

SARSAR – SR/00/372



Automatic redevelopment sites monitoring using SAR and OPTICAL images



Project Description



Overview

1. Context
2. Feasibility study
3. Proposed approach
4. Implementation
5. Programme of work

1. Context

- RDS = “Redevelopment Sites” (disused sites)
(SAR = “Sites À Réaménager”)

→ real estate property or a set of real estate properties:

- That was or is allocated to host an activity apart from housing
- Whose current condition is against the good management of the site or represents a deconstruction of the urban canvas



1. Context

- RDS Inventory
 - General objectives:
 - Finding the most suitable sites for:
 - Real estate projects
 - Economic activities
 - For particular purposes (e.g. along waterways/railways)
 - Support for:
 - Walloon Government's socio-economic policy
 - Spatial planning policies
 - Need of the Walloon Public Service / DG04:
 - Periodic update of the RDS Inventory (2213 sites on nearly 3800 hectares in 2017)

1. Context

- RDS Inventory update
 - Current Methodology:
 - Systematic review: change of status verification (RDS or not RDS) by survey with the communes and field visit (human resources = 6 full-time / 2 years)
 - Lack of resources = too long periodicity
 - From 2018 → use of aerial images: photo-interpretation by an operator to detect and qualify change on all sites (ISSeP)
 - Need for improvement → Automatic detection of changes from satellite images at high temporal resolution

2. Feasibility study

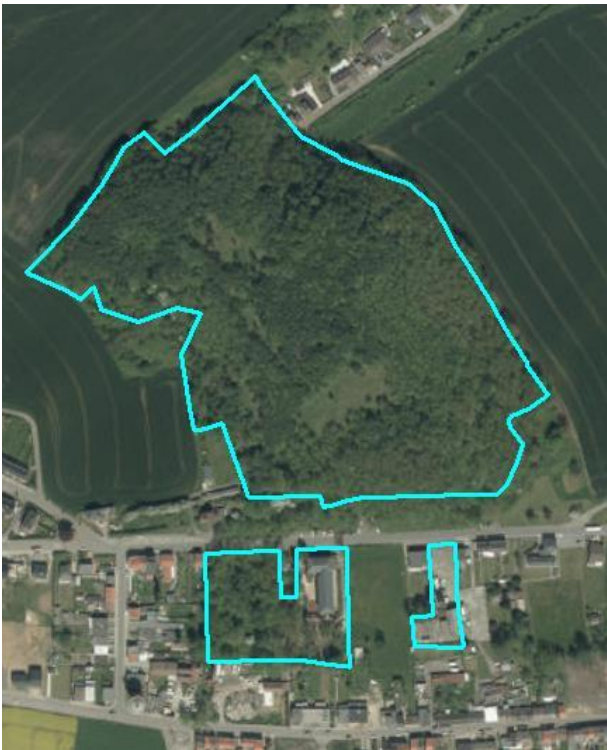
- Conducted as part of a previous ISSeP & RMA activity
- Using high spatial resolution data
 - Data: Lidar, Aerial Orthophotos (AOP), Pleiades
 - Photogrammetry -> nDSM
 - + change detection
- Using high temporal resolution data
 - Data: Sentinel1/Sentinel-2
 - Sigma0/Spectral indexes
 - + change detection

2. Feasibility study

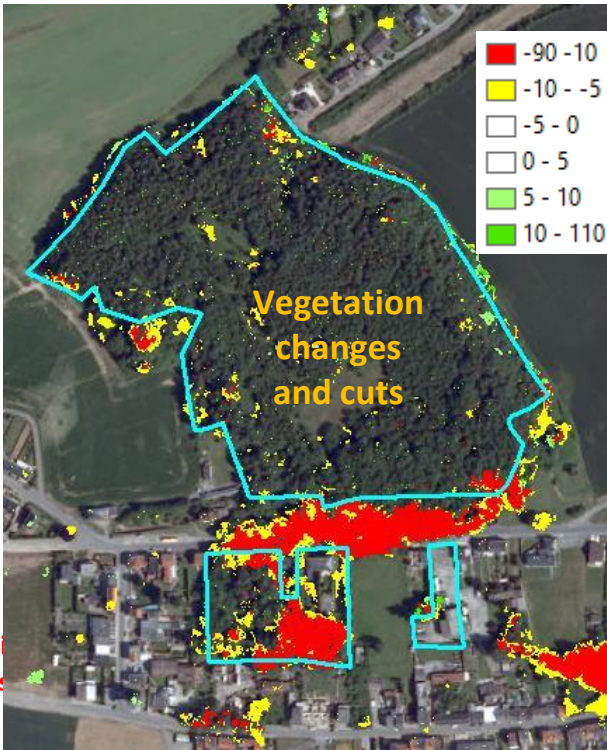
- Normalized Digital Surface Model changes



AOP 09/10

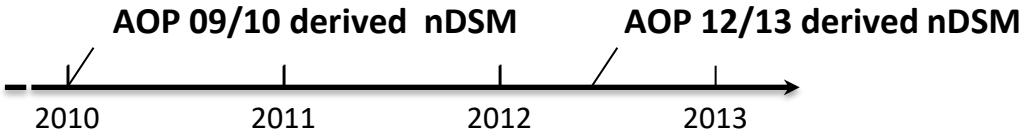


AOP 12/13



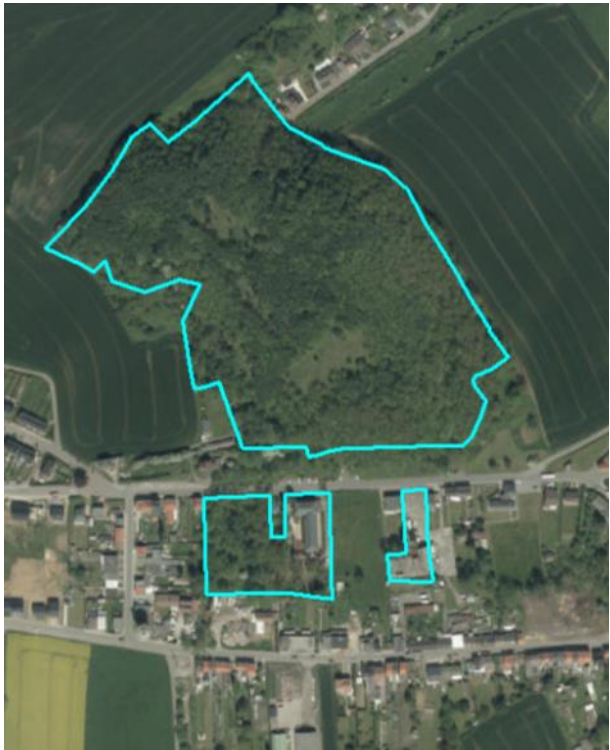
Change in height

Change in neighboring of the site
→ indication of future changes?

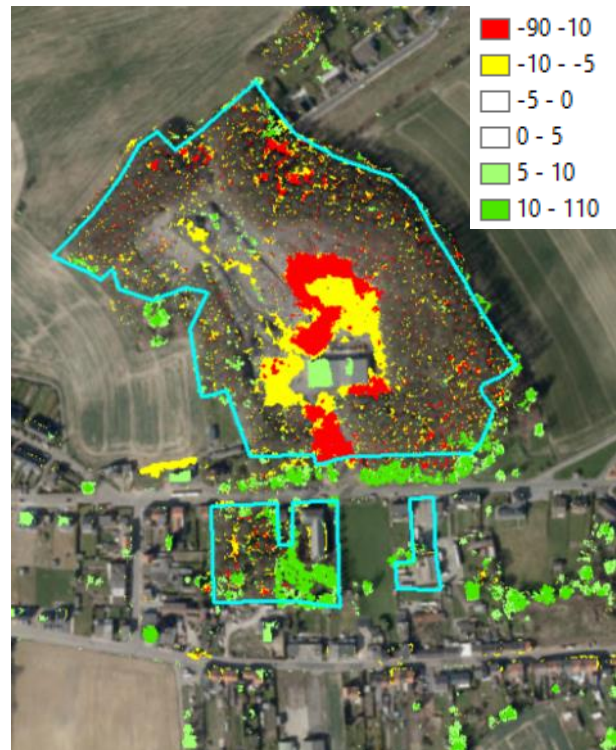


2. Feasibility study

- Normalized DSM changes



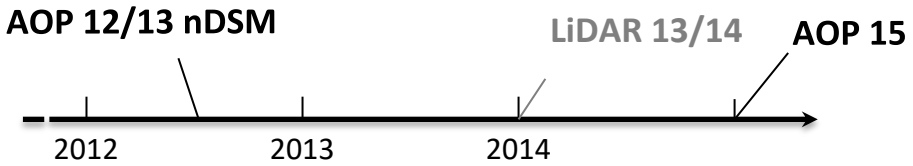
AOP 12/13



Change in height 12/13 – 13/14



AOP 15



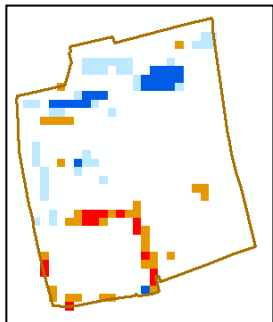
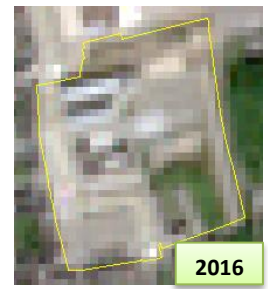
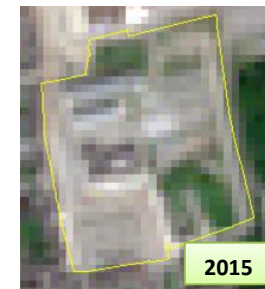
CONFIRMATION!

2. Feasibility study

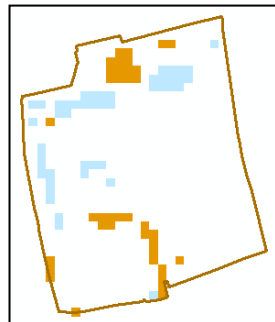
- Changes of Sentinel-2 Band ratios



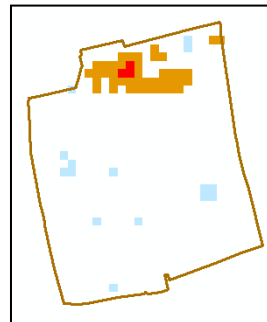
1. Ground modification
2. Sealing surface creation
3. Road construction



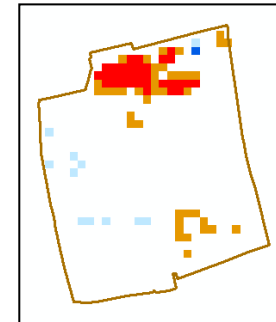
BI



BI2



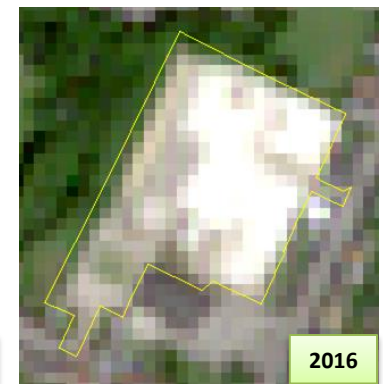
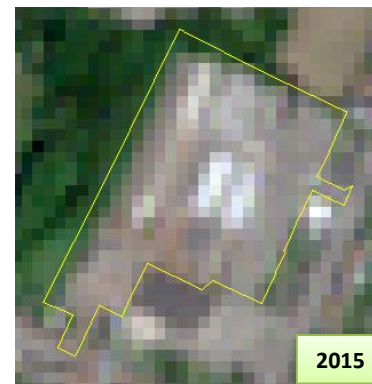
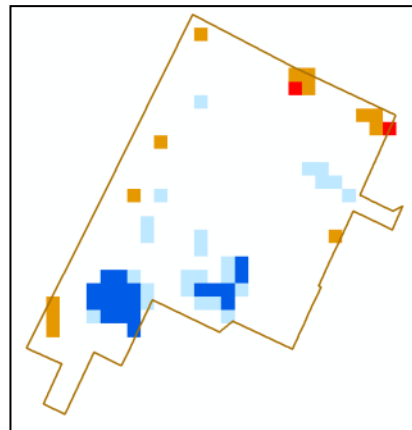
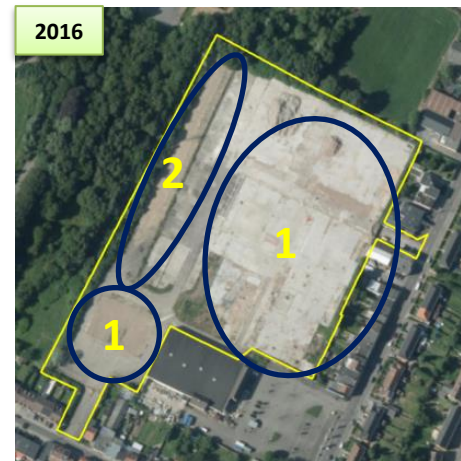
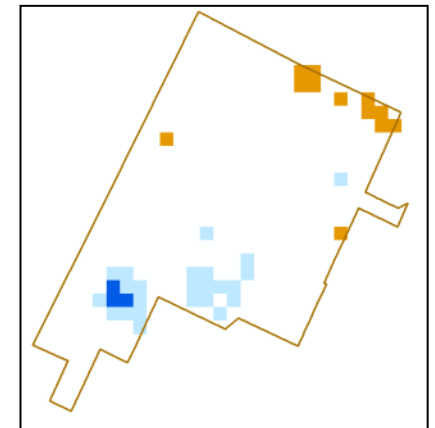
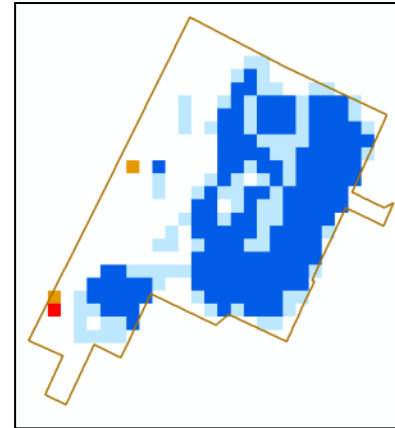
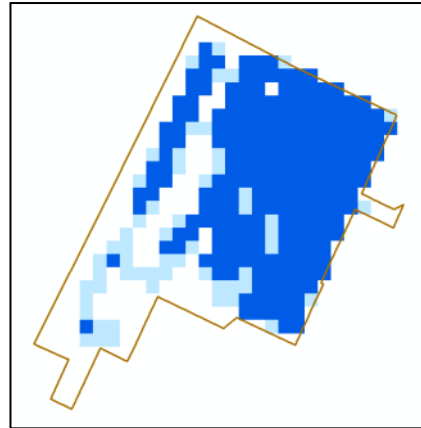
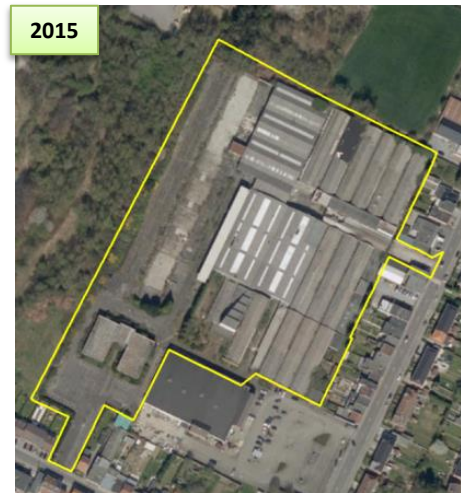
NDVI



SAVI

2. Feasibility study

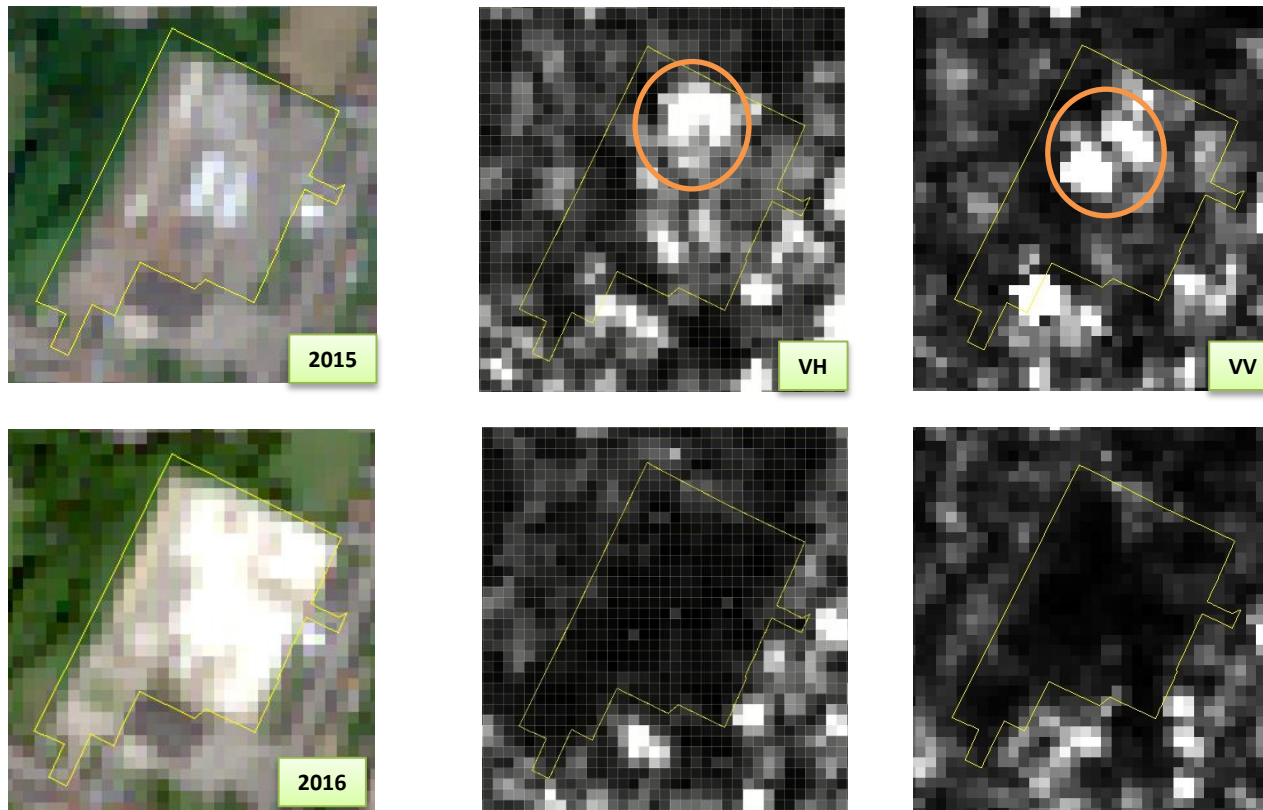
Optical resolution issue? (Sentinel 2)



1. Buildings demolition
2. Change of coating layer colour

2. Feasibility study

Synthetic aperture radar (Sentinel 1)



No more backscattering from buildings after demolition

2. Feasibility study

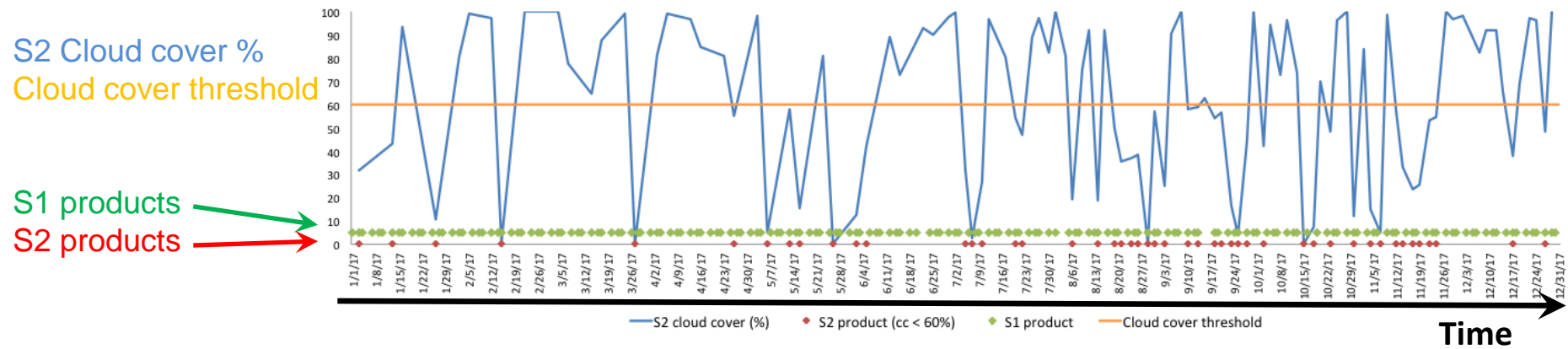
- Lessons learned:
 - Difficulty to obtain VHR data
 - Sentinel spatial resolution seems good enough
 - Expert knowledge required / manual intervention
 - A database of actual changes is necessary to validate a method → now available!

3. Proposed approach

- Goal: Develop an operational tool to
 - Systematically analyze the (2000+) sites
 - Regularly (every month)
 - Assess (probability of) changes for each site
 - Update inventory with quantitative / qualitative information
 - Probability of change
 - Given the measurements, what is the probability a change occurred?
 - Type of change
 - Cut vegetation / building change / ...
 - Provide a “priority list” of the sites to further analyze
 - To confirm interpretation
 - Using VHR
 - Or on-site visit

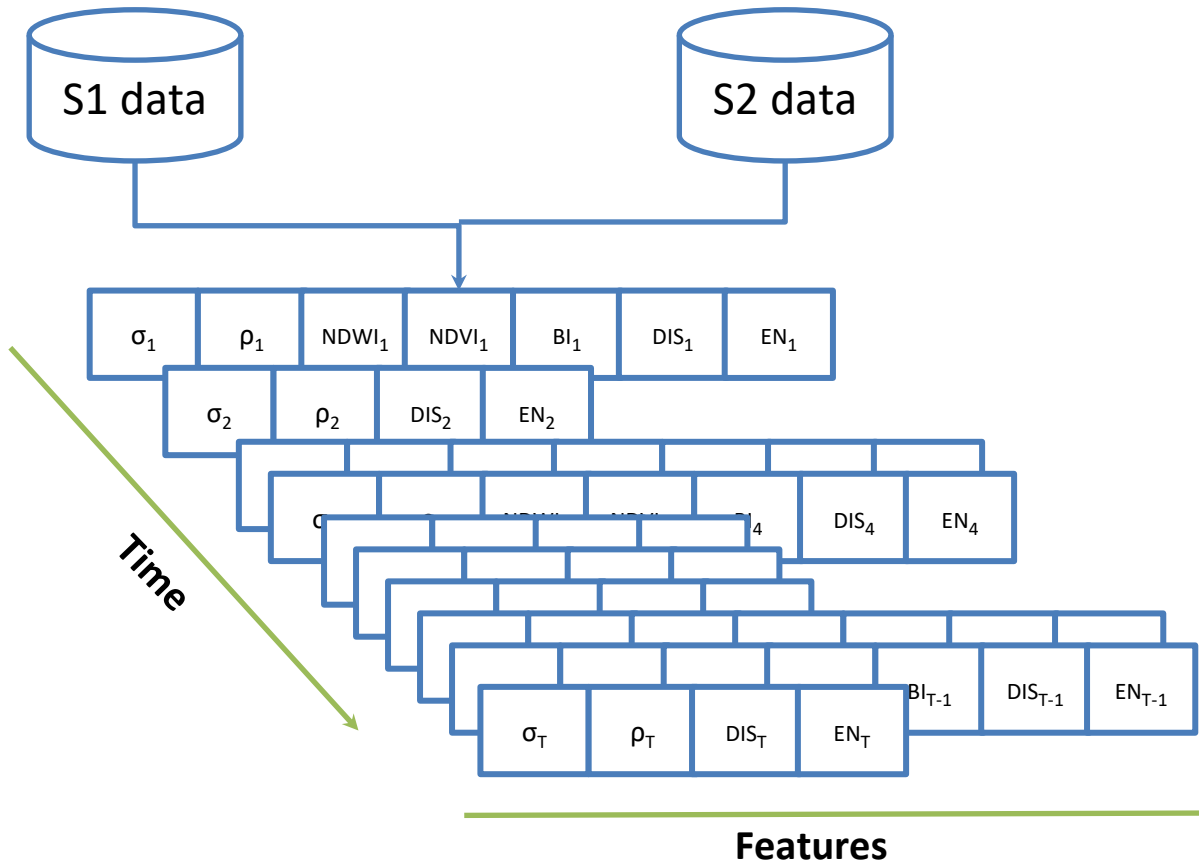
3. Proposed approach

- Methodology:
 - Exploitation of
 - Sentinel-1 time series (sigma naught, textures, ...)
 - Not affected by cloud cover → higher temporal resolution
 - Sentinel-2 time series (spectral indexes, textures, ...)
 - Process
 - Extract feature vectors
 - Rule-based classification
 - Produce report & update state (of each site)



3. Proposed approach

- Feature Extraction:
 - Adaptive Feature Aggregation
 - Feature vector of variable size



$$NDWI = \frac{NIR - SWIR}{NIR + SWIR}$$

$$NDVI = \frac{NIR - RED}{NIR + RED}$$

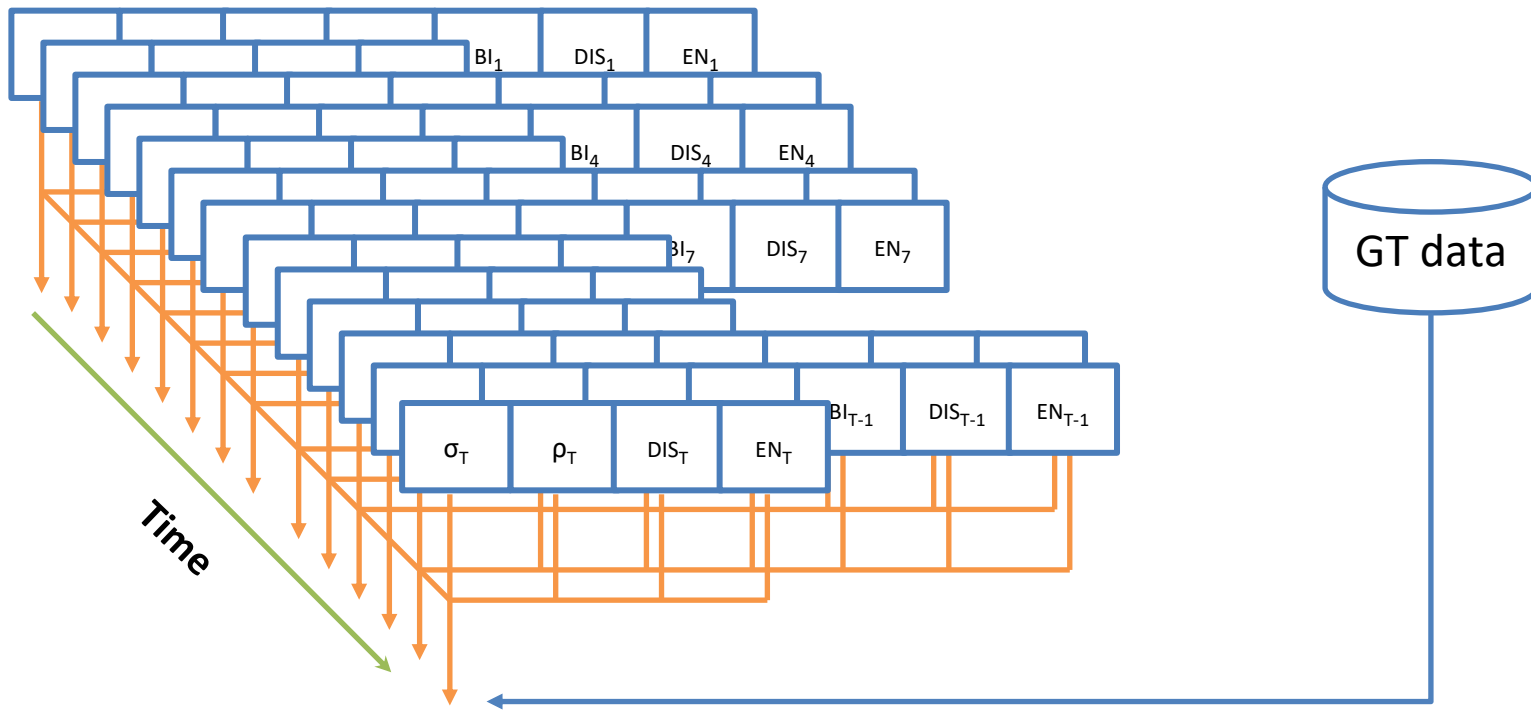
$$BI = \frac{(RED + BLUE) - GREEN}{(RED + BLUE) + GREEN}$$

$$DIS = \sum_{i,j=0}^{N-1} P_{i,j} |i - j|$$

$$EN = \sum_{i,j=0}^{N-1} P_{i,j} (-\ln P_{i,j})$$

3. Proposed approach

- Classification:
 - Fuzzy Rule-based classification



Rule 1: (σ_t is low AND σ_{t-1} is high) AND (BI_t is high AND BI_{t-1} is low) \rightarrow building demolition

Rule 2: (σ_t is high AND σ_{t-1} is low) AND ($NDVI_t$ is high AND $NDVI_{t-1}$ is low) \rightarrow vegetation growth

...

Rule N: (σ_t is ... AND σ_{t-1} is ...) AND ($NDWI_t$ is ... AND $NDWI_{t-1}$ is ...) \rightarrow ...



3. Proposed approach

- Evaluation of the performance of the tool
 - Using historical data
 - Aerial Orthophotos (2016, 2018) & Pleiades
 - The current inventory database
 - Separation between learning and validation dataset

4. Implementation

- Technical side
 - Platform: Terrascope (Belgian CGS)
 - Virtual Research Environment (python)
 - Availability of S1 & S2 images
 - Likely « modest » processing requirements
- Long-term maintenance
 - Extension of existing structural/contractual relationship between SPW and ISSeP.
 - RMA may be a subcontractor of ISSeP

4. Implementation

- Organizational / Structural
 - Fits within tasks of SPW/DGO4/DAO
 - Personnel for ground-truth collection
 - Day-to-day operation
 - Exploitation of the “reports”
 - Resources of SPW/DGO4/DiGIT
 - Integration in the existing IT workflow
 - Automation of the exploitation of the “reports”
 - List of sites to visit, priorities, “quicklooks”, ...

4. Implementation

- Knowledge transfer
 - Communicate about the tool
 - Fine-tuning of requirements
 - Interfaces, performance
 - What are the expected inputs
 - What is the expected output
 - What are the limitations of the tools
 - Channels
 - User workshop
 - User / installation manual
 - Training session(s)

5. Programme of work

Deliverables

WP0: Project management & coordination

D0.1: Kick Off report	T0 + 1M
D0.2: Midterm report	T0 + 13M
D0.3: Final report	T0 + 24M

WP1: Users' Needs

D1.1: User Requirements Document	T0 + 3M
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WP2: Dynamic Monitoring of Redevelopment Sites

D2.1: Tool for the dynamic monitoring of redevelopment sites	T0 + 21M
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WP3: Validation and platform integration

D3.1: Performance assessment report	T0 + 24M
D3.2: EO service for the dynamic monitoring of redevelopment sites	T0 + 24M

WP4: Technology transfer

D4.1: User manual, including examples and analysis of the performance of the tool	T0 + 24M
D4.2: Hands-on training session on how to use the tool	T0 + 24M

WP5: Dissemination

D5.1: User workshop for the Walloon Region	T0 + 24M
D5.2: Draft paper on dynamic monitoring of redevelopment sites	T0 + 24M

Team

- SPW / DG04
 - Christophe Rasumny
- Royal Military Academy
 - Xavier Neyt
 - Mattia Stasolla
- ISSeP
 - Eric Hallot
 - Sophie Petit
 - Gerard Swinnen



Thank You