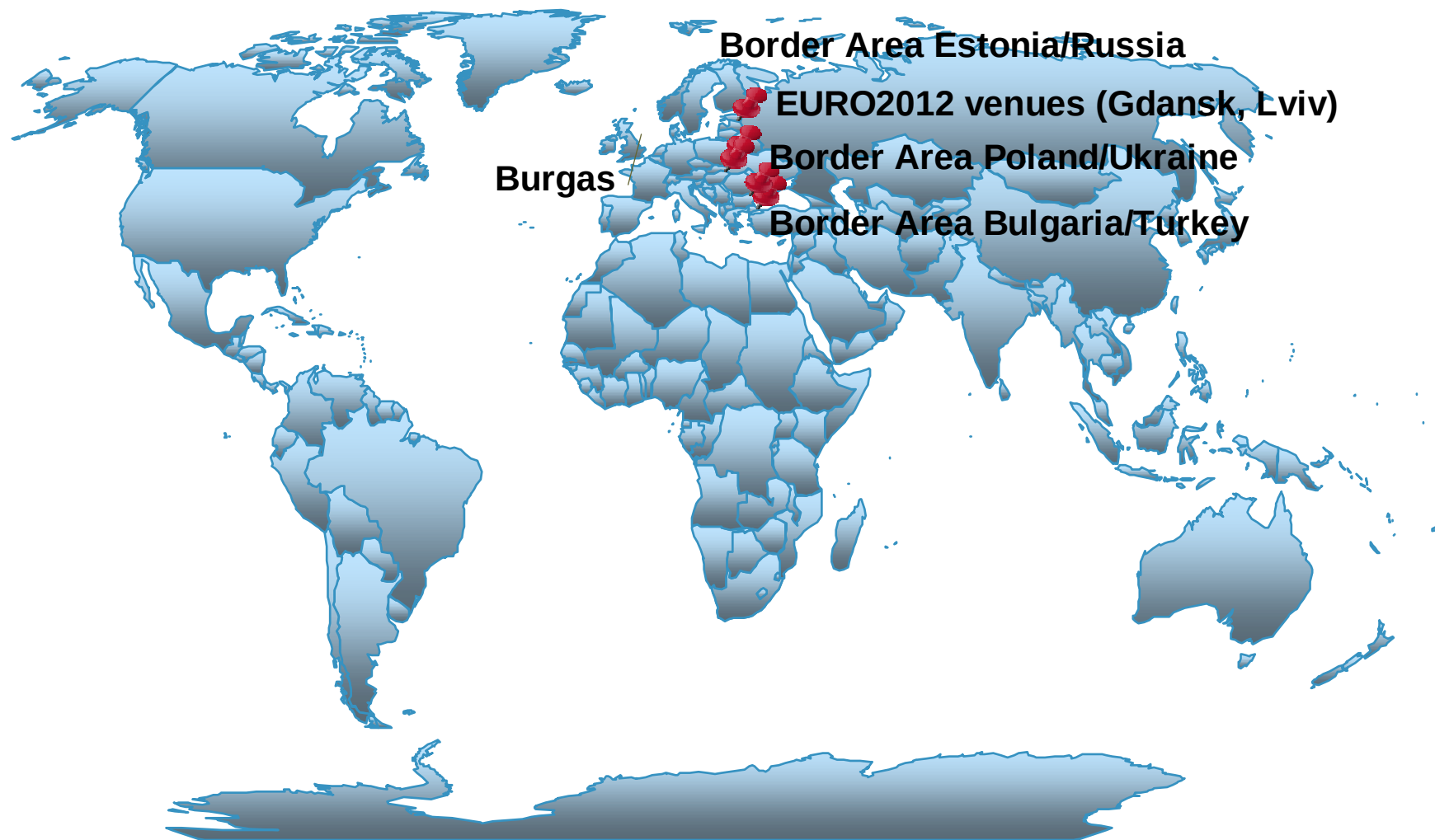
SC#9 Crisis Management.

SC#10 Post-crisis Assessment

Built around typical crisis phase

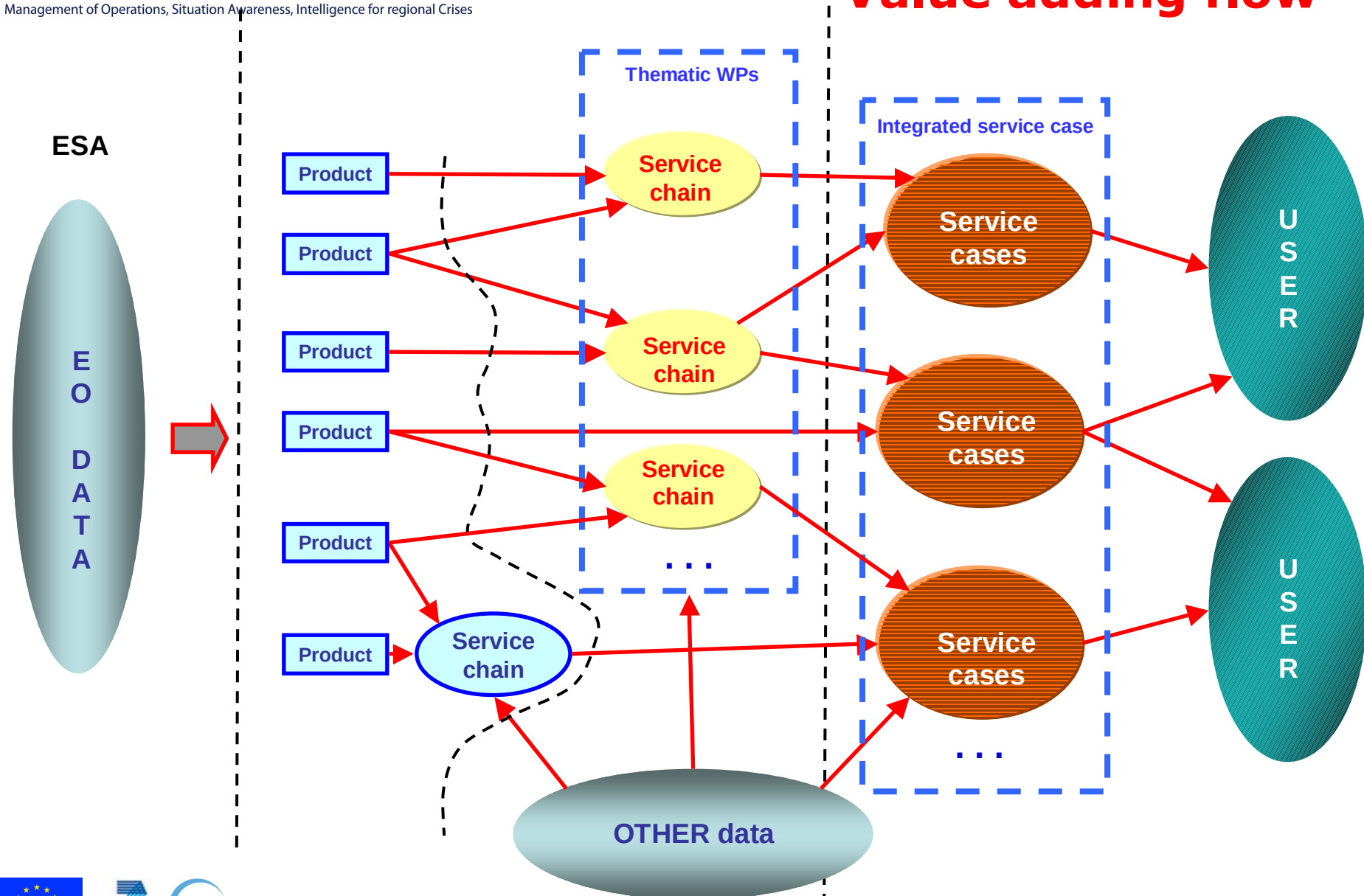
Usually well profiled users (e.g. defense, peacekeeping agencies, etc)

Reference/Assessment service chain scheme (duly tuned for security)



Area	Description	Addressed issues	Involved Service Chains	Users
Border area Poland / Ukraine	Border regions are prone to military but also to other cross border issues such as migrations, terrorism, traffic and suspicious accumulations.	Provide support to situation awareness and activities along borders	Sch #11 Border monitoring	General Staff of the Polish Armed Forces, Military Intelligence Directorate J2 Polish National Defence University
Border area Bulgaria / Turkey	Geographic permeability related to illegal traffic and migration	Extended Routes (migration, illegal traffic etc.)	Sch # 11 Border monitoring Sch #12 Migration Routes and Settlements	ASDE
Border area Estonia / Russia	Disputes over cross-border pollution or shared assets can cause political tension and even conflict. Countries experiencing an economic transition or political stress are particularly vulnerable to environmental damage and resource competition.	Provide support to situation awareness and activities along borders	Sch #11 Border monitoring	Estonian Ministry of Interior (user engagement ongoing)
Gdansk / Lviv (EURO2012 venues)	EURO2012 will be hosted by Poland and Ukraine and the progress of construction at this sites and in their environments (critical infrastructure) will be monitored and documented.	Monitoring of infrastructure development and construction progress	Sch #6 Critical Assets Monitoring	EURO 2012 Organizing Committee (user engagement ongoing)
Burgas	Burgas is an important industrial, transport, cultural and tourist centre; the service case shows the broad range of civil security	Critical Assets (here: harbour area) “Blue” border	Sch #6 Critical Assets Monitoring Sch #11 Border monitoring	ASDE ...

Value adding flow

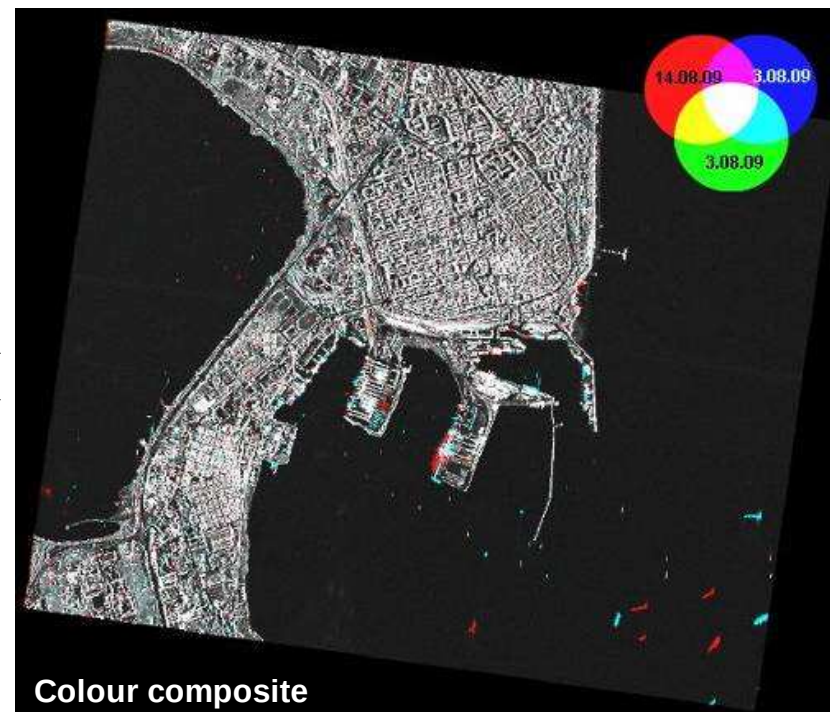
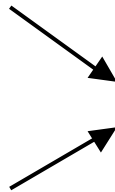
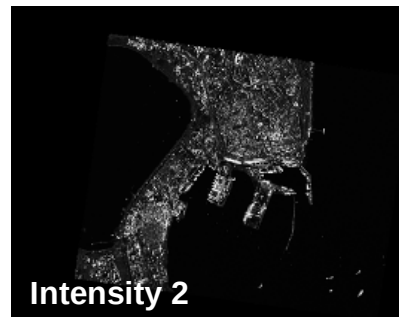
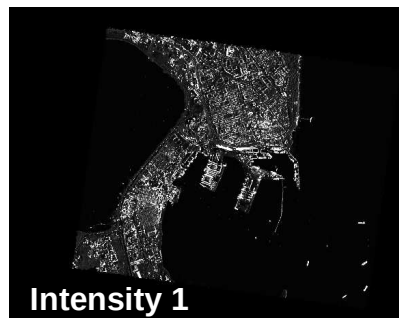


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- Change detection and security related applications:
 - Small to large scale monitoring
 - Assessment after natural disasters (Haiti, Chile)
 - Site / border monitoring

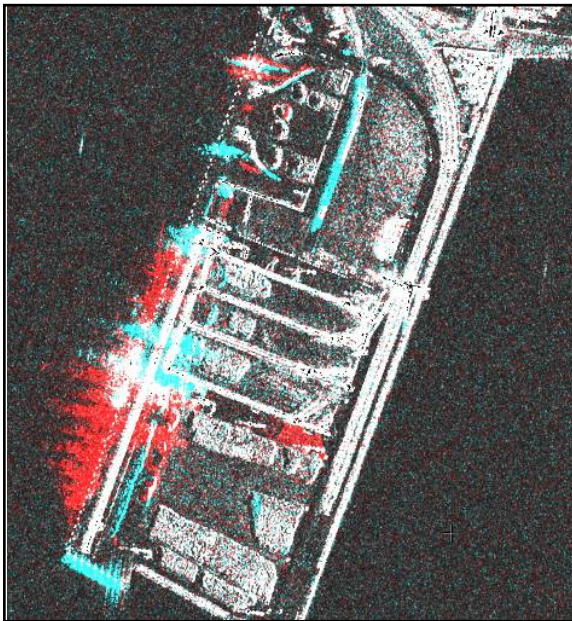
- Amplitude Change Detection (ACD)
 - RGB colour composite as change indicator (satellite images are assigned to different channels [red, green, blue])
 - Intensity ratio as change indicator (Intensity = amplitude²)
- Coherence Change Detection (CCD)
 - Coherence is used as change indicator

- RGB colour composite
- Coloured areas indicate changes

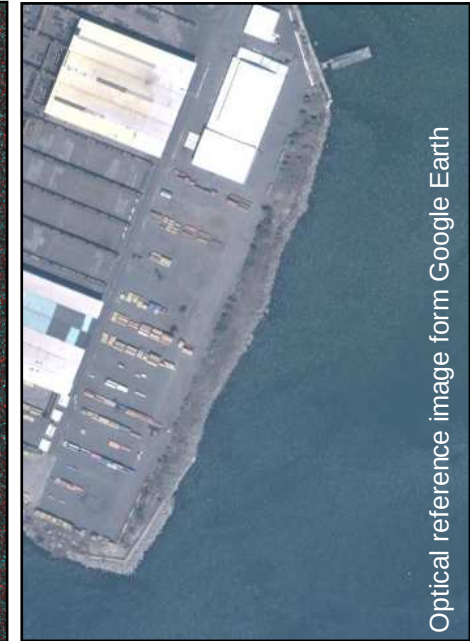
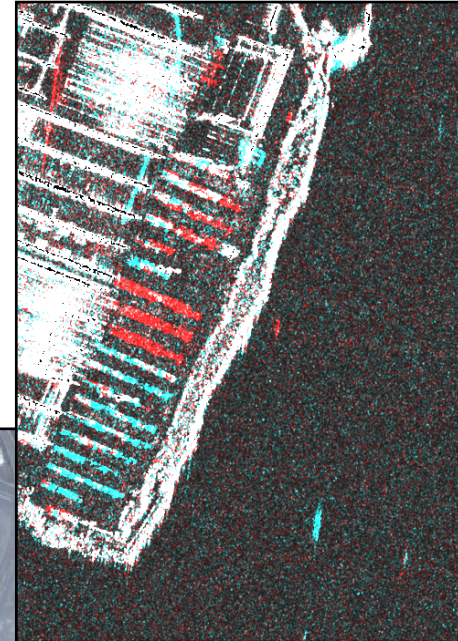
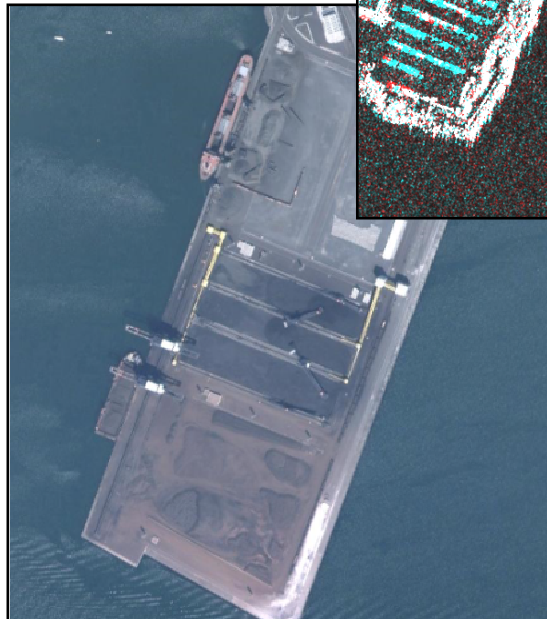


Harbour Monitoring - BURGAS

Amplitude Changes
Harbour Installation



Location of locomotive cranes



Optical reference image from Google Earth

Number of containers

R: 2009-08-14
G and B: 2008-08-03

Critical Assets Map - Burgas Harbour, Bulgaria



TerraSAR-X High Resolution SpotLight Acquisition

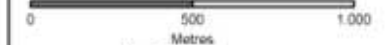
Location of Scene:



Satellite Image Information

Image Colour	Blue and Green	Red
Acquisition date	2009-06-03	2009-06-14
Satellite	TerraSAR-X	
Imaging Mode	High Resolution Spotlight	
Ground Range Resolution	0.75m	
Polarisation	HH	
Incidence Angle	50.1 - 51.1	
Pass Direction	Descending	
Acquisition time (UTC)	04:10:27	
Product Type	SIC (geocoded)	
ITDID	000010001.0005	000010001.0007
BW A release number	404-12-00-1702-180	404-12-00-1702-178

Scale: 1:20 000 for DIN A4 printing



Map Projection

Geographic: Universal Transverse Mercator
 Ellipsoid: WGS 84
 Datum: WGS 84
 Zone: 35N

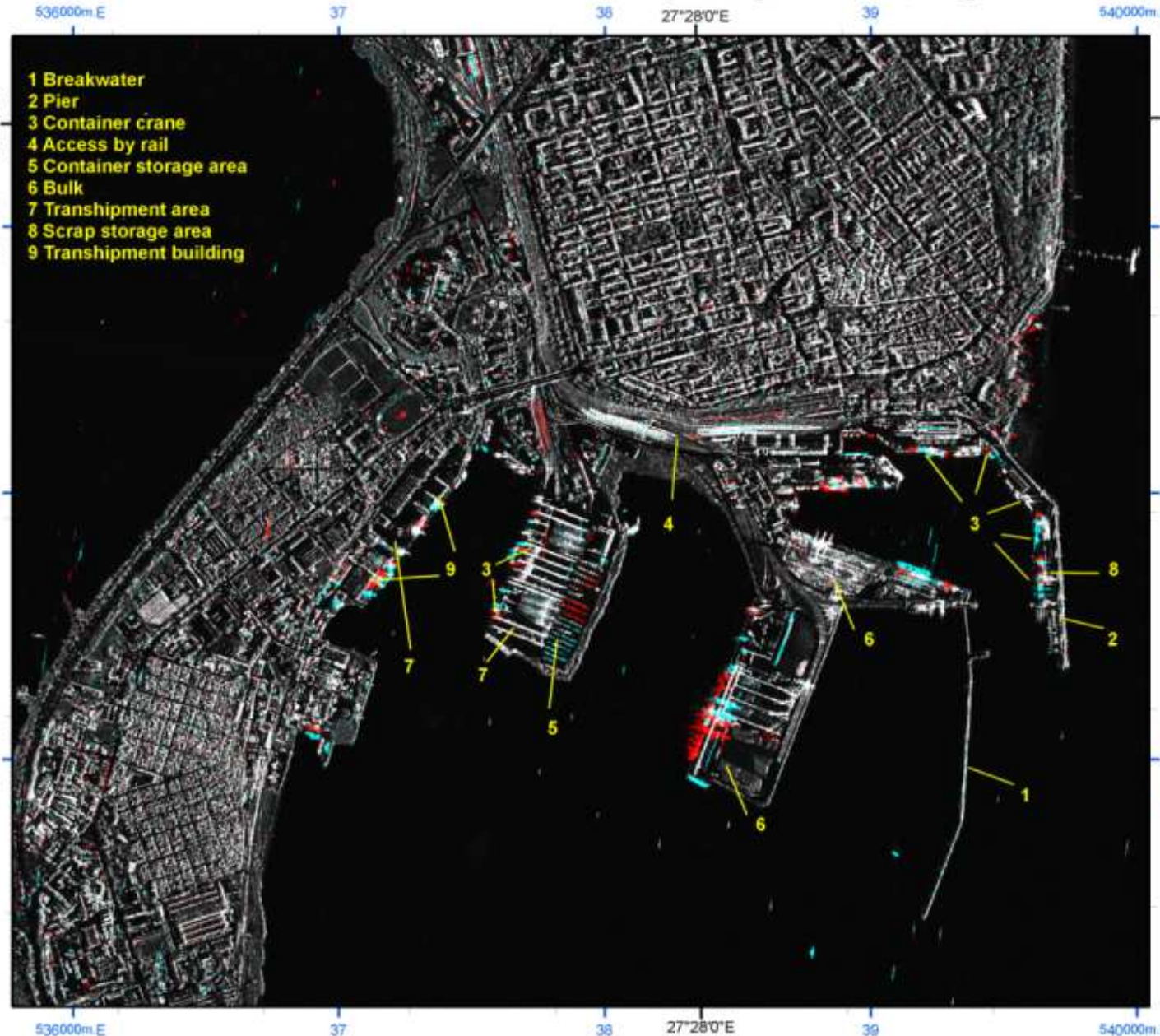


Co-Funded by the European
 Commission's Seventh Framework
 Programme (FP7/2507-2013)



Date of Map generation: 2010-02-02 Map coordinate system: UTM

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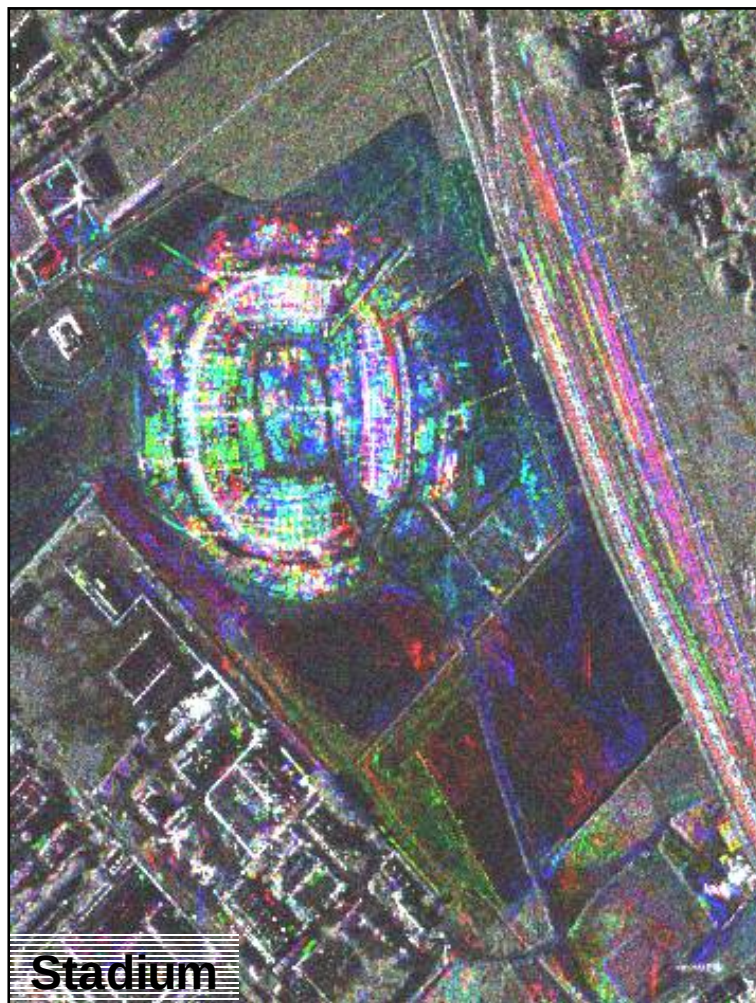
Construction Site Monitoring I

Gdansk,
Poland
(left)

Lviv,
Ukraine
(right)

Amplitude
Changes

Construction
works



R: 2009-08-11

G: 2009-09-13

B: 2008-10-16

R: 2009-08-13

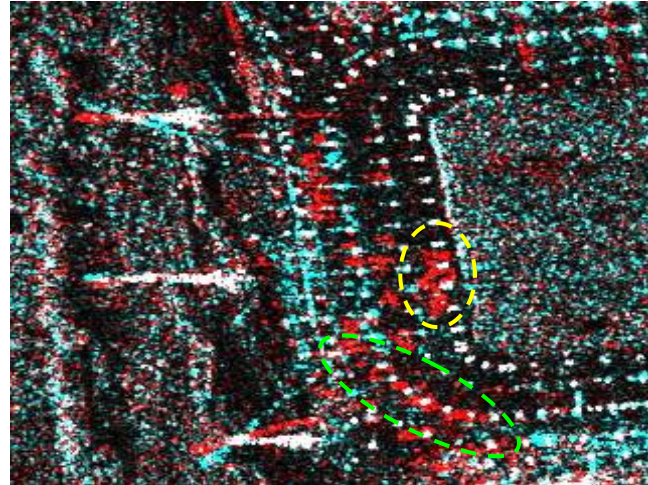
G: 2009-09-15

B: 2008-10-18

Sofia, 25–26 March 2010

Construction Site Monitoring II

Lviv,
Ukraine



Amplitude Changes

R: 2009-08-13

G: 2009-09-15

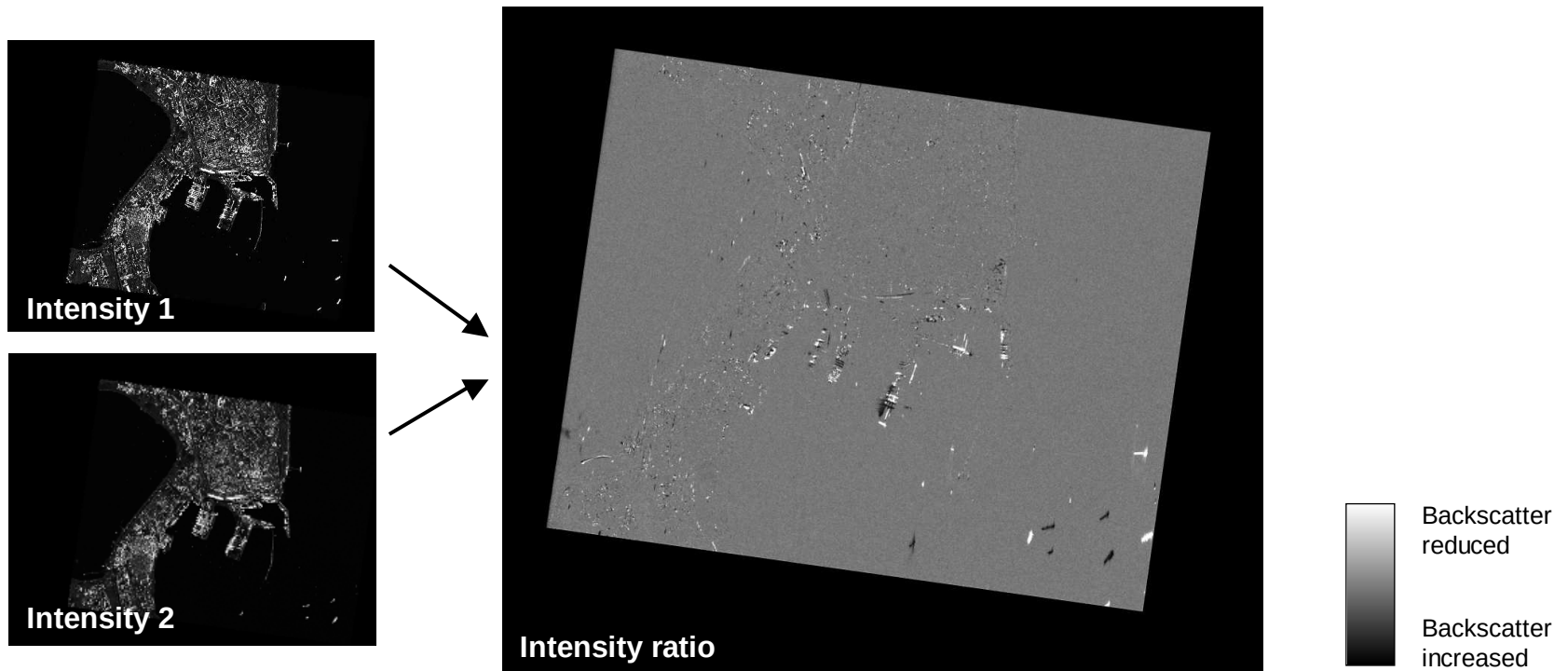
B: 2008-10-18



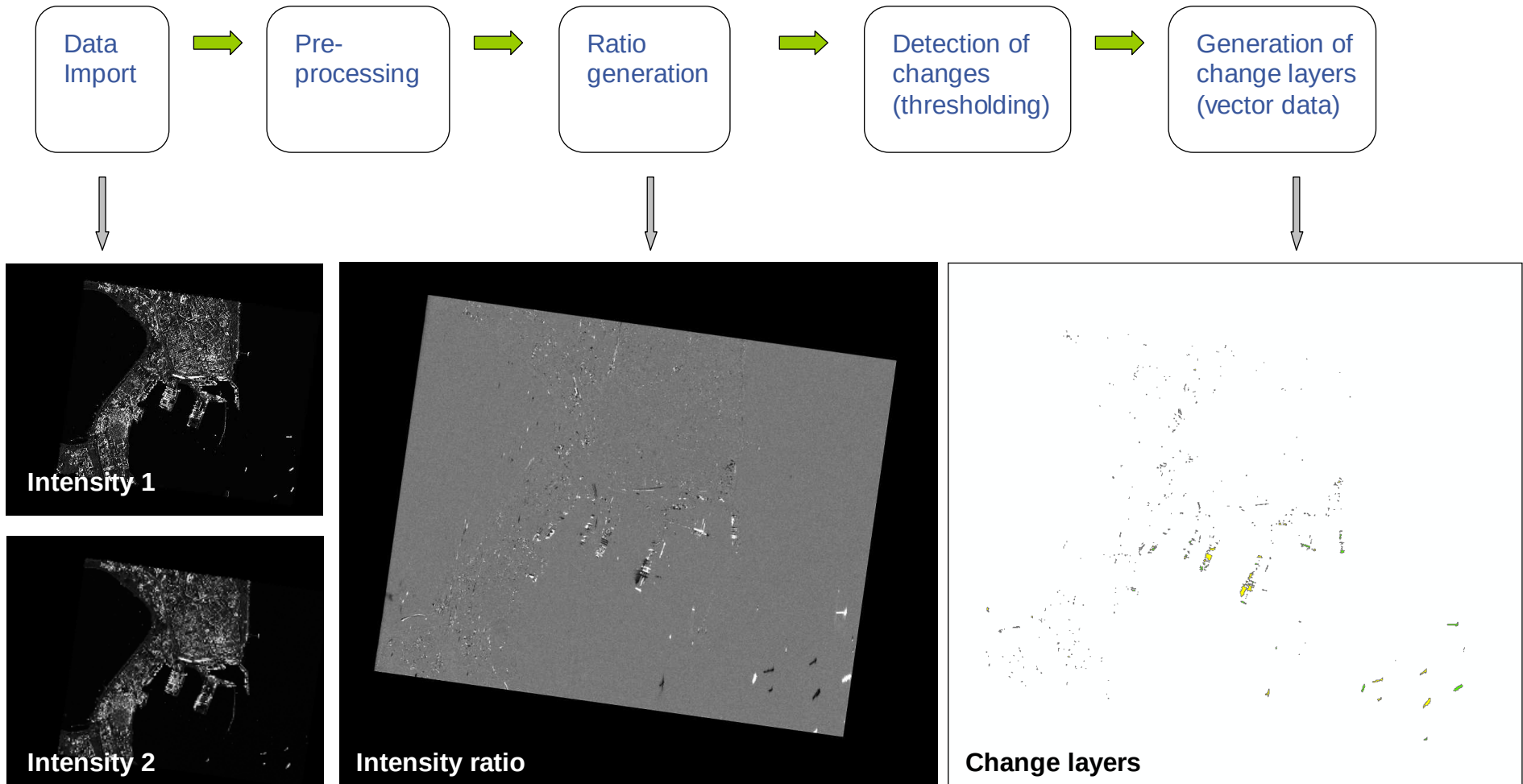
- Amplitude Change Detection (ACD)
 - RGB colour composite as change indicator (satellite images are assigned to different channels [red, green, blue])
 - Intensity ratio as change indicator
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 - Coherence is used as change indicator

Intensity ratio as change indicator

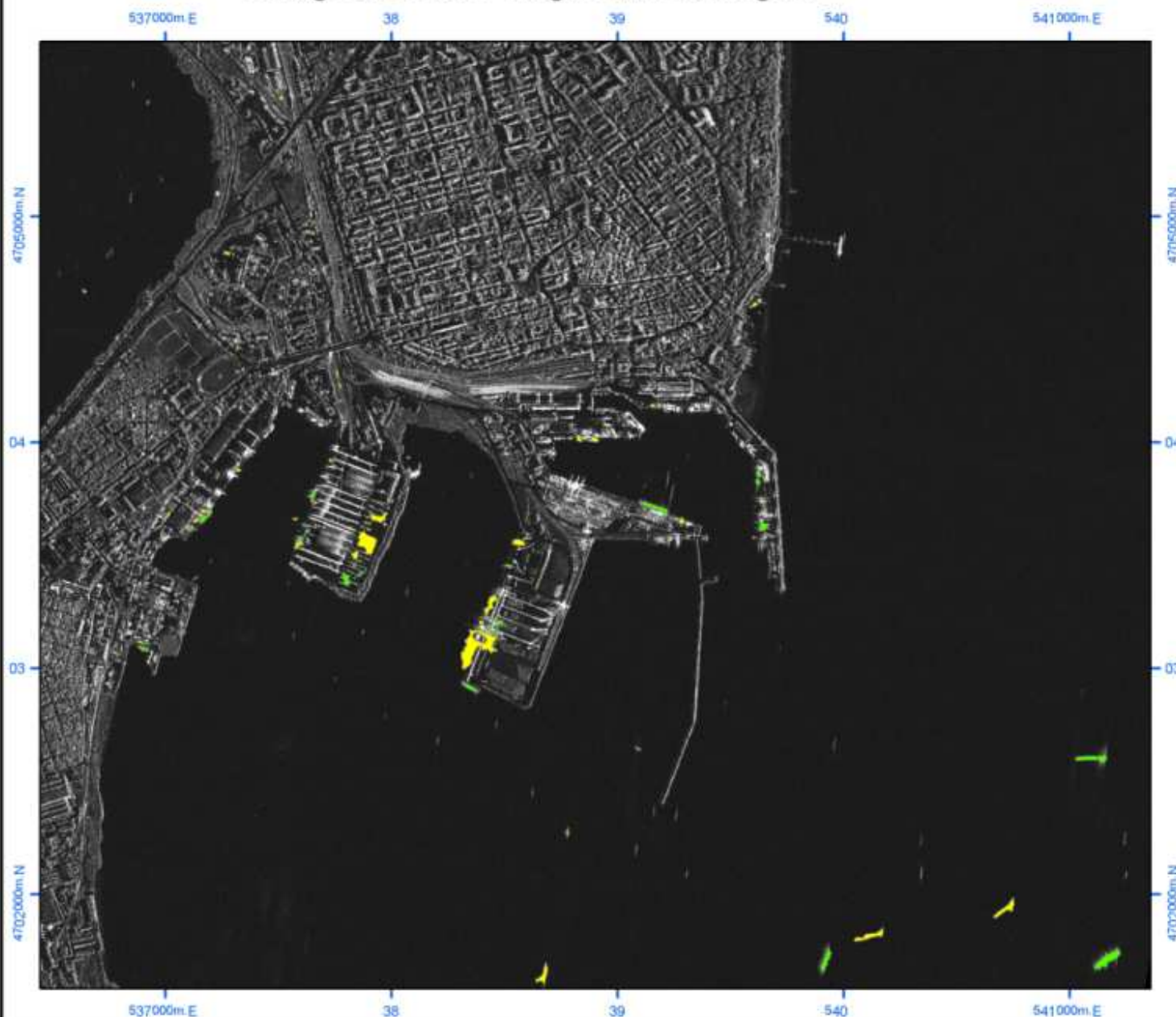
- Very dark and very bright areas indicate changes (backscatter increased / reduced)



AUTOMATIC change detection based on intensity ratio



Change Detections - Burgas Harbour, Bulgaria



TerraSAR-X High Resolution SpotLight Acquisition

Location of Scene:



Satellite Image Information

Acquisition date	2009-08-03	2009-08-14
Satellite	TerraSAR-X	
Imaging Mode	High Resolution Spotlight	
Ground Range Resolution	0.75m	
Polarization	HH	
Incidence Angle	90.1 - 91.1	
Pass Direction	Descending	
Acquisition time (UTC)	04:10:27	
Product Type	SAR (geocoded)	
ITD-ID	000012061_0009	000012061_0007
BAF/Release Number	424-12-00-1102180	424-12-00-1102178

Automatically detected amplitude changes

- Backscatter increased
- Backscatter reduced

Scale: 1:23 000 for DIN A4 printing
0 500 1 000 Metres

Map Projection
Geographic: Universal Transverse Mercator
Ellipsoid: WGS 84
Datum: WGS 84
Zone: 35N

G-mosaic



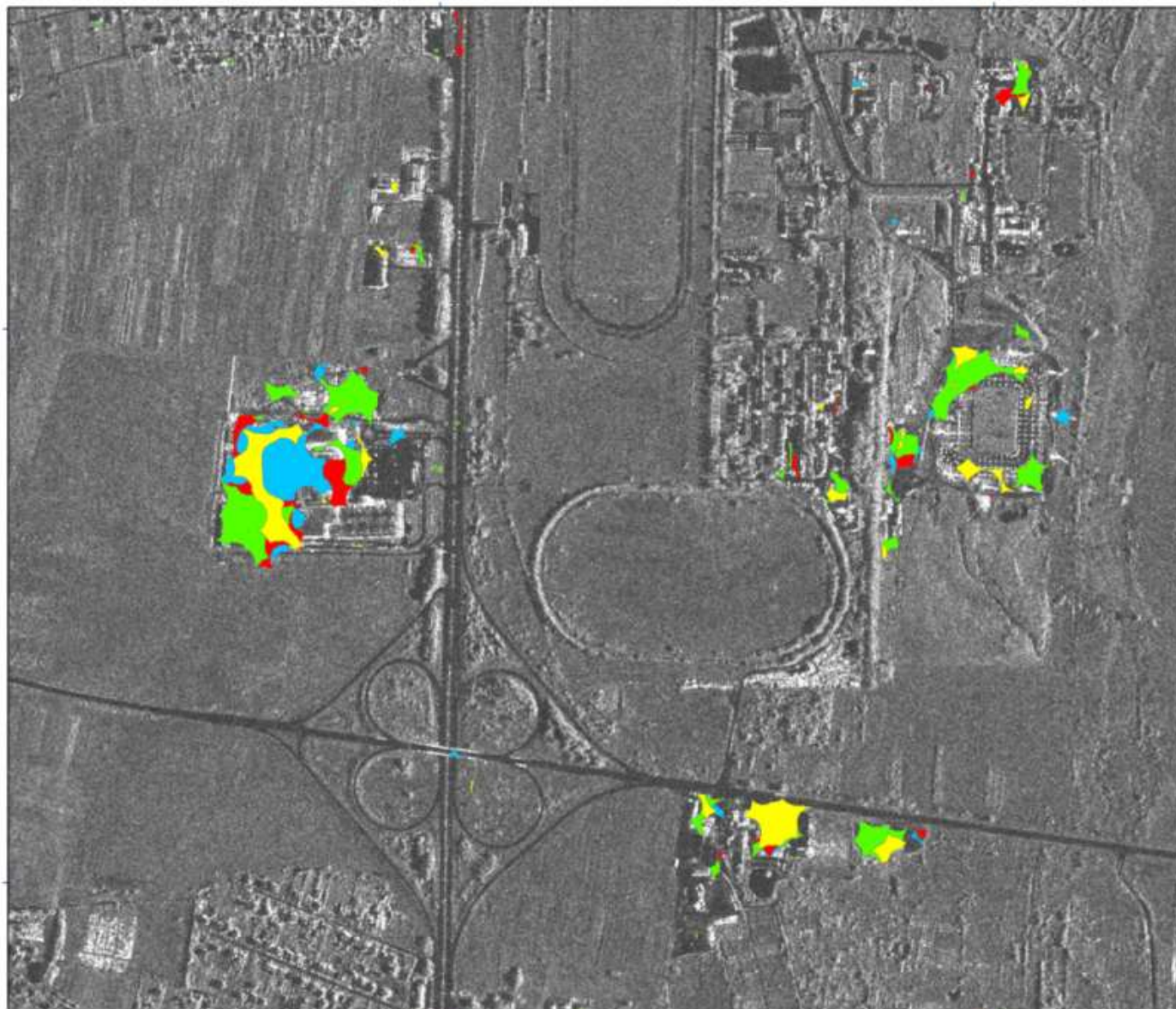
Co-Funded by the European
Commission's Seventh Framework
Programme (FP7/2007-2013)



Date of this product: 2010-01-22 Map created: 2010-01-22

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Change Detections - Lviv, Ukraine



TerraSAR-X StripMap Acquisition

Location of Scene:



Satellite Image Information

Parameter	2008-08-12	2008-09-15	2008-10-18	2008-11-20	2008-12-23
Acquisition	2008-08-12	2008-09-15	2008-10-18	2008-11-20	2008-12-23
Orbit	10000	10000	10000	10000	10000
Resolution	3m	3m	3m	3m	3m
Swath	10000	10000	10000	10000	10000
Acquisition	2008-08-12	2008-09-15	2008-10-18	2008-11-20	2008-12-23
Product	10000	10000	10000	10000	10000
Product Type	10000	10000	10000	10000	10000
Reference	10000	10000	10000	10000	10000

Automatically detected amplitude changes

- Changes between August 12th and September 15th
- Changes between September 15th and October 18th
- Changes between October 18th and November 20th
- Changes between November 20th and December 23rd



Map Projection

Geographic	Universal Transverse Mercator
Ellipsoid: WGS 84	Ellipsoid: WGS 84
Datum: WGS 84	Datum: WGS 84
	Zone: 18N



Co-Funded by the European
Commission's Seventh Framework
Programme (FP7/2007-2013)



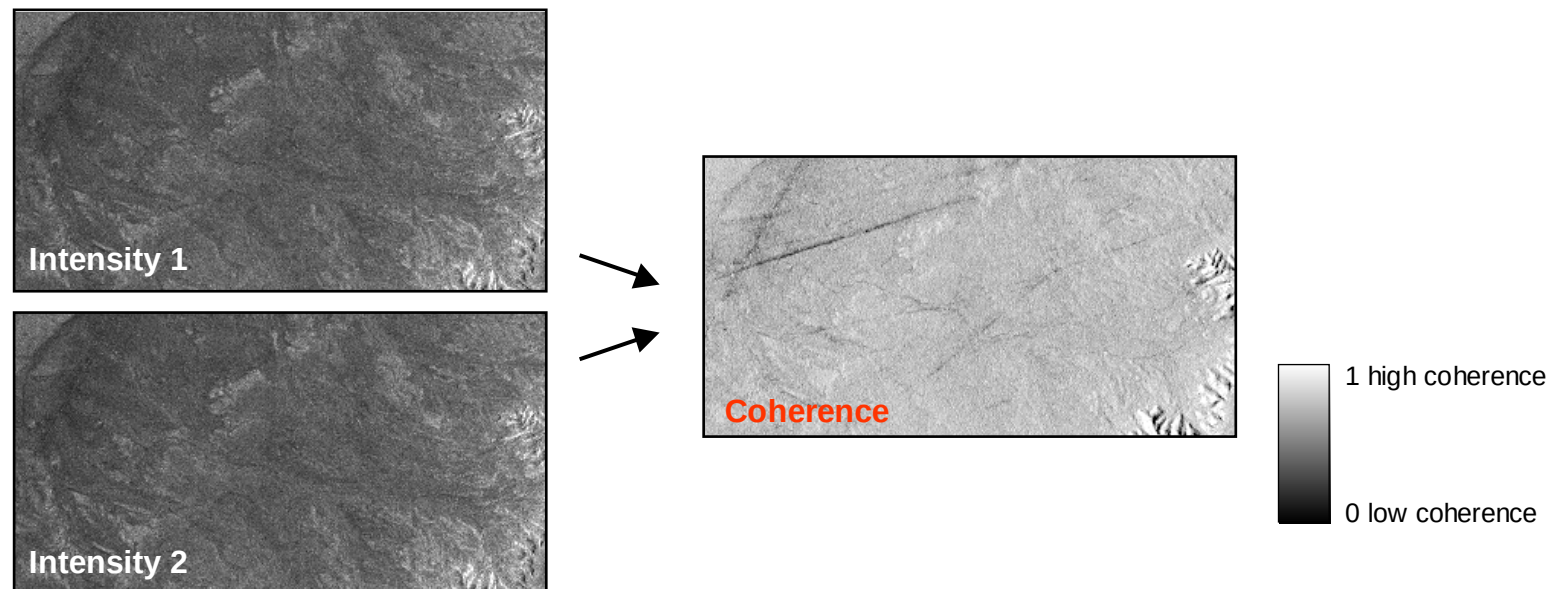
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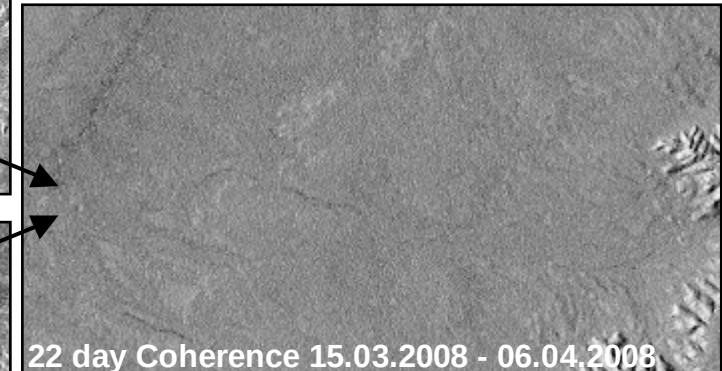
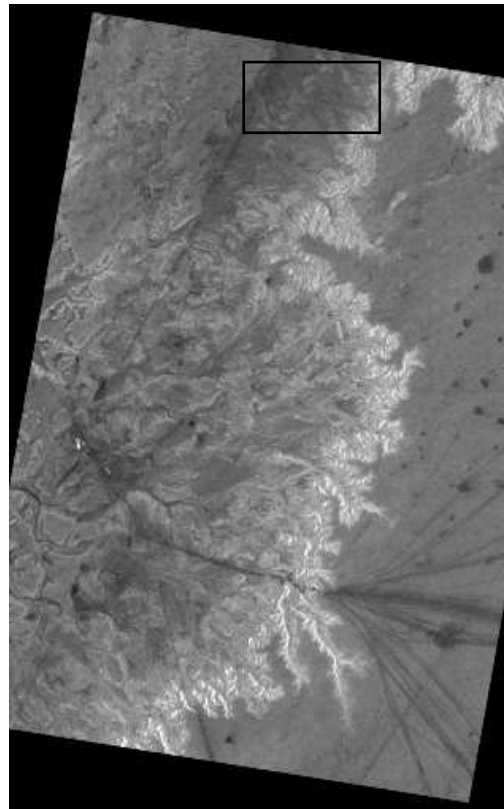
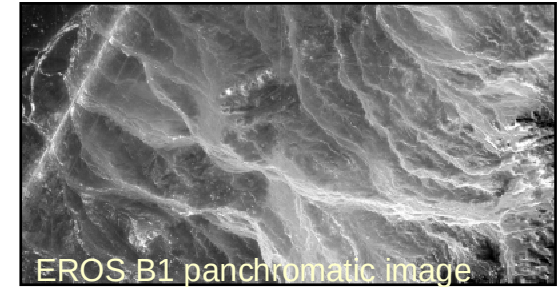
Date of Map generation: 2010-05-07, Map version: 1.0

- Amplitude Change Detection (ACD)
 - RGB colour composite as change indicator (satellite images are assigned to different channels [red, green, blue])
 - Intensity ratio as change indicator
- Coherence Change Detection (CCD)
 - Coherence as change indicator

Coherence as change indicator

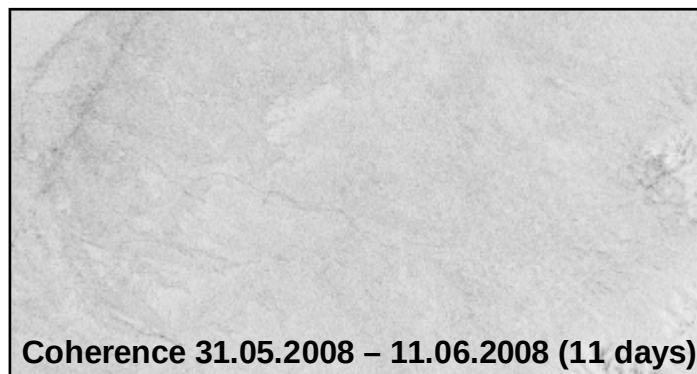
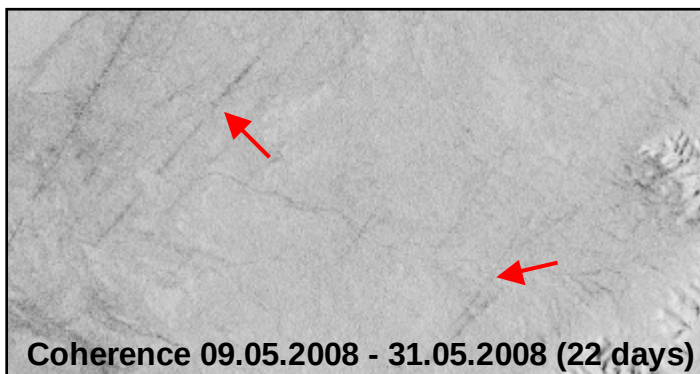
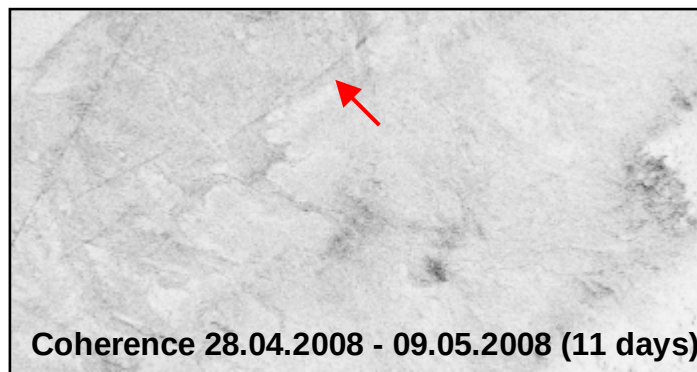
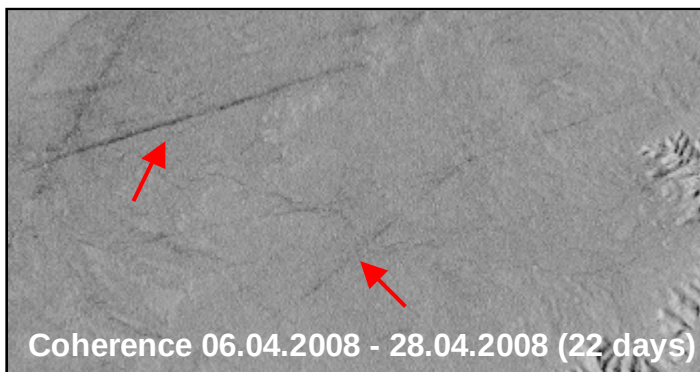
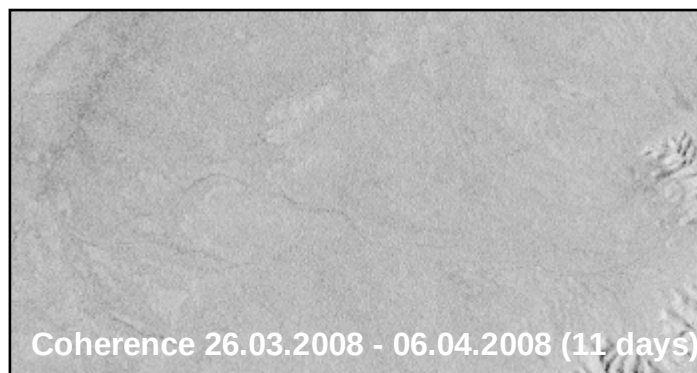
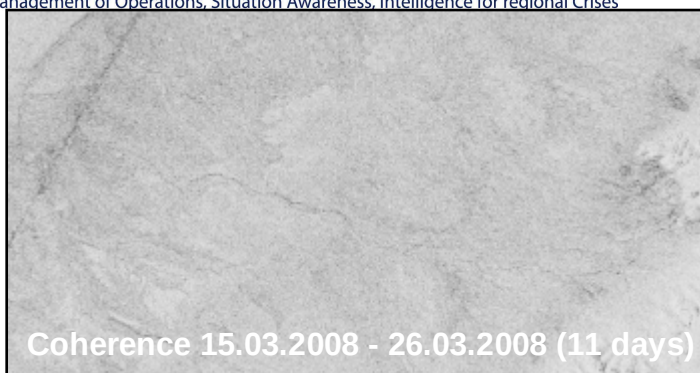
- Interferometric phase information is also sensitive to surface changes – even to subtle changes – which may remain undetected by approaches based only on the amplitude
- Coherence, i.e. the complex correlation coefficient of two SAR scenes, is used as an indicator of changes (low coherence indicates changes)



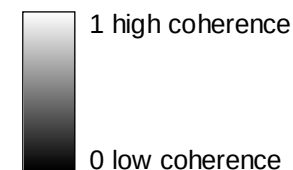


**Lines of loss in coherence
probably due to differently
used vehicle tracks**

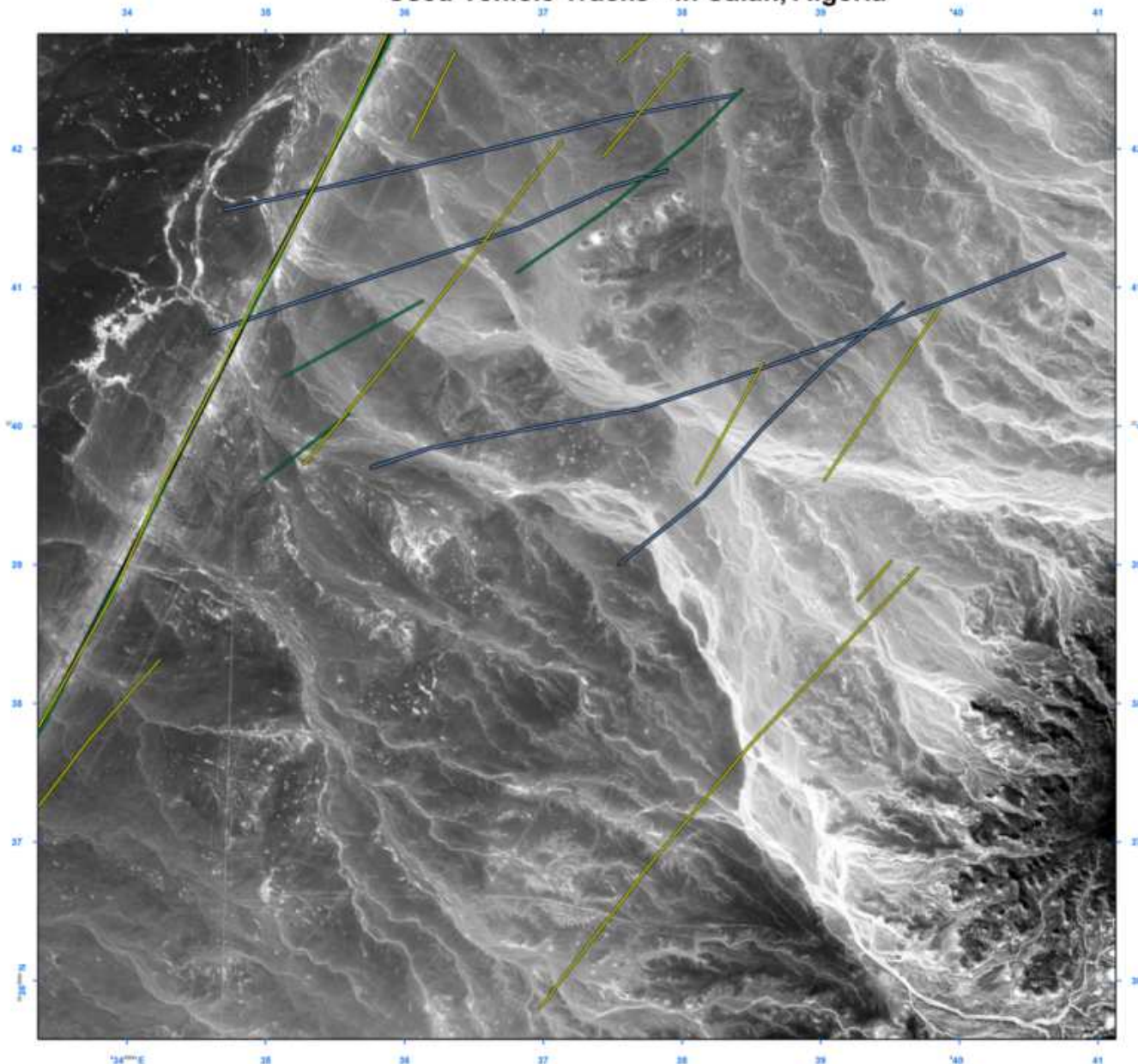
Vehicle Track Monitoring - multitemporal CCD



Lines of loss
in coherence
probably due
to differently
used vehicle
tracks
between
acquisitions



Used Vehicle Tracks - In Salah, Algeria



TerraSAR-X StripMap Acquisition

Location of Scene:



Satellite Image Information

Acquisition date	06 04 2008	26 04 2008	06 05 2008	31 05 2008
Satellite	TerraSAR-X			
Imaging Mode	StripMap			
Polarisation	HH			
Incidence Angle	44.4°			
Pass Direction	Descending			
Acquisition time (start)	05:48:30			
Acquisition time (end)	05:48:43			
Product Type	SSC			
ITD-ID	50 81267			
SAFA Release Number	1100805	1100806	1100807	1100808

SWATH DATA			
SWATH SW1	SWATH SW2	SWATH SW3	SWATH SW4
SWATH SW1	SWATH SW2	SWATH SW3	SWATH SW4

Legend

- Tracks used between May 9th and May 31st
- Tracks used between April 28th and May 9th
- Tracks used between April 6th and April 28th



Map Projection
Geographic

Universal Transverse Mercator

Ellipsoid: WGS 84
Datum: WGS 84

Ellipsoid: WGS 84
Datum: WGS 84
Zone: 31N



Co-Funded by the European Commission's Seventh Framework Programme (FP7/2007-2013)

G-mosaic

TERRA SAR X SERVICES

Date of Map generation: 2010-03-12 Map template version: 0

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- As a pilot service G-MOSAIC contributes to the development of a security related core service (cf. SAFER)
- Service developments address a broad range of security related applications
- Service case concept is used for operational demonstration scenarios
- TerraSAR-X imagery is a suited data source for monitoring and change detection applications

Thank you for your attention!

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