Surface Movement Monitoring (SMM) Based on High-Resolution TerraSAR-X Satellite Data

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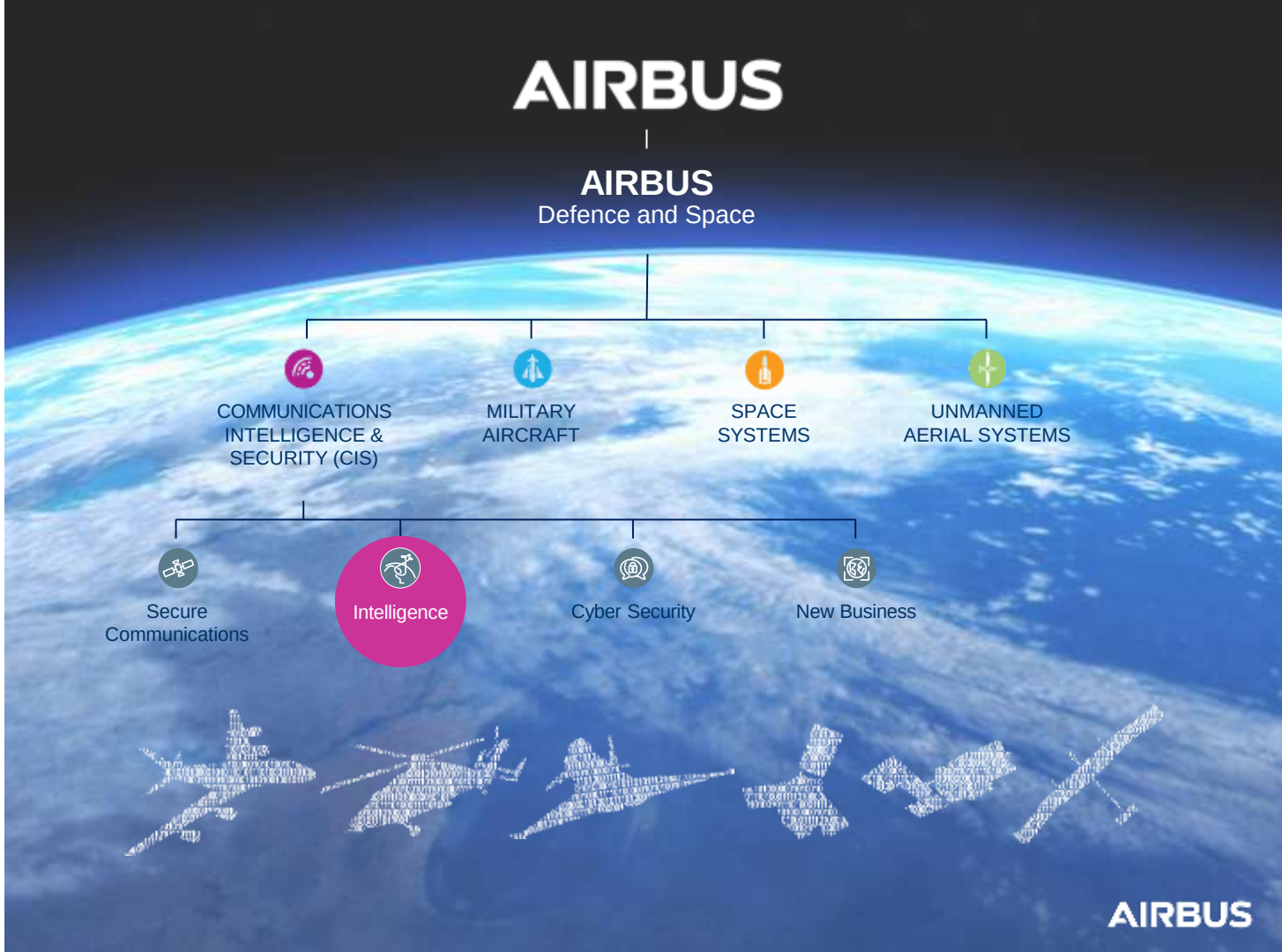
11 April 2018

The **Power** of **AIRBUS**

As part of Airbus, we benefit from the **power and strength** of a **global leader** in aerospace, defence and related services, **guaranteeing confidence** in our commitment to provide sustainable Earth observation and defence solutions.



Serving Customers in Versatile Markets

Intelligence supports decision makers worldwide to increase security, boost performance, optimise mission planning and operations and improve management of natural resources.

Defence & Security

Oil, Gas & Mining

Avionics

Maritime Surveillance

National Planning

Forestry & Environment

Public Security

Location-Based Services

Agriculture

Surface Movement Monitoring (SMM) based on High-Resolution TerraSAR-X Satellite Data

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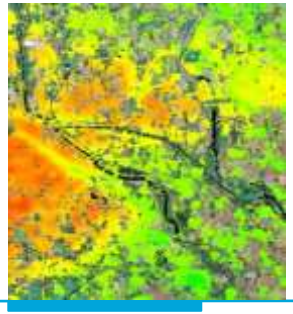
Pioneering Earth Observation Data and Services

SATELLITE IMAGERY

- Pléiades
- SPOT 6/7
- TerraSAR-X
- TanDEM-X
- DMC Constellation
- FORMOSAT-2



MONITORING SERVICES

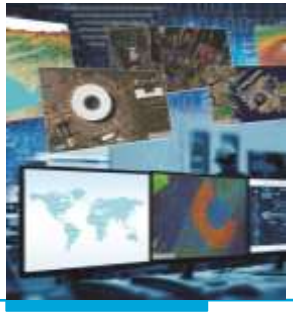
- GO Monitor
- GO Monitor Forest
- Global Seeps
- Geological Studies
- Surface Movement Monitoring
- Change Detection

REFERENCE LAYERS

- WorldDEMTM
- GEO Elevation
- SPOTMaps
- GEO GCPs
- Foundation Layers

PLATFORMS & SOFTWARE

- Pixel & Street FactoryTM
- SAFEcommandTM



DATA ACCESS & MANAGEMENT

- GeoStore
- Direct Reception Services
- Data Management Solutions

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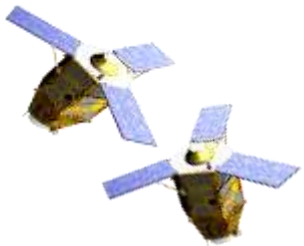
Our Constellation - The Imagery that Suits You

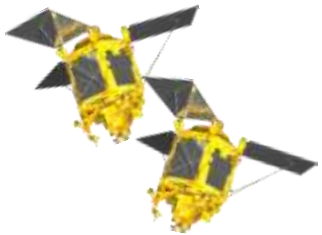
Pléiades

- Very high resolution twin satellites [50cm]
- Daily revisit capacity and highly reactive tasking



SPOT 6/7

- High resolution twin satellites [1.5m]
- 60km swath for large-area coverage
- Daily revisit capacity



TerraSAR-X TanDEM-X

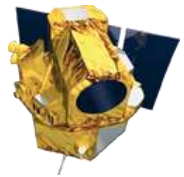
- Radar satellite formation
- Various resolutions [0.25m to 40m] and scene sizes

DMC Constellation

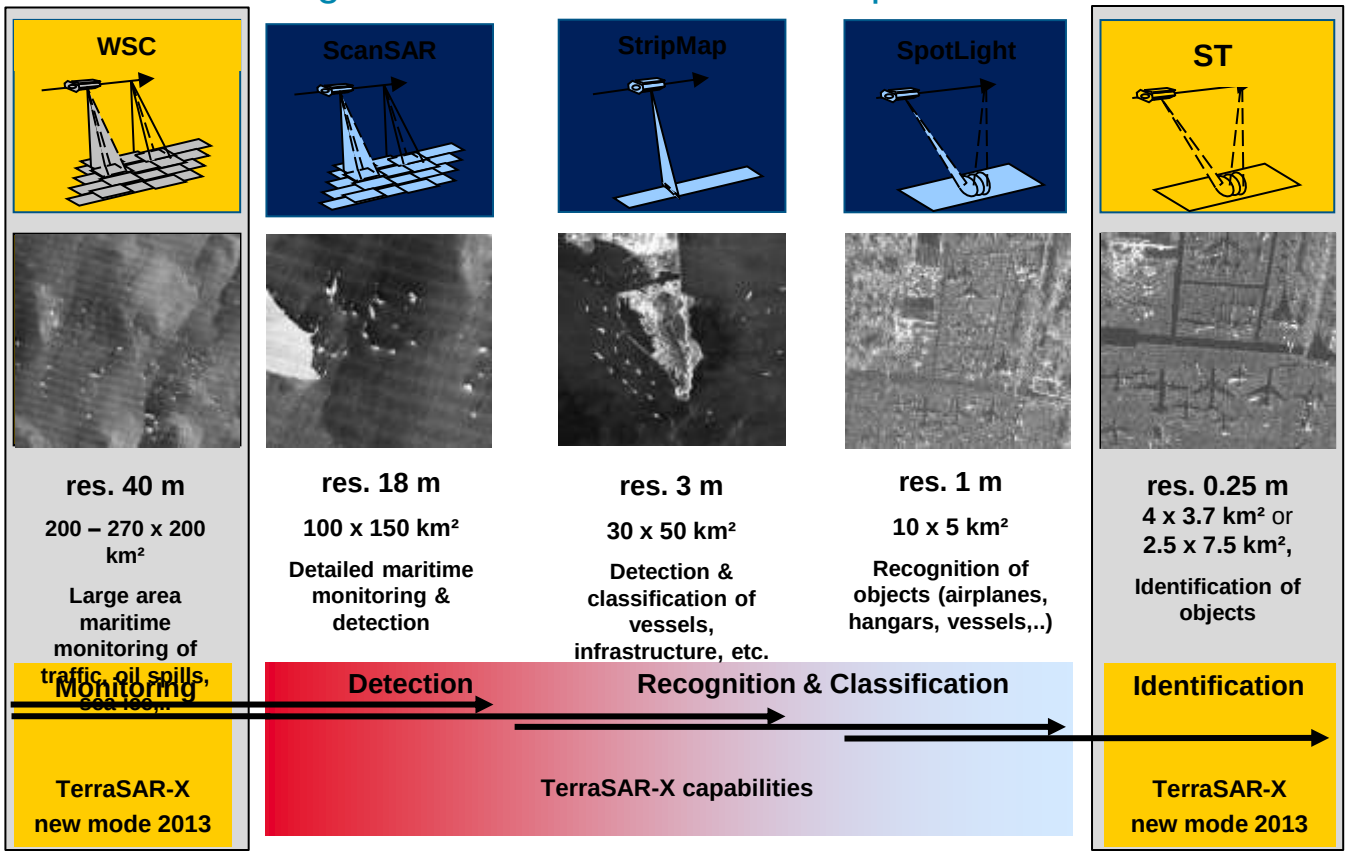
- Vast daily collection capacity
- 600km swath for rapid coverage and revisit

FORMOSAT-2

- Reactive 2m-res satellite
- Daily revisit capacity with the same viewing conditions



TerraSAR Image Products and New Developments



Surface Movement Monitoring (SMM) Concept

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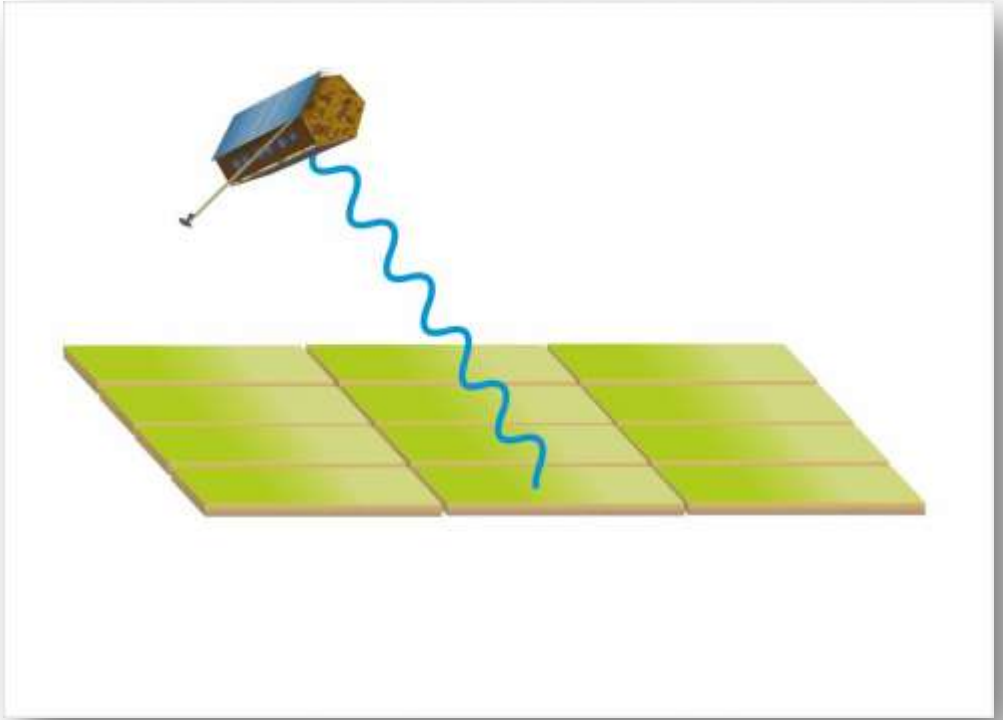
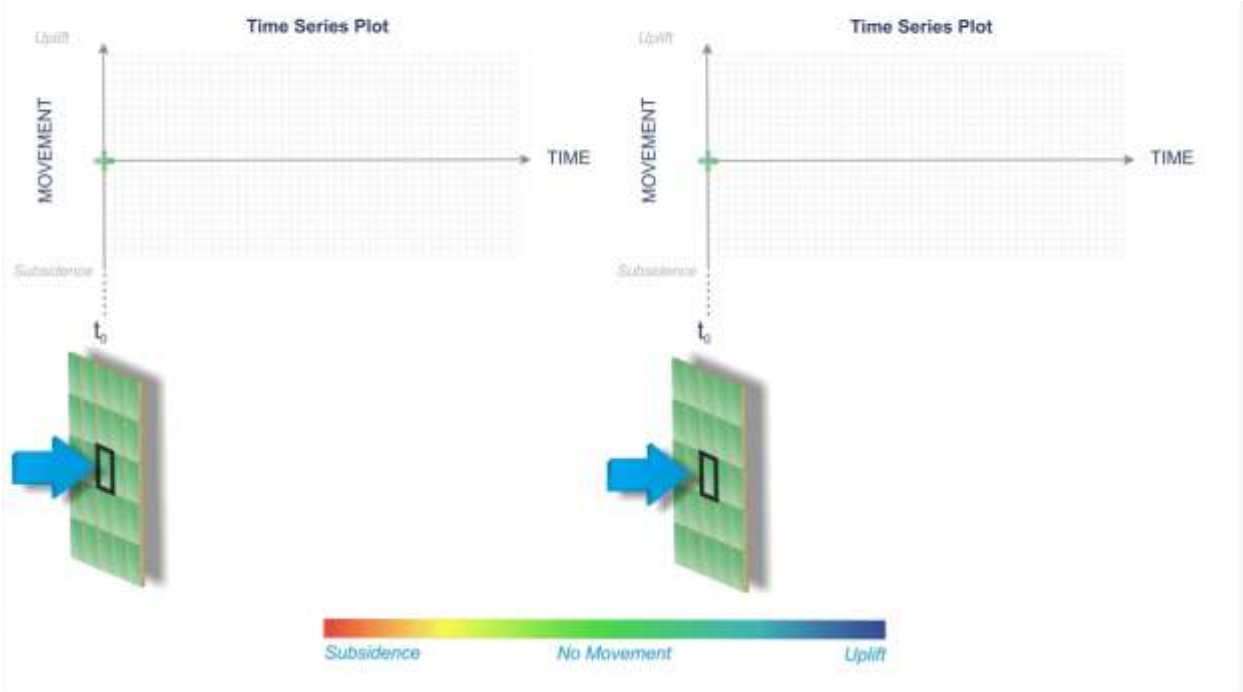
Surface Movement Measurement Principle

- Comparing a pixel in a set of acquisitions at different times, the movement of the pixel within this period can be measured.
- The measurement direction is along the line of sight of the satellite sensor.
- Movements are indicated by a path length difference.



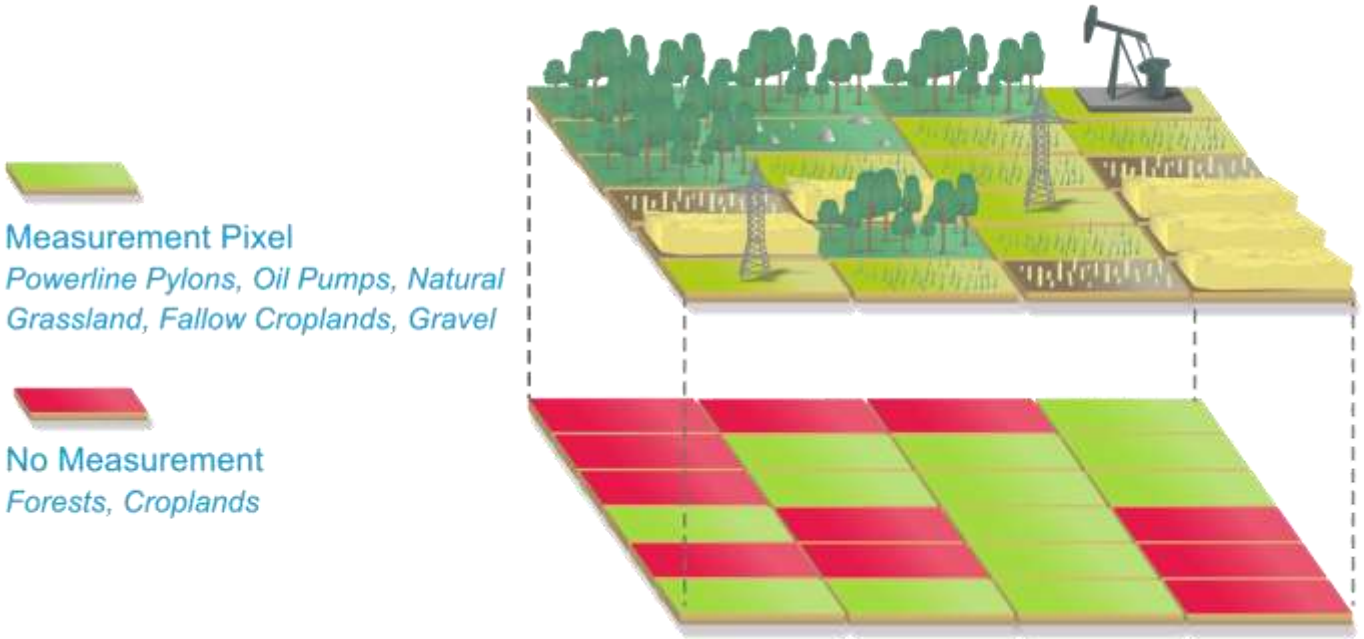
Time Series of Surface Movement - 1

- If more than two acquisitions are made, time series of movement can be evaluated



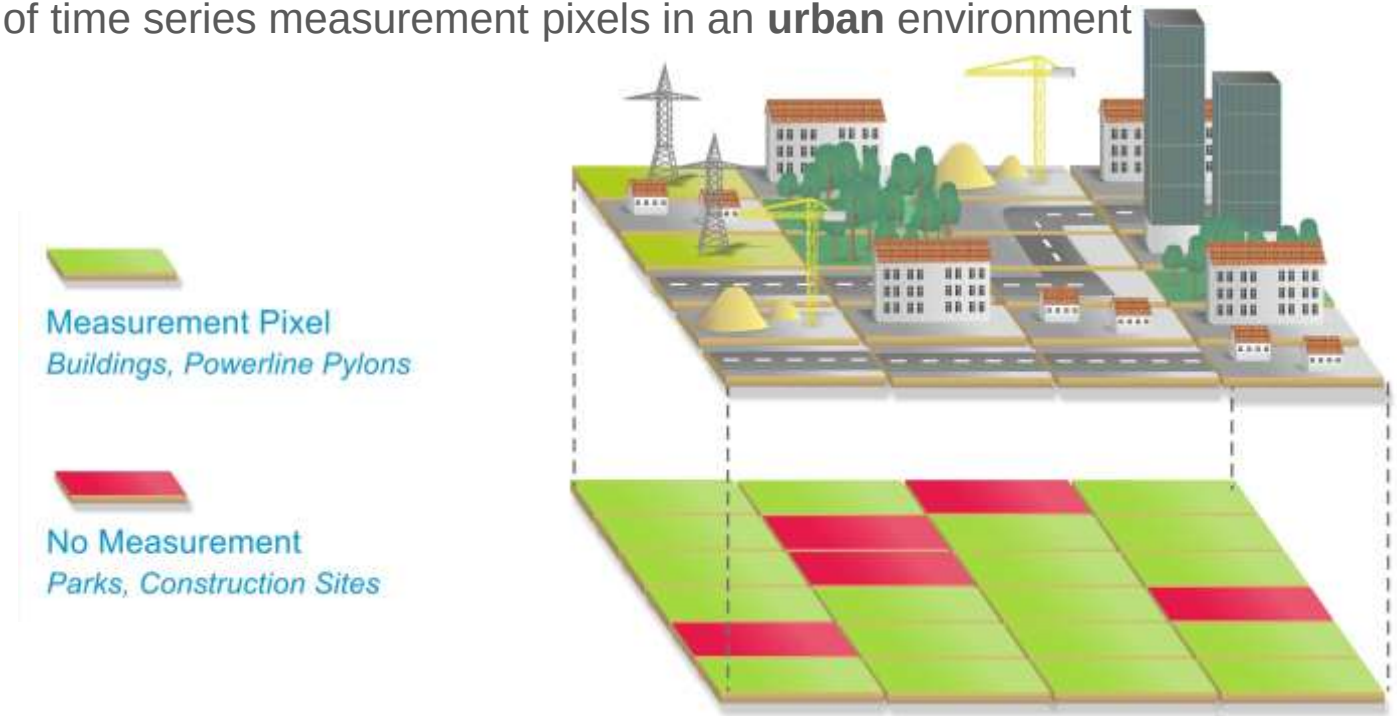
Time Series of Surface Movement - 3

- Example of time series measurement pixels in a **rural** environment



Time Series of Surface Movement - 4

- Example of time series measurement pixels in an **urban** environment



Surface Movement Monitoring – Mosul Dam, Iraq

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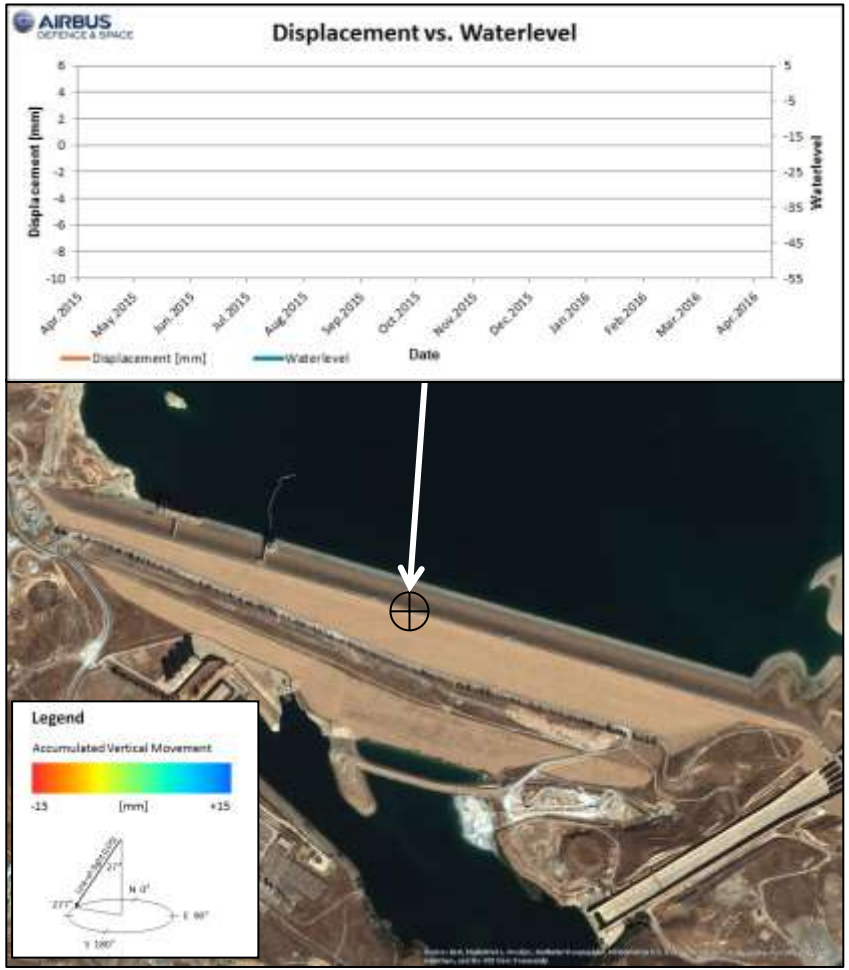
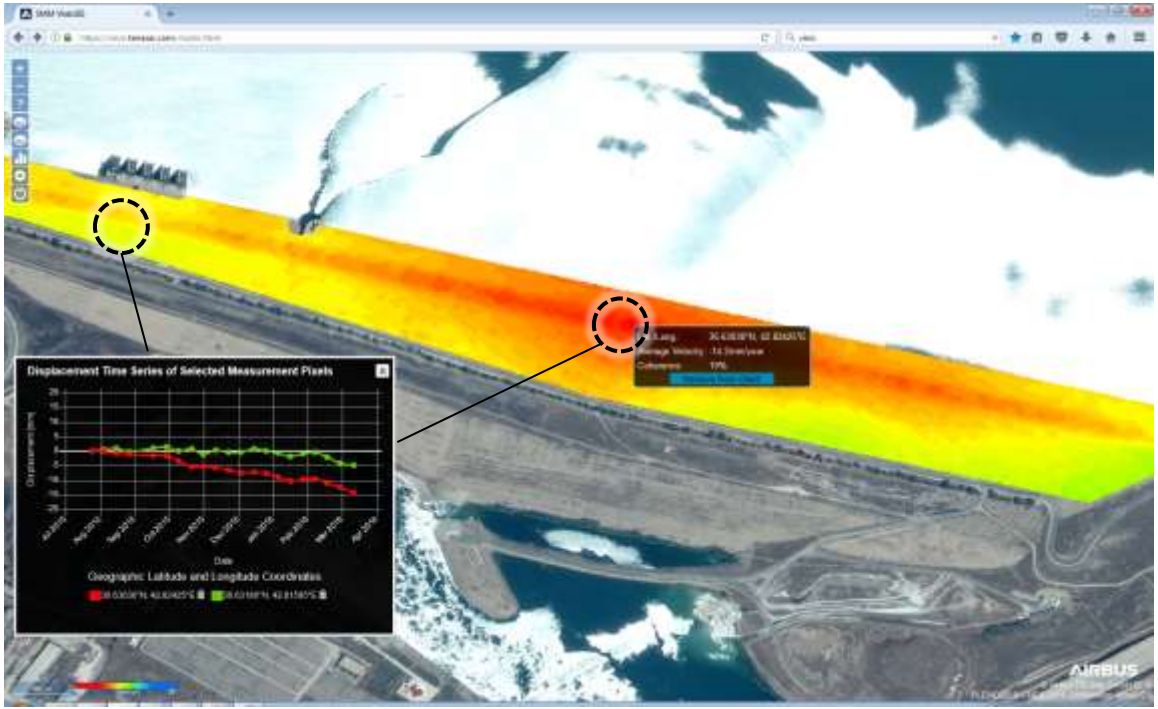
Mosul Dam, Iraq

- Satellite based high resolution monitoring of terrestrial infrastructure
- Precise estimation of surface movements
- Remote measurements independent on local situation
- High revisit time interval of few days
- Cross correlation of movement time series with additional data



Mosul Dam, Iraq

- SMM WebGIS
  - Web-Application (App)
  - Access via internet
  - Easy to handle
  - Provides information ready for decision makers



SMM WebGIS (Web-Application) & Data Mining

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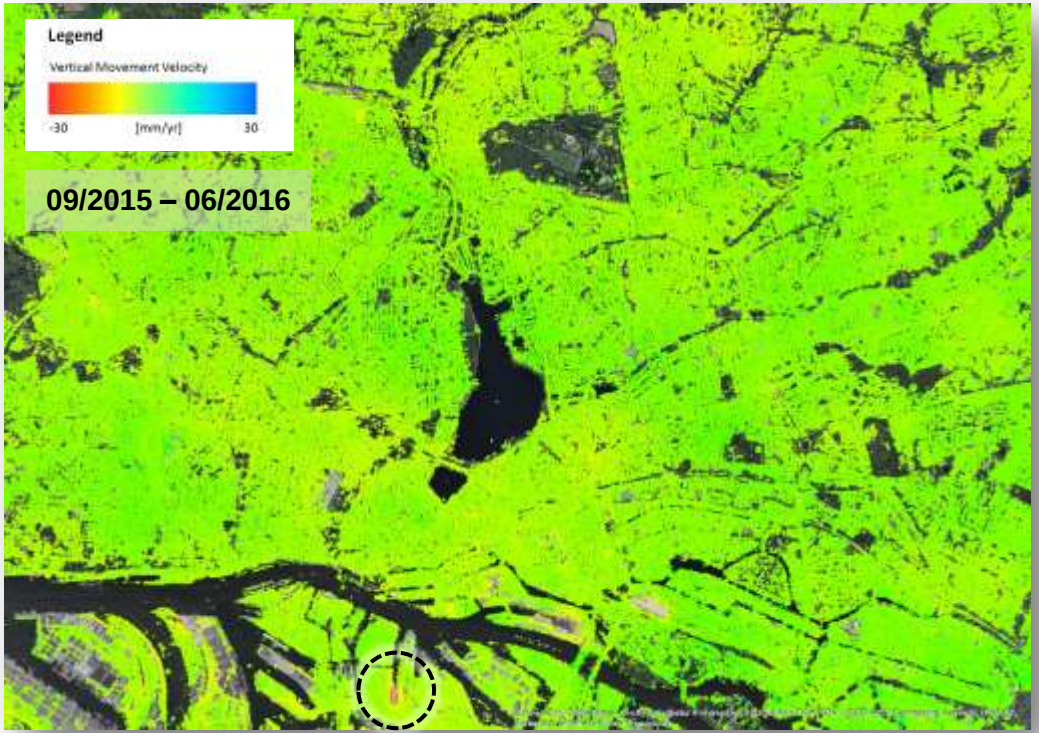
SMM Result based on TerraSAR-X: Hamburg, Germany

- City-wide surface movement monitoring
- TerraSAR-X StripMap Mode Data
- High spatio-temporal resolution
- **>3 Million** measurement pixel



Surface Movement Monitoring (SMM) based on High-Resolution TerraSAR-X Satellite Data

Processed with SARscape

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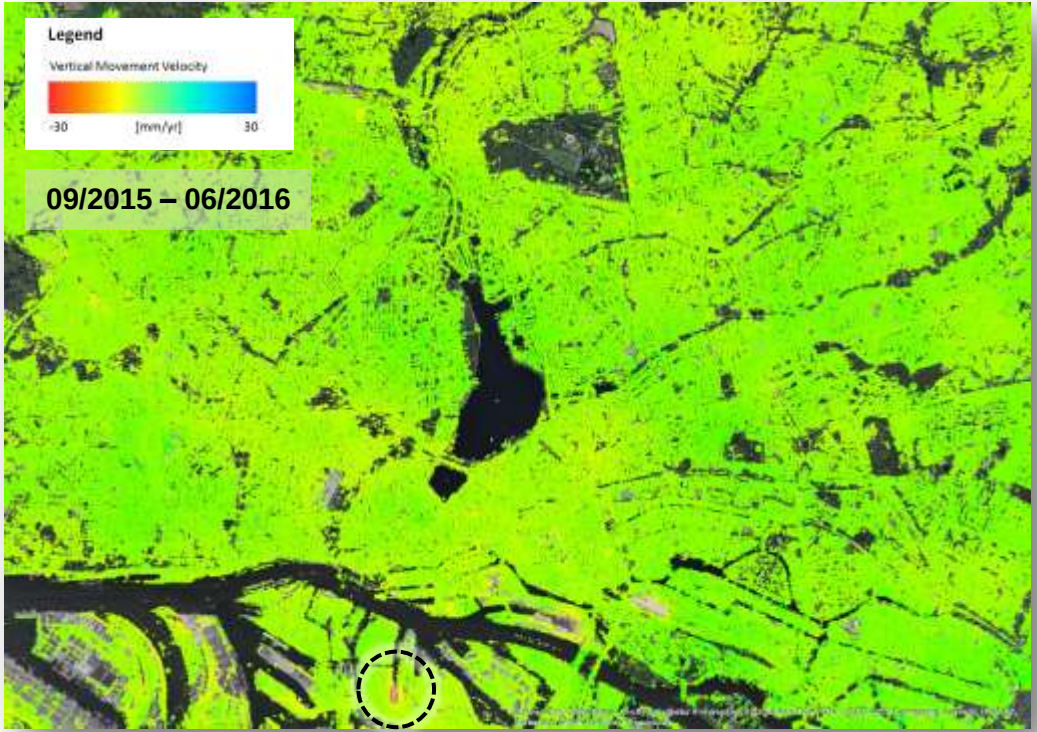
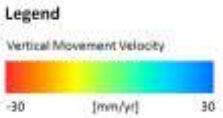
SMM Result based on TerraSAR-X: Hamburg, Germany

- **Millions** of measurements to be evaluated
- **Impossible** to be evaluated by human
- **Required** information are buried in this data mass

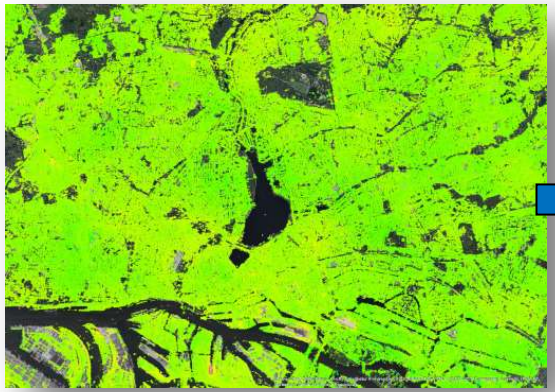
→ **Derivation** of required information
  - Generalisation
  - Classification
  - Clustering



Data Mining



Original Mass of Measurement



> 3 Million Measurements

Assigned to Building Polygons

~0.16 Million Polygons

SMM WebGIS

Web-Application

Mass Reduction

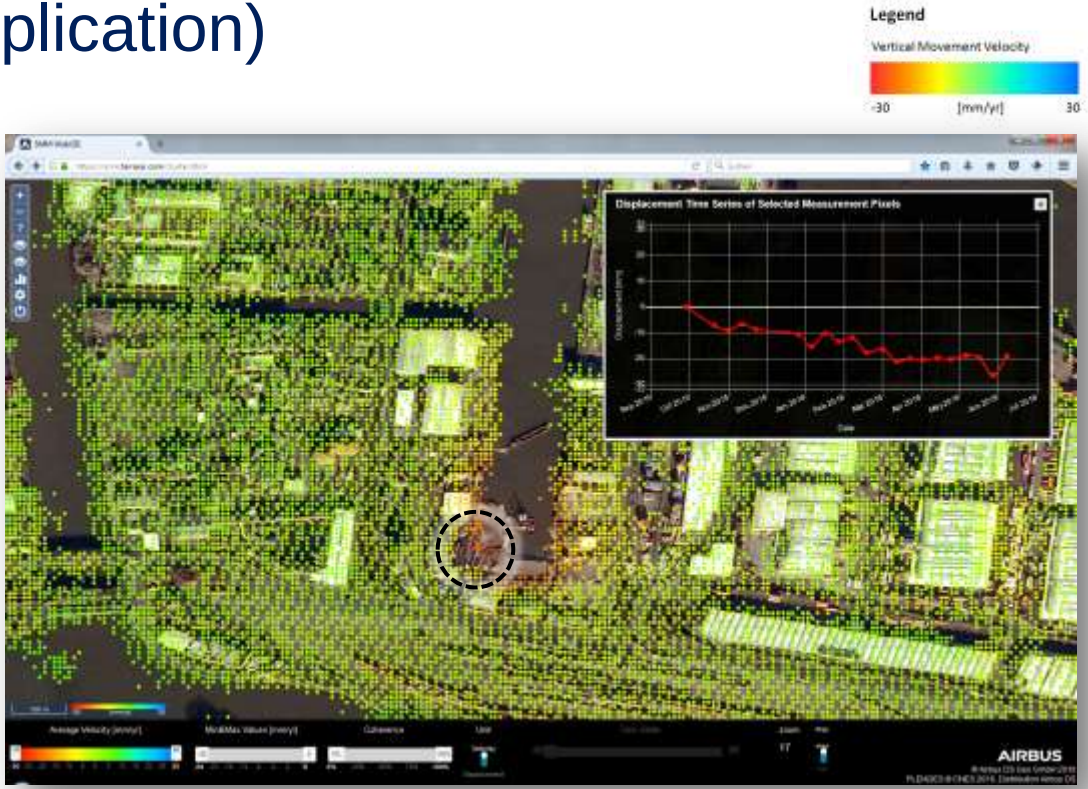
From Data to Information

SMM WebGIS (Web-Application)

- Generalisation and clustering of measurement mass
- Allocation of measurement to houses
- No additional software required
- Easy to handle (intuitive)
- Analytic tools

SMM WebGIS (Web-Application)

- At higher zoom level full resolution measurement available
- Individual measurements can be analysed
- Provides information ready for decision makers



TerraSAR-X vs. Sentinel-1

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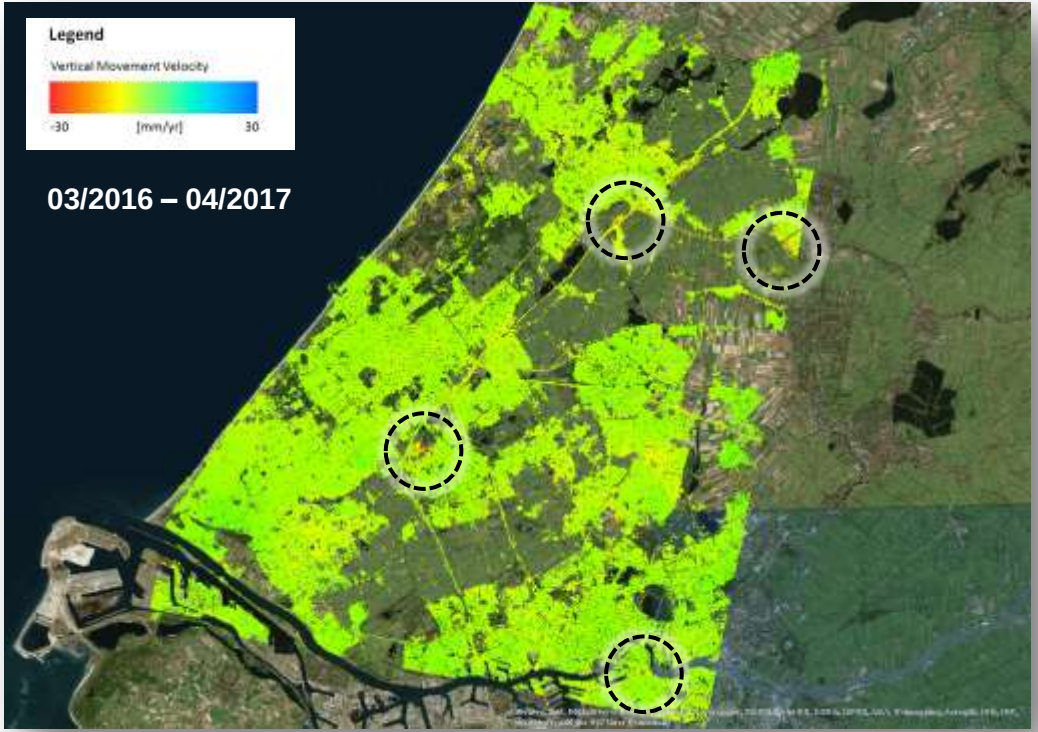
SMM Result based on TerraSAR-X: SBAS

- Colour coded representation of vertical movement velocity [mm/yr]
- Illustrates progressive surface movements
- Measurement pixels only available over non-vegetative areas like houses, roads, railways, bridges, dams, …
- Hot-spots identified



SMM Result based on Sentinel-1: SBAS

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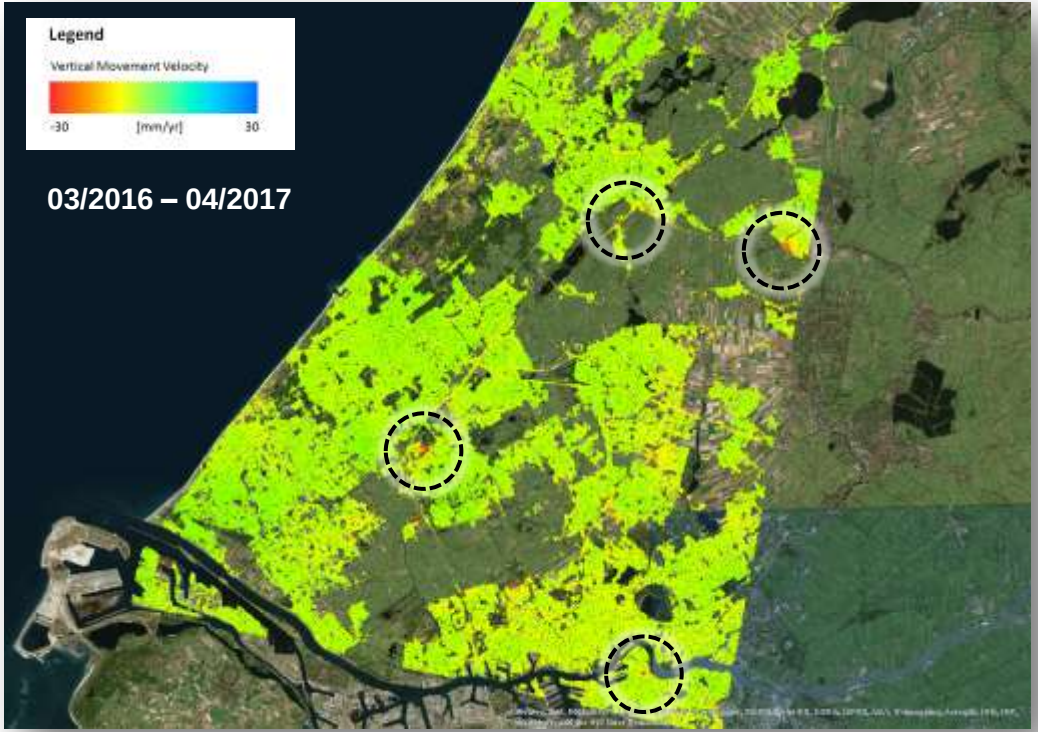
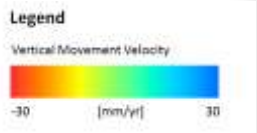
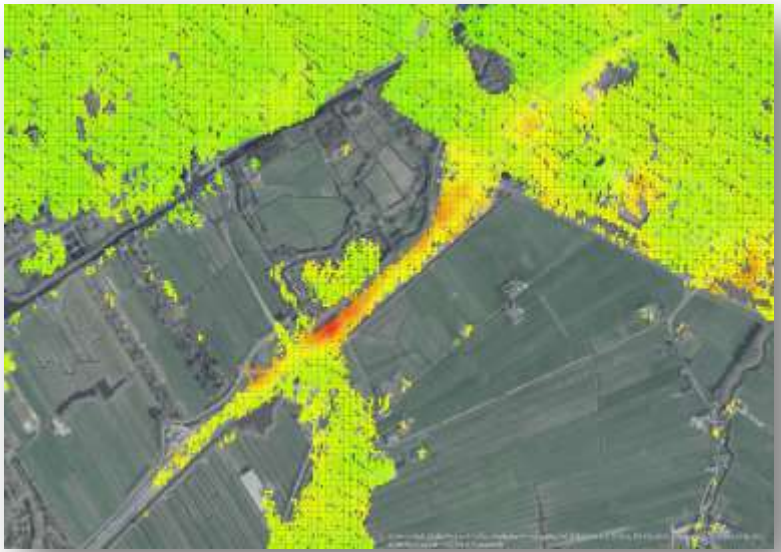


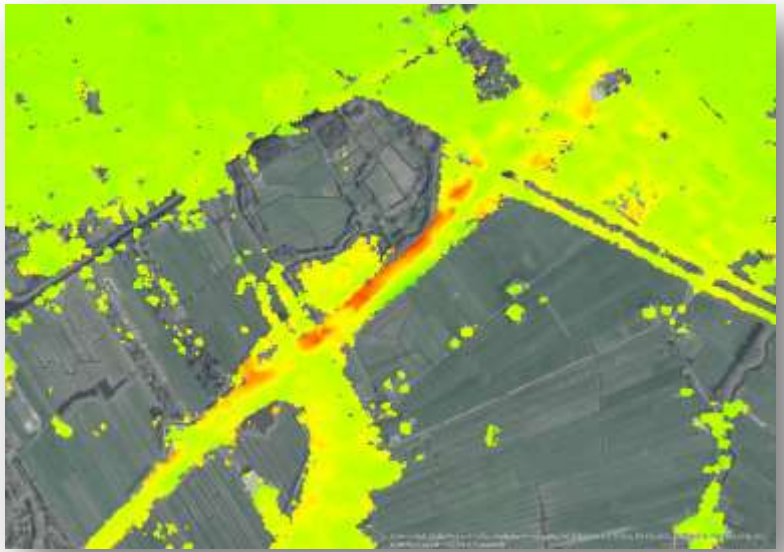
SMM Result Comparison: Sentinel-1 vs. TerraSAR-X



03/2016 – 04/2017



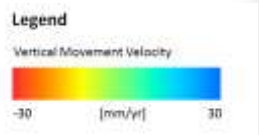
I: Sentinel-1 (+)



I: TerraSAR-X (+)

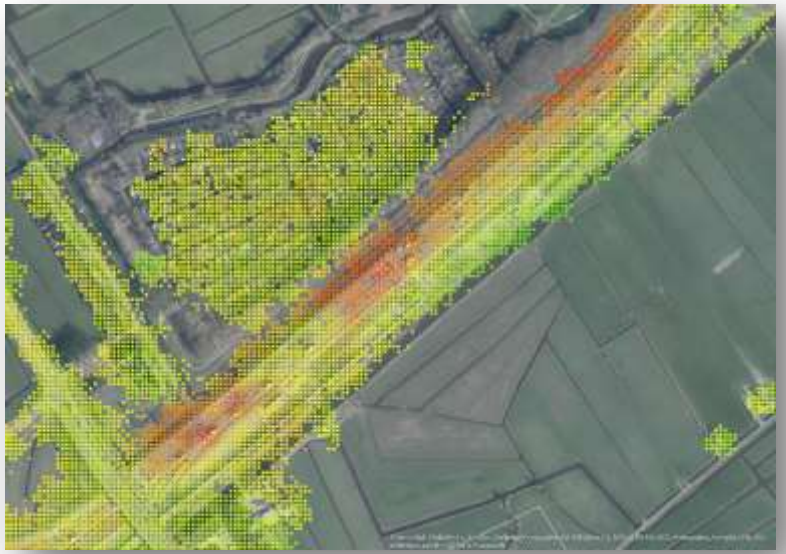
Subsidence of recent built traffic lane

SMM Result Comparison: Sentinel-1 vs. TerraSAR-X



03/2016 – 04/2017

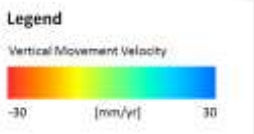
I: Sentinel-1 (++)



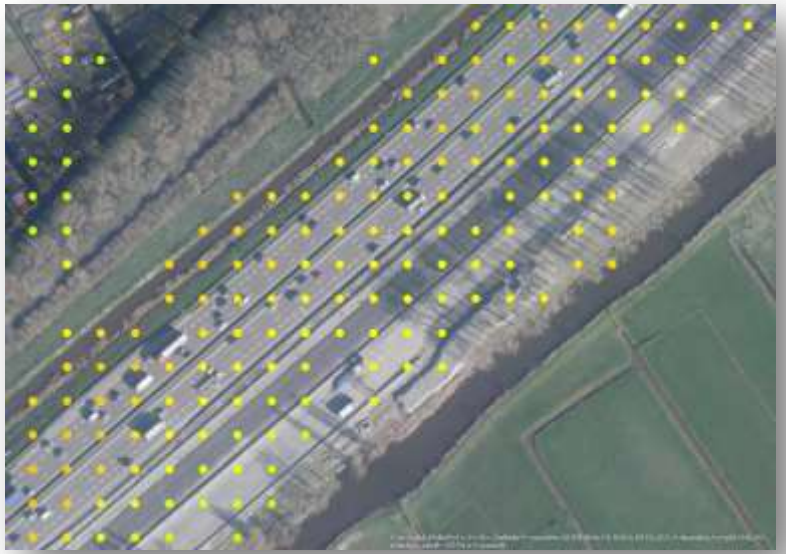
I: TerraSAR-X (++)

Subsidence of recent built traffic lane

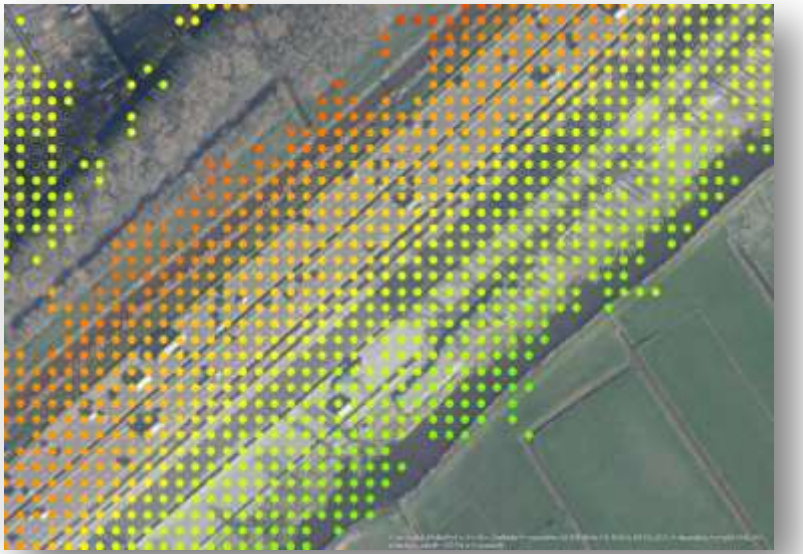
SMM Result Comparison: Sentinel-1 vs. TerraSAR-X



03/2016 – 04/2017



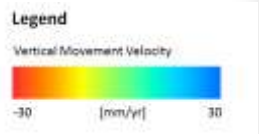
I: Sentinel-1 (+++)



I: TerraSAR-X (+++)

Subsidence of recent built traffic lane

SMM Result Comparison: Sentinel-1 vs. TerraSAR-X



03/2016 – 04/2017

II: Sentinel-1 (++)

II: TerraSAR-X (++)

Railway Monitoring

SMM Result Comparison: Sentinel-1 vs. TerraSAR-X

Conclusion

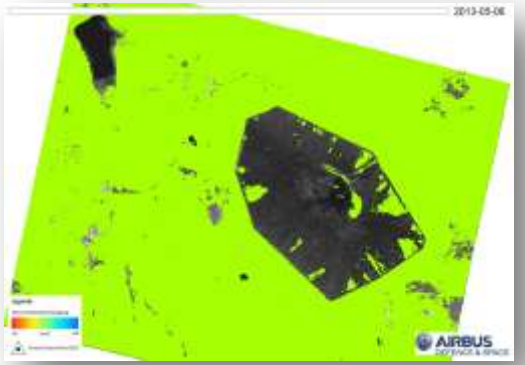
- Sentinel-1
  - suitable for large-scale (overview) monitoring ✔
  - suitable for hotspot identification ✔
  - not suitable for single object/hotspot monitoring (e.g. railway, roads) ✘

- TerraSAR-X
  - suitable for single object/hotspot monitoring (e.g. railway, roads) ✔
  - suitable for precise measurements ✔
  - suitable for civil engineering/surveying ✔

Oil & Gas: Austria

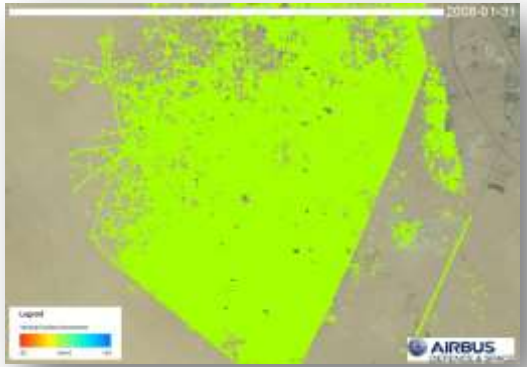
Mining: Germany

Mining: South Africa



Civil Engineering: Germany

Oil & Gas: Kuwait

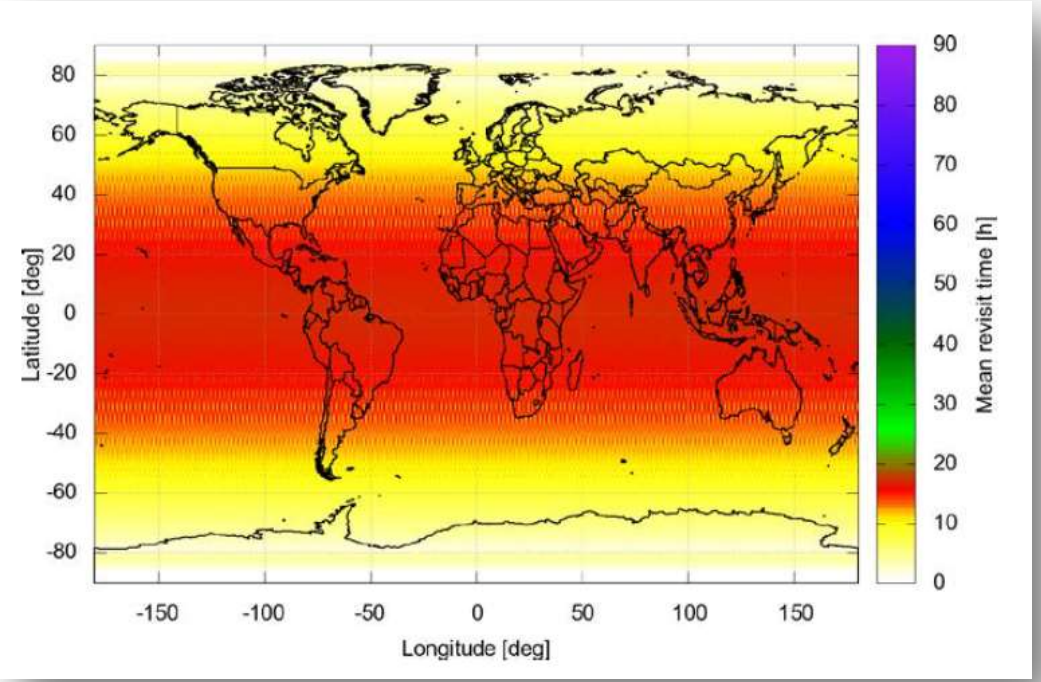


Civil Engineering: Germany

TerraSAR-X / PAZ Constellation: Global Mean Revisit Time

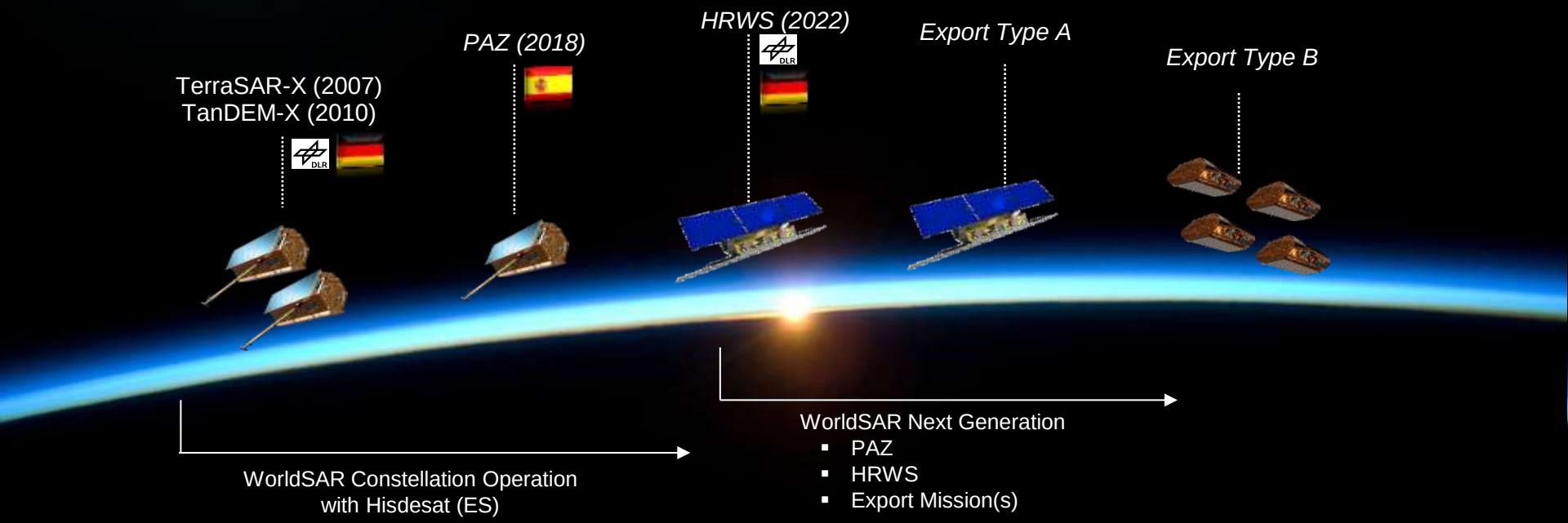
PAZ Features:

- Mission operated by Hisdesat (Spain)
- Launched: Feb 2018
- Operational: Q3 2018
- Repeat cycle: 4/7 days
- Full constallation with TerraSAR mission
  - Identical modes
  - Synchronized data order



WorldSAR Concept: Current and Future Missions

Airbus DS Intelligence Services & Space Systems Export



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