POLITIQUE SCIENTIFIQUE FEDERALE - FEDERAAL WETENSCHAPSBELEID

RESEARCH PROGRAMME FOR EARTH OBSERVATION STEREO III

ACTIVITY REPORT

CONTRACT SR/00/372

SARSAR

Automatic redevelopment sites monitoring using SAR and OPTICAL images

Date : 19/05/2020

Direction de l'Aménagement opérationnel et de la Ville (DAOV) - Service public de Wallonie
Royal Military Academy (RMA)
Institut Scientifique de Service Public (ISSeP)

1 CONTENT

2 PARTNERSHIP INFORMATION

2.1 CHANGES IN PROJECT STAFF

Additional staff member:

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Type of position: Researcher
Type of contract: Fixed-term

3 PROJECT INFORMATION

3.1 PROJECT PROGRESS AND RESULTS[1]

Until the end of February 2020 the project development was on track. A disruption has occurred following the Covid-19 outbreak. Some adjustments had to be made and it is foreseen a delay for the deliverables and the final end date of the project.

WP1: USERS' NEEDS

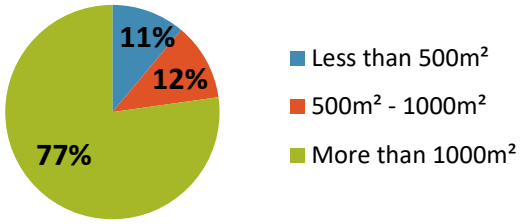
In this WP, the objectives of the project, the state of the RDS inventory and the way in which this project could help the Walloon Region to manage the RDSs have been investigated and defined. This has been done knowing that the main goals of the inventory update are:

- Avoiding misleading the actors who consult the RDS inventory (available on line since 2017)
- Reducing time spend on inventory update as the DAOV estimates that less than 10% of RDSs are likely to "change" from one year to the next

Currently the RDS inventory is mostly updated by field verification, which is time consuming and does not allow all the sites to be verified every year. Since a couple of years, aerial ortho-photos have been used for investigating every single RDS on the territory by using a photo-interpretation methodology ("SAR" project: DAOV-ISSeP internal subvention). In total 2213 RDSs over 3800ha in Wallonia have been verified in 2017. The inventory with the ortho-photo campaign of 2018 has just ended. In the context of the SARSAR project, these inventories updates will be used to validate our methodology.

[1] Referring to tasks and time schedule in contract – explain delays - technical documents and reports to be put in annex

In the Users' Needs we first defined what the contribution of the Sentinel images would be, knowing that the spatial resolution limits de size of the RDSs that can be analysed. The figure below gives an estimation of the percentage of the sites that could be examined.



We then identified the different Users' needs and requirements as follows:

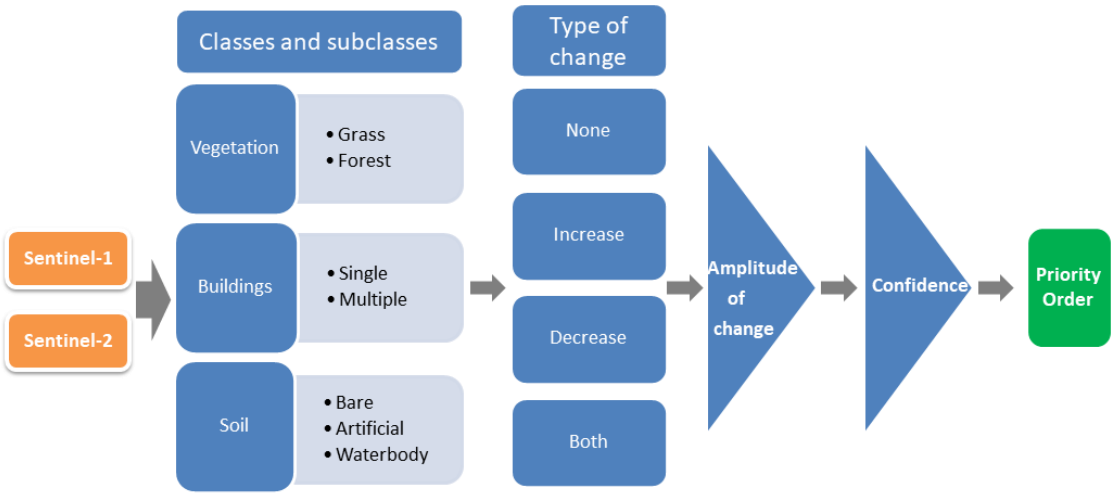
- Needs:
  - Lower costs by limiting the number of sites to be field verified
  - Automate, as much as possible, change detection
  - Facilitate the work of the operators by pre-identifying the elements to check
  - Decrease the subjectivity of the operator

- Requirements:
  - Determination of categories of changes → highlight different types of change scenarios and their importance
  - Deadlines for the RDS inventory updates
  - Respect of the users' priorities
  - Dissemination and sharing of results
  - Implementation of trainings

Subsequently, we detailed the different part of the needs and requirements.

First, the different types of change scenarios and their importance were divided in 2 categories:

- Must have: list of sites with their probability of having changed (based on the list of the sites most likely to have not changed)
- Nice to have: confidence, site-by-site, of changes based on a selection of pre-established scenarios (categories and types of changes). Importance of taking into account specific situations where no long-term change may mean that the site is maintained (e.g. pasture meadow). The following diagram also summarize the "Nice to have" scenario



Then, the deadlines were also divided in two:

- Must have: 1 time per year
- Nice to have: 1 time every 2 months

The process will thus be applied several times and two values will be reported for each RDS. The reliability will be different due to the noise in the Sentinel-1 data and variability in the availability of Sentinel-2 images. There will also be the possibility to make special request "On demand" for specific sites when needed.

Finally we focused on the needs and requirements for the dissemination, sharing and trainings. First, it was asked by the DAOV to receive the results in an easy-to-use and sustainable format (.csv or .txt). This file should contain the identifier of the RDS and a priority order based on change detection. The results will be sent by email, the raw results will be made available on demand, and if possible a WFS and/or an alert system on the RDS website will be put in place. Concerning the trainings, it was asked to have face-to-face courses of ½ to 1 day with theoretical and practical parts, a user manual in PDF will also be provided. Beside the trainings, the tool may also be presented to national events and existing Regional Earth Observation Working Groups (GTEO, GT-COWAL …)

As a final point, it was highlighted that the Users' Needs may evolve during the duration of the project. The users' feedback will thus be evaluated at any time and the Users' Needs document updated when needed.

WP2: DYNAMIC MONITORING OF REDEVELOPMENT SITES

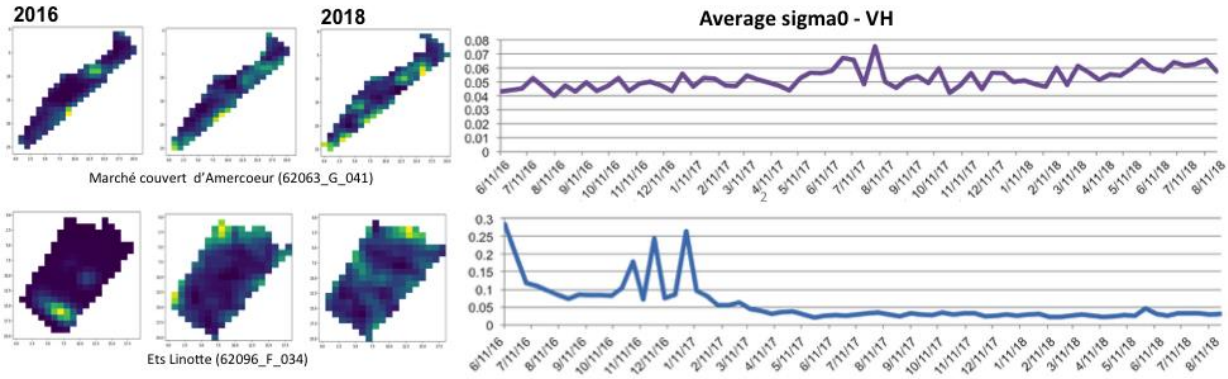
The first part of the WP2 is devoted to the extraction of relevant features from SAR and optical images that will be used to detect changes in the RDSs. As of now, the development has been separately carried out for Sentinel-1 and Sentinel-2 images, by RMA and ISSeP respectively.

Around 20 tests sites have been selected in the area of liege and Charleroi where we have Pleiades images available. These sites were chosen for their representativeness in terms of different types of changes (including no change).

Sentinel-1

As far as Sentinel-1 (S1) is concerned, the processing has been directly done on the Terrascope platform using orthorectified calibrated GRD products.

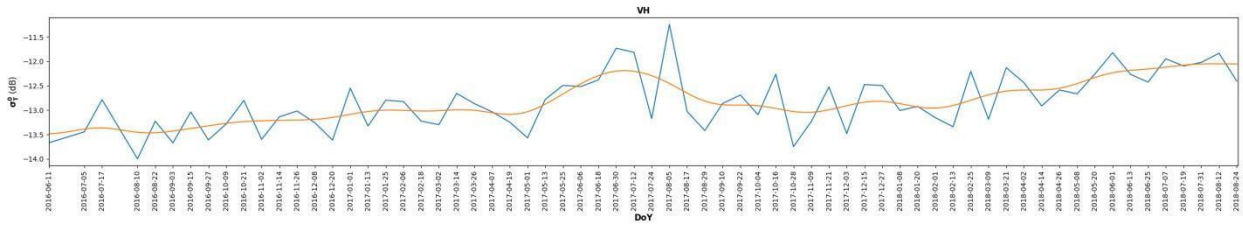
In an initial phase, the RDS shapefile provided by the Walloon region has been processed as is to study the behaviour of the sites in terms of radar backscatter. The average values of sigma0 for each RDS polygon have been extracted from time series of VH and VV channels and used to generate temporal profiles. The VH profiles of two test sites (Marché couvert d'Amercoeur and Ets Linotte) are provided here below as an example.



The goal is to exploit the temporal profiles to detect changepoints, i.e. positions in time where the RDSs are likely to have experienced a change. As a first step, a check on the coefficient of variation (cv) of the temporal profile is run. If the cv is below a certain value (the threshold has been empirically set to 1), the change is unlikely, and the RDS is tagged as unchanged. If cv > 1, a change in the RDS might have occurred, therefore a changepoint analysis is carried out to determine if and when it happened.

For the above mentioned test sites, we obtained two different results.

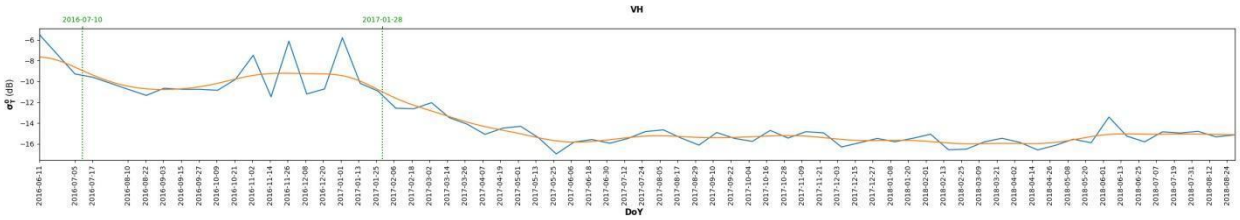
In the case of the Marché couvert d'Amercoeur, the cv turned out to be less than 1, which directly led to the conclusion that the site remained unchanged (or had irrelevant changes).



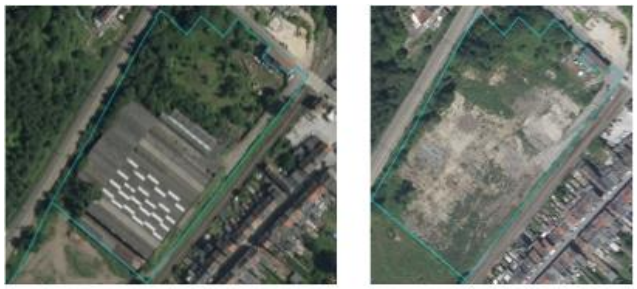
This result is confirmed if we look at the ground truth aerial images taken in 2016 and 2018.

AOP 2016 AOP 2018

Contrarily, the temporal profile of Ets Linotte is characterized by a cv greater than 1. We therefore run the changepoint detector and obtained two possible dates where a change might have occurred.



More precisely, the changepoints correspond to a reduction of backscatter (high to low), which has been confirmed to be a result of the demolition of a building, as can be evinced from the ground truth images below.



AOP 2016 AOP 2018

We are currently investigating the use of other input features, mainly focusing on texture information computed from grey level co-occurrence matrices (GLCMs). In particular, the following texture features are under study:

$$Angular\ Second\ Moment\ (ASM) = \sum_{i,j=0}^{N-1} P_{i,j}|i-j|$$

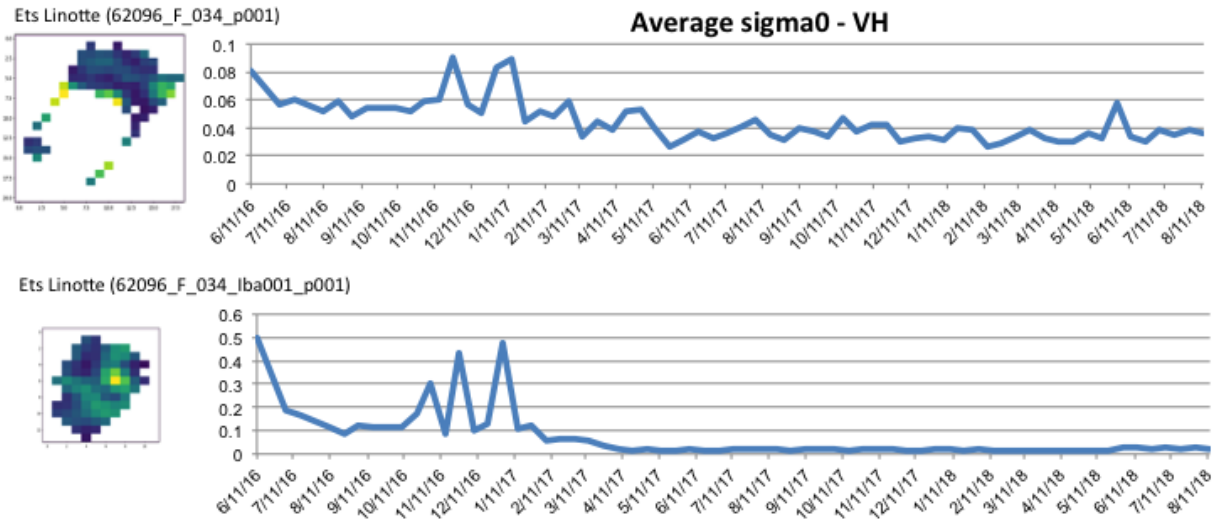
$$Dissimilarity\ (DIS) = \sum_{i,j=0}^{N-1} P_{i,j}|i-j|$$

$$Homogeneity\ (HOM) = \sum_{i,j=0}^{N-1} \frac{P_{i,j}}{1+(i-j)^2}$$

$$Correlation\ (COR) = \sum_{i,j=0}^{N-1} P_{i,j}\left[\frac{(i-\mu_i)(j-\mu_j)}{\sigma_i \sigma_j}\right]$$

where i is the row number and j is the column number of the GLCM, N is the number of rows/columns, $P_{i,j}$ is the probability value recorded for the cell i,j, and μ and σ are the GLCM mean and variance, respectively.

As discussed during the SC meeting (see Section 5.3), we have also integrated the information from the inventory of buildings (IBA) into the original RDS shapefile. This led to an increased number of polygons to process (for the original selection of 22 test sites, the total number of polygons has increased to 94), yet we expect it to ameliorate the detection of changes of type 'construction/demolition' of buildings. The analysis is still ongoing; however, if we look for example at the site Ets Linotte, which is now composed of two polygons (62096_F_034_p001 and 62096_F_034_Iba001_p001), we can notice that it is possible to observe different types of changes within the same site, as shown here below.



Sentinel-2

The processing of Sentinel-2 (S2) was first done manually to determine the best way to detect changepoints, since the work in Terrascope directly requires non-negligible preparation work.

The number of images taken into account for the manual work for the 2 areas of test sites is:

- UER tile: 12 images between 2016/09/08 and 2018/07/02
- UFS tile: 15 images between 2016/07/20 and 2018/07/02

The dates (cloud free) are based on the ortho-photos campaigns chosen to represent the general evolution of the sites.

As for S1, the initial phase was to process the RDS shapefile provided by the Walloon region to study the behaviour of the sites in terms of indexes. The first tests were done with the following indexes:

- Normalized Difference Vegetation Index

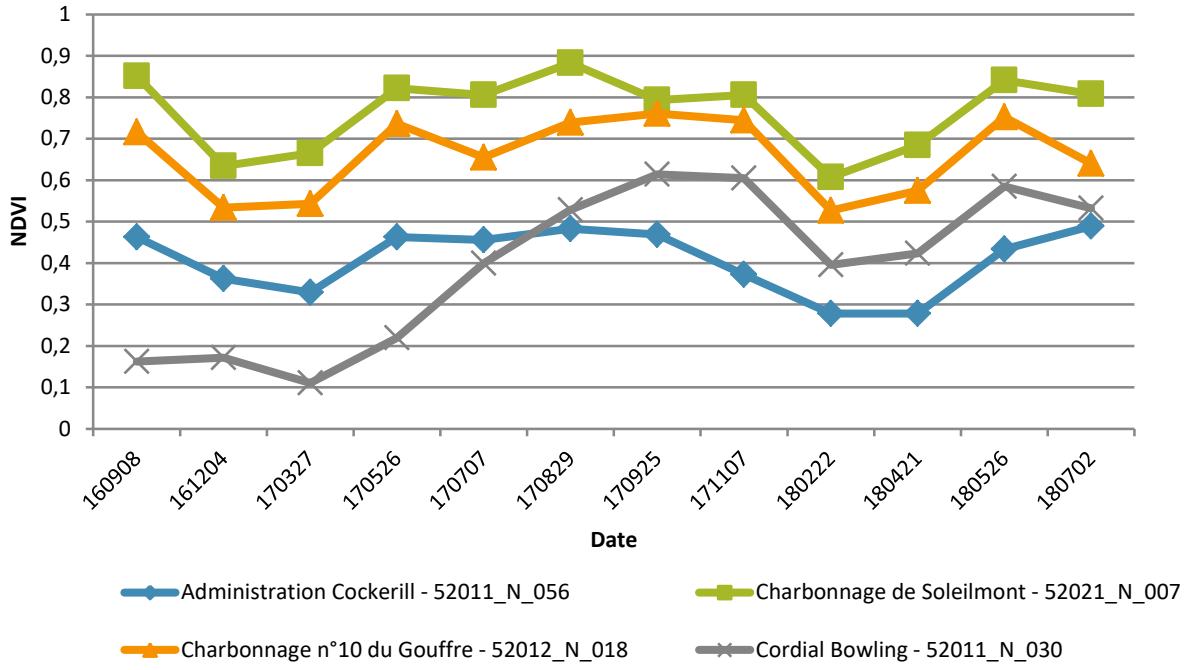
$$NDVI = \frac{NIR - RED}{NIR + RED}$$

- Normalized Difference Built-Up Index

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

The average values, for each RDS polygon, of the different indexes tested have been extracted from time series and used to generate temporal profiles.

The temporal profiles of the average NDVI per site, for 3 sites without changes and one with changes, are provided here below as an example:

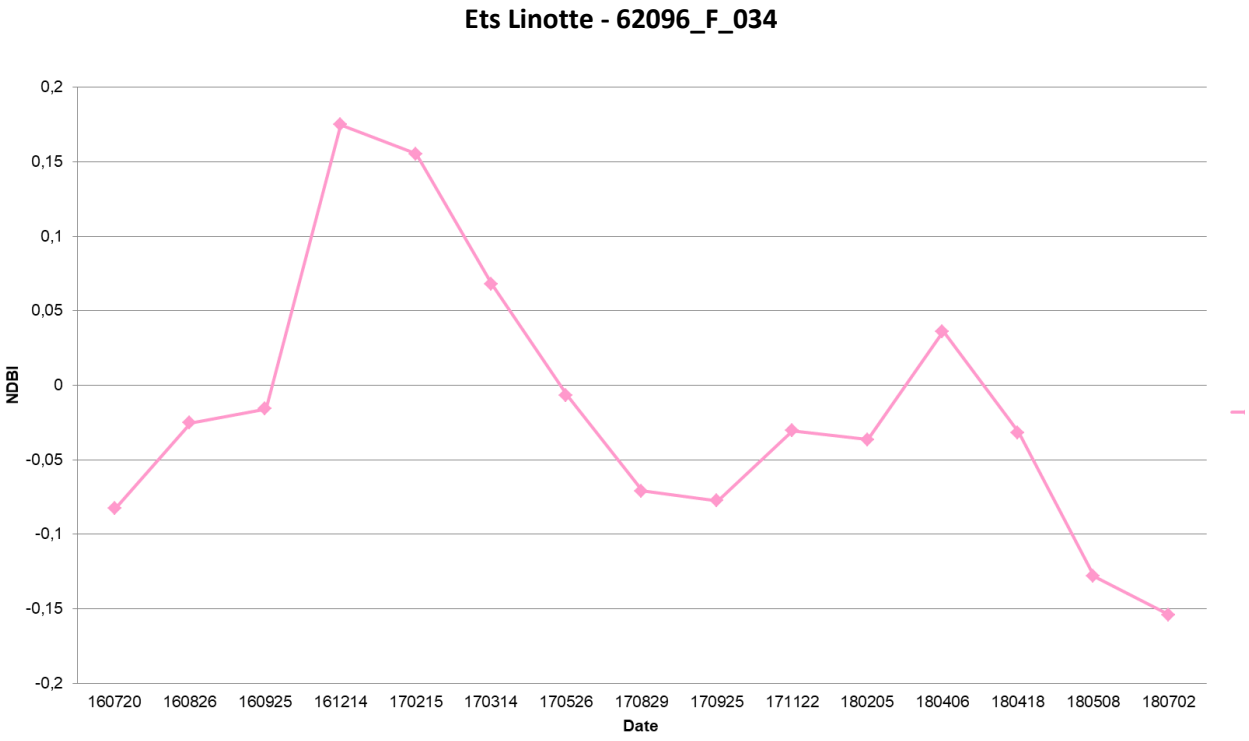


We can see on this graph that the Cordial Bowling has an increase of the NDVI which is different from the seasonal variation of the vegetation. This is confirmed by the aerial images taken in 2016 and 2018.

AOP 2016

AOP 2018

The same analysis was done for the NDBI. The temporal profile confirms the change detected by S1, and shows that a building demolition has occurred.



AOP 2016

AOP 2018

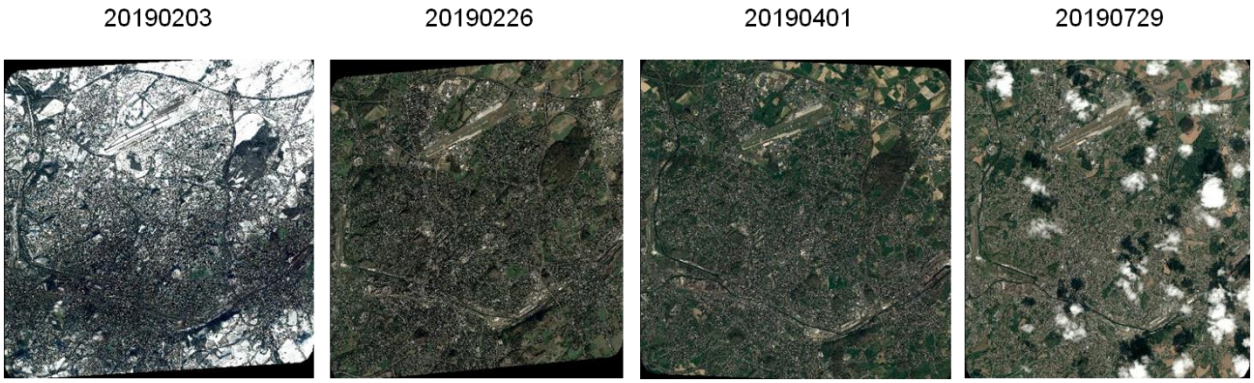
After this initial phase, it was decided to continue de S2 analysis directly in Terrascope focusing first on the automation of the data processing, as it will reduce the time needed for the change detection analysis. Indeed, this will allow us to directly test any index or change detection method as well as any kind of segmentation. The work done directly in Terrascope is presented below in this same section (WP3).

WP3: VALIDATION AND PLATFORM INTEGRATION

Performance assessment

- *Pleiades images*

As explained in the next section, Pleiades images will be used for the tool validation. Initially, it was planned to acquire one image per month over 2 years on two areas of 100km²: one in Liege and another in Charleroi. For the first year, instead of 12+12 images we have received only 8 images for the Charleroi area and 10 images for the Liège area. Moreover, some images are difficult to use due to the presence of snow or scattered clouds, as illustrated in the figure below.



For these reasons, in September 2019 we asked to BELSPO, which approved the request, to have access to 7 archive images. These images were effectively received in March 2020.

We have also requested and obtained permission to order some additional Pleiades images:

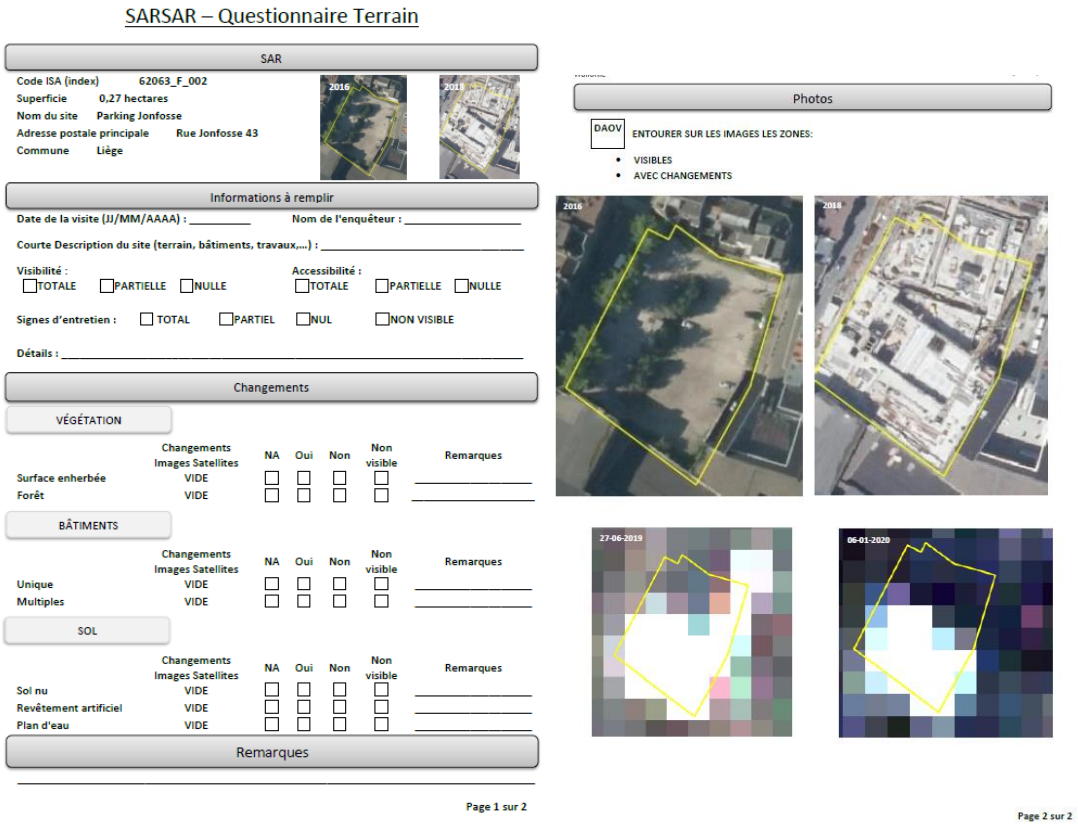
- A new area of 100 km² centered on La Louvière, with about 55 RDS has been defined for an amount of 2.160 EUR. This new order aims to increase the number of sites, and especially the type of RDS, in the framework of the future validation phases.
- For the Liège region, new images in spring and autumn will be acquired in order to better define the vegetative periods, in particular for certain invasive plants (such as Japanese knotweed, *Fallopia japonica*) present on several RDS, for an amount of approximately 600 EUR.

- *Field Sheets*

In order to verify the change detection results, field sheets have been created. This will support the comparison of the remote sensing results with ground truth.

First, a generic sheet has been created in collaboration with DAOV field staff. This sheet includes different pre-filled section, like administrative information, and sections to fill in the field with a focus on the changes that could be detected by remote sensing, and on the site visibility in the field.

Then, the sheets have been pre-filled in for the 20 tests sites used in the WP2. For each site, images from the 2016 & 2018 ortho-photos campaign and the latest Sentinel-2 data are also provided. The image below shows the example of Parking Jonfosse (62063_F_002).



SARSAR – Questionnaire Terrain

SAR

Code ISA (index) 62063_F_002
Superficie 0,27 hectares
Nom du site Parking Jonfosse
Adresse postale principale Rue Jonfosse 43
Commune Liège

Informations à remplir

Date de la visite (JJ/MM/AAAA) : _____ Nom de l'enquêteur : _____

Courte Description du site (terrain, bâtiments, travaux,...) : _____

Visibilité : ☐TOTALE ☐PARTIELLE ☐NULLE
Accessibilité : ☐TOTALE ☐PARTIELLE ☐NULLE

Signes d'entretien : ☐ TOTAL ☐PARTIEL ☐NUL ☐NON VISIBLE

Détails : _____

Changements

VÉGÉTATION

Changements Images Satellites	NA	Oui	Non	Non visible	Remarques
Surface enherbée	VIDE	☐	☐	☐	☐ _____
Forêt	VIDE	☐	☐	☐	☐ _____

BÂTIMENTS

Changements Images Satellites	NA	Oui	Non	Non visible	Remarques
Unique	VIDE	☐	☐	☐	☐ _____
Multiples	VIDE	☐	☐	☐	☐ _____

SOL

Changements Images Satellites	NA	Oui	Non	Non visible	Remarques
Sol nu	VIDE	☐	☐	☐	☐ _____
Revêtement artificiel	VIDE	☐	☐	☐	☐ _____
Plan d'eau	VIDE	☐	☐	☐	☐ _____

Remarques

_____

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Photos

DAOV ENTOURER SUR LES IMAGES LES ZONES:

- VISIBLES
- AVEC CHANGEMENTS

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DAOV field staff carried out the field visits and sent back to ISSeP the completed sheets.

EO service for the dynamic monitoring of redevelopment sites

– *Terrascope*

One of the main deliverable of the project is the (set of) routine(s) itself. These routines will run on the Terrascope which is the Belgian collaborative ground segment for Sentinel missions. It provides access to data, derived products, web service and processing capacity through virtual machines. This will allow to automate processes by reading the Terrascope catalogue and the RDS shapefile to extract features, generate time profiles and change points and finally create a .csv output file. We are currently working on the processing of Sentinel-1 and Sentinel-2 images on the Terrascope server to improve the change detection method. As far as Sentinel-2 is concerned, even if some post-processed data and indexes are directly present in Terrascope (fAPAR, fCOVER, NDVI ...), not all the necessary data is available. We then

decided to use the Top-Of-Canopy (TOC) images; and to record the pixels corresponding to the RDSs in a date-indexed database, so that all possible indices can be easily calculated.

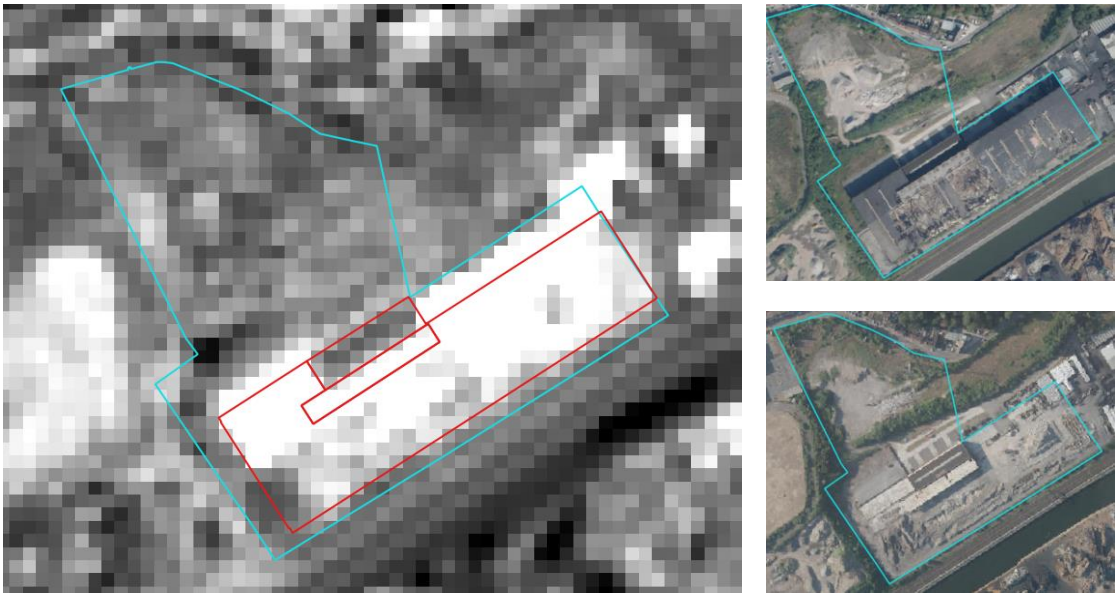
3.2 WORK PLAN FOR NEXT YEAR

As already mentioned, a disruption in the project plan has occurred following the Covid-19 outbreak and some delay is foreseen for the deliverables and the final end date of the project. This will also impact the date of the next Steering Committee meeting. In the current situation, we plan to hold a face-to-face meeting in early 2021. However, depending on the evolution of the health situation, the meeting may be postponed again or carried out by video conference.

WP2: DYNAMIC MONITORING OF REDEVELOPMENT SITES

As discussed in the section above (3.1 – WP2), the inventory of building (IBA) is currently being tested and the first results show an improvement in the detection of changes. Further tests will be set up to prove the overall benefit of this type of segmentation.

We also started to investigate other types of segmentation, like mentioned in section 5.3. An example of what could be detected is shown in the figure below. It use the "Projet Informatique de Cartographie Continue" (PICC) as a base for segmentation (in red in the figure), combined with the 2016-2018 difference of the BI2 index on S2 images. The ortho-photos clearly show the destruction of some buildings, represented in white on S2 composition.



Next year, if needed, we will also compare these methods to change detection by pixel or via a regular grid, following the recommendations of the Steering Committee.

As far as Sentinel-1 is concerned, we will start using as an input feature the coherence images derived from SLC products, which have been recently added to the Terrascope catalogue (although the release is still unofficial) and should allow us to better discriminate between types of changes in a RDS.

Finally we will focus on the S1 & S2 change detection results fusion.

WP3: VALIDATION AND PLATFORM INTEGRATION

Performance assessment

- *Pleiades images*

All the Pleiades images (monthly acquisition and archives on Liège and Charleroi, as well as the additional requests) will be fully used later in the project when the validation phase of the first results of the S1 and S2 image processing will be launched.

- *Field Sheets*

The work plan for next year is to analyze the results of the field/remote sensing comparison done with the field sheets.

- *SAR project*

In relation with the SAR project (mentioned in the section 3.1 WP1 and detailed on section 4.3), next year's work plan is divided into two parts. The first is the comparison and validation of the results from the dynamic monitoring of the RDSs with the 2016-2018 ortho-photos inventory update, already available. The second part is the strengthening of the change detection results with the comparison of the 2019 ortho-photos analysis, knowing that the work on the 2019 ortho-photos will take place later in 2020.

- *Municipality feedback*

As proposed by the Steering Committee, we will contact the municipalities to receive as much feedback as possible on the change chronology and history of the RDSs in their territories. DAOV and ISSeP are currently working on identifying the most appropriates contacts and on the best way to request the needed information, keeping in mind that the municipalities are not themselves always aware of the changes taking place on the site.

EO service for the dynamic monitoring of redevelopment sites

- *Terrascope*

One of the first next steps that will be done in Terrascope will be to include a snow mask present in the SCENECLASSIFICATION Tiff data.

Then, when we will have the SQLite database, we will be able to automatically calculate all the possible indices at an acceptable speed and extract graphs representing their evolution over time as well as the changepoint.

Once the process automation of the S2 data will be finished, we will concentrate on the automation of the S1 and S2 fusion. Finally, we will focus on the creation of the final report that will allow the DAOV to prioritize their work.

WP4: TECHNOLOGY TRANSFER

This work package is planned to start once the automation in Terrascope is finalized.

WP5: DISSEMINATION

A first introduction to this project has been done at the GT-COWal in November 2019. The project has also been presented at the Belgian Earth Observation Day 2019, the URSI Benelux Forum 2019 and the CISS Lecture Series 2020. The plan for next year is to develop the communication and dissemination related to the project.

4 DESSIMINATION ACTIVITIES

4.1 MISCALLENEOUS MISSIONS: STAYS AT PARTNER'S ORGANISATION, MEETINGS, CONFERENCES, ...[2]

Name staff member: Stasolla Mattia, Xavier Neyt

Assignment: "The SARSAR Project: Detecting Changes by means of the Copernicus Sentinels", presentation at the 28th URSI Benelux Forum 2019, Brussels, Belgium.

Date: Dec 2019

Name staff member: Sophie Petit

Assignment: "The potential of SAR and OPTICAL Sentinel images for the automatic monitoring of redevelopment sites", presentation at the Belgian Earth Observation Day 2019, Kluisbergen, Belgium.

Date: Nov 2019

Name staff member: Sophie Petit

Assignment: "The Potential of SAR and OPTICAL Sentinel Images for the Automatic Monitoring of Redevelopment Sites", Poster at the EARSeL joint workshop, Liège, Belgium.

Date: May 2020, but postponed due to Covid-19

4.2 SCIENTIFIC PAPERS

[2] Per project team member

PUBLISHED[3]

N/A

SUBMITTED

N/A

IN PROGRESS

N/A

4.3 COLLABORATION WITH OTHER PROJECTS

SARSAR is deeply linked to the SAR project, which is a collaboration between DAOV and ISSeP for the update of the RDS inventory by using a photo-interpretation methodology. Since 2018, ISSeP conducted the creation of a "ground truth" of the state of RDSs by analysing the latest ortho-photos campaigns (2012-13, 2014 and 2016). Beginning of 2020, the analysis of the 2018 campaign was finalized.

At the end of 2018, a joint publication by the European Commission, Nereus and ESA featured 99 success stories from different regions in Europe. An article on the updating of the SAR inventory was published, covering the various precursor works to the SARSAR project. This publication is available at the following address:
http://esamultimedia.esa.int/docs/EarthObservation/copernicus4regions_2018.pdf.

In 2019, a video presented by Mr. Christophe Rasumny (Administrative Officer at the Wallonia Public Service for Land Planning, Housing, Heritage and Energy) and Dr. Eric Hallot (Head of Remote Sensing and Geodata Unit at the Institut Scientifique de Service Public) talked about how Sentinel-2 data are being used to support inventory and monitor the evolution of brownfield sites in Wallonia. The future SARSAR project is mentioned through the collaboration with the Royal Military Academy. The video, available in English and French, is available at this address:
http://www.nereus-regions.eu/copernicus4regions/videos/wallonia/.

4.4 OTHER TYPES OF OUTREACH

PRESS

N/A

SOCIAL MEDIA

N/A

[3] Full bibliographic reference, including doi

PHD

N/A

OTHER (AWARDS, GUEST LECTURES, WEBINAR, …)

- Stasolla Mattia, "Exploiting the Copernicus Sentinels for the Automatic Monitoring of Redevelopment Sites", presentation at the CISS Lecture Series 2020, Royal Military Academy, Feb 2020, Brussels, Belgium.
- Petit Sophie, "Exploitation des données de télédétection (Optiques et Radar) pour la surveillance automatique de sites d'intérêts. Cas des Sites À Réaménager (SAR)", présentation at the GT-COWal, Nov 2019, Namur, Belgium.

5 STEERING COMMITTEE

5.1 COMPOSITION / CHANGES IN COMPOSITION

Fabio DELL'ACQUA (University of Pavia, IT)

Jan HAAS (Karlstad University, SE)

Florence TUPIN (Telecom Paris, FR)

5.2 REPORT OF STEERING COMMITTEE

GENERAL COMMENTS

This is a well organised interesting project with a sound and well-thought out methodological approach that combines optical and SAR imagery to monitor redevelopment sites.

The criticisms offered by the reviewers of proposal have been addressed in a satisfactory way, in particular as regards the methodology and the concerns about the spatial resolution of the Sentinel images.

The project is likely to end up with results which will be useful for the Walloon administration and likely exceed the expectations.

RECOMMENDATIONS CHANGE DETECTION

1. The possible negative impact of averaging of information over a site should be investigated by using archived satellite imagery, in particular SAR imagery, and verifying whether all the changes were caught by the proposed methodology. An alternative to averaging information could be looking into features extracted on a pixel basis or into segmenting the sites of interest.
2. At the moment, the Sentinel 1 and 2 data obtained through TERRASCOPE are not co-registered, which could pose problems for a pixel-based comparison. Vectorization of remote sensing data

may offer a solution here. Averaging of pixel values over RDS polygons could be avoided by creating an array of vector points with equal distance (e.g. pixel spacing or raster spatial resolution) within the RDS polygons. The extraction of pixel values that match the spatial location of the point features would result in individual sets of extracted features (one feature set per point containing both S1 and S2 features) rather than only one averaged one per polygon. The feature sets could then be fed to the change detection decision engine following the proposed methodology. This would enable the observation of per pixel changes but increase data volume and arguably increase processing performance).

3. The methodology should allow for the detection of different types of change? In depth investigation into detecting slow change in particular is warranted. It may be worthwhile to contact municipalities where case study sites are situated for specific, concrete information in order to establish a change chronology and history. Such data cannot only be used for validation purposes but also for fine-tuning the algorithm.

CHANGE INFORMATION SHEETS

The change sheet that is to send to the administration should contain a before and after picture of the site, in order to help the administration to decide whether the change reported is relevant.

5.3 FEEDBACK TO STEERING COMMITTEE

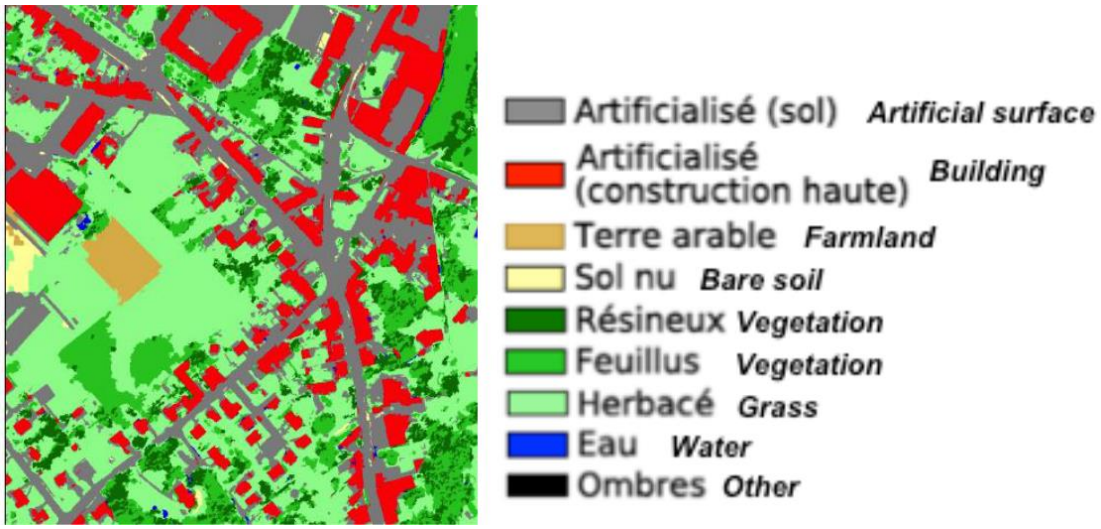
1. We definitely agree that by averaging the information over the entire RDS we will likely reduce our capability of detecting changes, especially in the case of very large sites. To overcome this problem, we will therefore split the current RDS polygons into smaller polygons based on 3 different additional sources, and evaluate which one would provide the best trade-off between accuracy and computational cost.
    a. IBA: along with the external perimeter of the RDS, we will use the information provided by the current inventory of RDS buildings (IBA), and apply the change detection method to the objects belonging to the classes ‘Building’ and ‘Other’. An example of the new RDS shapefile is provided in the image on the right.
    Instead of the original RDS polygon (cyan line), the site will consist of 3 separate objects: 2 Buildings (in black) and 1 ‘Other’ (RDS \ IBA).

    b. *PICC*: the second source will be the Projet Informatique de Cartographie Continue (PICC), which not only contains the polygons of the buildings, but also the objects belonging to the class ‘Vegetation’ (trees, non-grass). An example is

provided below, where the new RDS shapefile (originally a single polygon outlined in red) will consist of various objects within the class 'Building' (orange + lilac), 5 objects in the class 'Vegetation', and the rest in the class 'Other'.

c. *WALOUS*: the last test will be run on the segmentation obtained via the WALlonie Occupation et Utilisation du Sol (WALOUS), which provides a number of INSPIRE classes that for our purposes will be merged into 'Artificial surface', 'Building', 'Farmland', 'Bare soil', 'Vegetation', 'Grass', and 'Water'. All the rest would fall into the 'Other' class. Below, a segmentation example with 9 classes (that will be eventually merged into 8).



For all the three types of segmentations, small objects will be either removed (if isolated) or connected to adjacent objects of the same class through region growing.

2. If none of the solutions proposed at point 1 is proven to be successful, we will certainly consider to implement the change detection on a pixel basis. Although we will have to rely on the products' geolocation accuracy, which might differ from image to image, we should be able to mitigate the effect of the misregistration by applying a subsequent aggregation step where each pixel is flagged as 'changed' if for the majority of the pixels in its neighbourhood (e.g. within a 3x3 window) a change has been detected. However, the computation time will remain a relevant aspect to take into consideration in order to decide if this solution could be actually implemented.

3. Although it would be very useful, it is actually quite difficult to obtain from the municipalities such information. As a matter of fact, very often the communes are not even aware of the changes that might have happened to the sites on their territory. One of the scopes of the SARSAR project is precisely to provide a partial solution to the shortage of communication amongst the actors involved in the managing of the RDSs. However, for a few RDSs the Service publique de Wallonie and ISSeP can provide some additional information that would help us to better understand their evolution in time. As discussed during the SC meeting, we will also look into the Pleiades archives to see if a more detailed evaluation of the changes can be done.

4. In a recent meeting, the users have reiterated their request of having a simple txt file delivered, but we could of course also provide a visual change map, if desired. We will double-check with the users if that would be of interest to them.

6 ILLUSTRATIVE MATERIAL[4]

N/A

7 ADDITIONAL INFORMATION[5]

The "User Requirements Document" (D1.1.) has been finalized, and is available.

[4] In attachment or ftp link; high resolution photographs of collaborators, field campaigns, graphs and maps,

[5] Published and drafted papers, detailed methodology, reports, ...