Interreg Project ARCH

Assessing Regional Changes to natural Habitats – photo-interpretation, mapping and study of the potential of new remote sensing technologies for monitoring natural habitats and biodiversity in the Nord-Pas de Calais and Kent regions

N°2

Assessing Regional Changes to natural Habitats – photo-interpretation, mapping and study of the potential of new remote sensing technologies for monitoring natural habitats and biodiversity in the Nord-Pas de Calais and Kent regions

Synthesis of mission 5 report

« Operational feasibility and mapping update and monitoring»

DOCUMENT REFERENCES : VERSION OF THURSDAY 11 OCTOBER 2012
REFERENCES : CR59-62 - ARCH - SYNTHESIS REPORT MISSION 5 - 11-10-2012

Document description

- Partners:

ARCH Steering Group		
Coutry	**Organisation**	
France	Cécile LECLAIRE	Conseil régional Nord Pas de Calais Direction de l'environnement
United Kingdom	Laurence GUEDON	Kent County Council ARCH Team Flood Risk & Natural Environment

Contractors	
Country	**Organisation**
France	SIRS
United Kingdom	Flasse consulting

Partners	
Country	**Organisation**
France	EURISY

- Document

	Contractor	Names	Date
Authors	SIRS	Sébastien Delbour	2012/10/11
Contributions	SIRS		
Proof-reading	SIRS	Pascal Versmessen	2012/10/11
Validation	SIRS		

Version	Date	Authors	Description
1.0	2012/10/11	Sébastien Delbour	Version 1.0

Content

Tables list

Abbreviations list

ARCH	Assessing Regional Changes to natural Habitats
ASP	Agence de Services et de Paiement (Service and Payment Agency)
CORINE	Coordination de l'information sur l'environnement
CRNPdC	Conseil Régional du Nord-Pas de Calais
ESA	European Spatial Agency (Agence Spatiale Européenne)
GEOSUD	GEOInformation for SUstainable Development
GMES	Global Monitoring for Environment and Security
HR	High Resolution
KCC	Kent County Council
LUCAS	Land Use/Cover Area frame Statistical survey
MIR	Mid-wave Infrared
MT	Multi-Temporal
N/A	Not Available, Not Applicable
NASA	National Aeronautics and Space Administration
NLUD	National Land Use Database
NPdC	Nord-Pas de Calais
AP	Aerial Photography
API	Aerial Photo Interpretation
RE	Red-Edge
RGF	Réseau Géodésique Français (French Geodesic network)
GIS	Geographic Information Systems
SIRS	Systèmes d'Information à Référence Spatiale
VHR	Very High Resolution
IP	Image Processing
UMC	Minimal Unit Mapped
XS	Multi-Spectral

Introduction

As a result of the first three missions, four specific components have been selected in consensus where the remote sensing solutions prove to be potentially useful:

- Component (1) : the rapid detection of changes
- Component (2) : the identification of specific classes
- Component (3): intra class evolution within specific habitat classes
- Component (4): the automated mapping of specific classes

Mission 4 has proposed and tested potential solutions within each of these components in order to study their technical feasibility and to select, in consensus, only those able to fulfil technically and thematically the request.

Table 1: synthesis of Mission 4 results

	Data					Methods			
	AP	VHR	HR	MT	RE	PI	Classif Pix	Classif Obj	Thre
Component 1 : rapid detection of changes									
Vector layer of potential habitat changes			✓	✓			✓	✗	
Component 2 : specific classes identification									
Red-Edge layer		✓	✓		✓	✓			
multi-temporal layer		✓	✓	✓		✓			
Component 3 : Evolution within a specific habitat class									
Scrub on grasslands	✓	✓						✓	✗
Component 4 : Automated cartography of specific classes									
Vegetated shingle	✓	✓						✓	✗
Ambleteuse swards	✓	✓						✓	

AP: Aerial Photography ; VHR : Very High Resolution ; HR : High Resolution ; MT : Multi-Temporal ; RE : Red-Edge ; PI : Photo-Interpretation ; Classif Pix : Classification by pixels (supervised and non supervised) ; Object Clas : Object Oriented Classifications; Thres: Threshold

For component 1 (rapid detection of changes), and within the potential approaches which had shown a technical capacity to meet the requirements, the single date supervised classification from satellite images has been selected. Even if the results do not seem to show a significant contribution, the integration of the multi-temporality can improve the results at a regional level (due to the use of data with better spatial resolution than the Landsat data). The use of the multi-temporal data is therefore integrated in order to be evaluated during Mission 6.

Component 2 (identification of specific classes) has enable us to identify satellite databases in supplement to the aerial photography, facilitating then the API work. The Mission 4 tests have shown the contribution of the RapidEye data in coloured composite to new spectral information. Furthermore, the tests have demonstrated the interest of the multi-temporal data in accessing the phenological information. Thus, this data, if integrated in the production, have presented a real interest, achieving a high level of thematic precision and saving production time on some of the themes.

With components 3 (the intra class evolution within specific habitat classes) and 4 (the automated mapping of specific classes), the object oriented classification method from aerial photography has been selected for its excellent ability to detect rapidly the habitats with high contrast. During Mission 4, the tests have been conducted over the scrub on grasslands and vegetated shingle classes, but eventually, this method could be extended to other habitat classes with high contrast (see global segmentation of habitats).

Moreover - as we will see it in more details further in the report - the last evolutions in the development of Pleiades data satellites (in particular in relation to the affordable cost) leads us to integrate the VHR satellite, when for the components 3 and 4 this one was dismissed because of its cost and the agility of the actual satellites, (and in general for map updating). The arrival of new satellites Pleiades type leads us to look for new options.

Mission 5, objectives and implications

The Mission 5 objectives are, on one hand, to establish the operational feasibility of the potential solutions selected at the end of Mission 4 and, on the other hand, to establish a scenario, in the format of a brief which could be used for a future habitat map updating.

Indeed, in Mission 5, the potential solutions supporting the habitat map updating which were selected at the end of the previous mission, are being assessed within an operational feasibility study. The analysis carried out is based on operational variables (such as data, processing effort, expertise, etc…) and will enable us to target the viable options which meet the requirements. If need be, the selected solutions will be able to integrate a scenario and a brief to support the ARCH habitats map updating, compatible with the cross-border map and the fragmentation methodology. The cross-border workshop organized on 15th may 2012 enabled the selection of the elements of this scenario.

Then, Mission 6 will experiment this scenario within an operational context on test areas in the NPdC and Kent. It will enable the evaluation of the added value in using spatial remote sensing in comparison with the actual methods. Finally, Mission 7 will focus on the dissemination of the results.

1. Mission 5 Approach and development

1.1. Mission 5 organisation and development

In order to meet the objectives previously presented, Mission 5 has been organised as follow:

(a) Analysis of the operational feasibility for each technical solutions, individually considered and selected at the end of Mission 4
(b) Analysis of the operational feasibility of the technical solutions, considered all together and integrated in the map updating process
(c) A cross-border workshop in order to discuss and establish the directions of the scenario for map updating
(d) Setting a scenario/brief for a general map updating integrating the selected remote sensing solutions (viable technically and operationally)

1.2. Analysis and criteria

The operational feasibility analysis is based on a set of key "operational" variables, such as:

- Data:
  - Availability (actual/future)
  - Continuity
  - Conditions of access
  - Data cost
  - Mutual programme
  - Licence
  - Data periodicity
- Processing effort (staff-mth):
  - Pre-processing (preparation)
  - Information retrieval
- Level of expertise :
  - Image processing
- Total duration

The selection of the approach is made by evaluating these variables according to the feasibility criteria.
Specific thresholds do not exist for each of these variables as the institutional context is different depending on the region, and furthermore the context will evolve more or less rapidly in the future. It is precisely the global information discussed with the partners, enabling the selection of the solutions, which could operational. However, some criteria can be eliminatory, such as for example too high costs.

The analysis of the above variables needs a detailed knowledge of remote sensing data and information retrieval methods to be used, in particular within a context of operational usage.
The Mission 3 and 4 reports cover theses aspects from a technical point of view. For the databases and information retrieval methods selected during the technical evaluation (Mission4), both following sections cover synthetically their operational aspects. The details for each sensor and each information retrieval method can be found in the appendix.

1.3. The data

This section and the respective appendix 1 gather the operational characteristics of the selected satellite data. The sensors are proposed on the basis of the mission 3 and 4 results (ref relevant reports). All the families of sensors are not presented; the list is not exhaustive but targets the requirements resulting from the previous methods. Therefore, the information collected will enable us to meet the analysis and elimination criteria selected.

Within the VHR platforms selected:

- The **Pleiades** satellites which, very soon, will enable the coverage of territories at regional scale (implying a temporal coherence) with a similar spatial resolution to the AP (50 m) and, for a very competitive cost (however, pricing is not yet definitive)

- The **WorldView-2** which, beyond the excellent spatial resolution (50 m, equivalent to the AP), offers supplementary spectral bands, similar to the RedEdge band for example, less present with the actual satellites. The cost is very high and the agility of the satellite is limited.

- The **QuickBird-2** satellite, launched before WorldView, always offers VHR images and has very similar characteristics to its predecessor

- The **RapidEye** satellites which, due to its constellation of 5 satellites, offers a coverage of vast territories with a spatial resolution and an interesting periodicity (respectively 5 meters and potentially 1 day). Furthermore, the prices are very competitive. As it has been mentioned in the previous reports, a mutual programme exists in France (GEOSUD) and proposes RapidEye data over the whole French territory on an annual basis and free of charge for public bodies

- The **GeoEye-1** satellite offers as well VHR images with a spatial resolution equivalent to the AP (50m) with prices more interesting than for the Worldview-2 satellite. The spatial resolution is not as good

- The **Ikonos** satellite, which is the previous GeoEye satellite, offers not such good characteristics but the costs are slightly lower

- The **DMC NigeriaSat-2** which offers VHR image with a spatial resolution not as good as the satellites WorldView or GeoEye **(**5 meters) but which offers much more interesting swath (80 km against 10/15 km for the other satellites) enabling the potential acquisition of images on a wider scale

- The **IRS-P6 Resourcesat-1/2 (LISS-IV sensor)** satellite offers a resolution equivalent to RapidEye or DMC (5 meters) but the images are only accessible on archive images

- Le satellite **IRS-P6 Resourcesat-1/2 (capteur LISS-III)** qui propose des données à large échelle et notamment l'information spectrale MIR. Les tarifs appliqués sont compétitifs mais les données sont uniquement accessibles en archive.
- The **Landsat LDCM** satellite which will take over the Landsat-5/7 mission will always offer data at 30 meters with an interesting spectral resolution (from visible to MIR). The data will be accessible free of charge but only accessible from archive data

1.4. The information retrieval methods

As previously, this section and the respective appendix 2 gather the operational characteristics of data retrieval and, are proposed on the basis of mission 3 and 4 results in order to meet the analysis criteria previously selected.

The Mission 5 information retrieval methods are:

- The Photo-Interpretation
- The per pixel supervised classification
- The object oriented classification

1.5. The individual products

It is necessary to define a « product » for each individual solution identified in the previous missions which could be used to support the map updating. The tale below shows the scopes used for the specifications of these products. These specifications will enable us then to select only the feasibility options able to meet these specifications. Indeed, the specifications enable us to target a set of satellites and to exclude others based on spatial resolution, potential availability etc...

Table 2 : specification table types

Product	Products properties	Specifications
Product x	Type of image	
	Minimal unit mapped/ spatial resolution	
	Geometrical precision	
	Image acquisition	
	Geographical area	
	Coordinate system	
	Retrieval method	
	Legend	
	Thematic precision	

The full list of individual products (and of the associated component) is as follow:

- Layer of potential habitat changes (Component 1)
- Red-Edge layer (Component 2)
- Infrared layer (Component 2)
- Multi temporal layer (Component 2)
- Evolution of scrub on grasslands (Component 3)
- Map of Ambleteuse swards (Component 4)

- Map of vegetated shingle (Component 4)

2. Operational feasibility analysis – Individual services

The objective here is first to propose and analyse individually different feasibility options within each of the individual products resulting from all 4 components. These feasibility options will be proposed based on the previous section and in particular differ from one to the other, depending on the component, the sensor considered or the method proposed. Thus, in general, for the components 1 and 2, the feasibility options will diverge depending on the considered sensor, when for the components 3 and 4 it is the information retrieval method which will differ.

The analysis of the options is based then on operational variables, presented previously and which will enable us to target the ideal option in order to operationally meet the demand.

2.1. Layer of potential habitat changes (Component 1)

As a reminder, the objective of the component 1 is to investigate the different possibilities providing a map of “hot spots” of potential habitat changes over the area of study including the Nord-Pas de Calais and Kent regions, that is, to provide a layer of information enabling us to focus the API process directly on the polygons for which a potential habitat change is detected.

From the required specifications within the product framework « layer of potential habitat changes” diverge with the considered sensor. Given the constraint in relation to the family of satellites, that is VHR/HR presenting a spatial resolution of 5 to 10 metres, 4 platforms have been selected: Sentinel-2, SPOT-5, SPOT-6/7 and RapidEye. Based on the product definition and the associated specifications, the other satellites presented previously have been dismissed. For example, the IRS Resourcesat LISSIV satellite does not enable the coverage of the whole region of study with the available archive images.

The future arrival of the Sentinel-2 (2013) is determinant. The GMES programme will (the final policy is not yet finalized), include a free of charge policy of the data (« Full And Open Access ») for public bodies. Moreover, the satellite characteristics should be able to reduce the processing effort. Indeed, a single satellite passage is necessary to cover the whole region. Furthermore, the free access to the data enables us to envisage the acquisition of complete coverage several times over one year in order to embed the multi-temporal aspect into the method. This is possible because of the periodicity of the data.

The SPOT-6/7 data which will be available by 2013-2014, at the end of the SPOT-5 mission, will not be operational. Indeed, even if the prices are not known yet, the pictures will probably be more expensive than the SPOT-5 pictures.

In the end, the ideal recommended data is the Sentinel-2 data. Within the framework of mission 6 and the achievement of the tests over a demo area, the RapidEye data is recommended.

It should be noted that the level of image processing expertise reflects the additional expertise in relation to the retrieval method. It adds itself to the thematic expertise which stays, whatever the retrieval method, API or automated classification.

2.2. Red-Edge layer (Component 2)

As a reminder the component 2 objective is to identify how the remote sensing can contribute to the detection/mapping of specific classes.

The feasibility options analysed within the « RedEdge layer » diverge again with the sensor considered. Only 3 satellite sensors offer the spectral information RedEdge.

Indeed, two families of sensors integrate potentially the spectral information RedEdge: the aerial imagery and the satellite imagery. Concerning the aerial imagery, the RedEdge information is accessible with the hyper spectral sensors. For example, the sensor from the NASA: AVIRIS or Hymap. However, because high cost for the small areas covered, we are not able to extend the exploitation of these sensors beyond the remit of this study (ref mission 3 report).

As regards to the satellites, we can find the hyper spectral sensors and the multi spectral sensors. Within the hyper spectral sensors, for example, there is the American satellite EO-1 Hyperion (NASA) launched on 21 November 2000 and offering a swath of 14 km, a revisit of 7 days and a spatial resolution of 30 meters. Within the European satellites, we can find Proba CHRIS (ESA) launched on 22 October 2001 offering a swath of 14km, a revisit of 7 days and a spatial resolution of 18 meters.

These hyper spectral satellite sensors offer a low spatial resolution and a limited geographical coverage (figure 1). They do not suit the ARCH objectives (ref. mission 3 report). At the moment, the multi spectral satellites are therefore the most operational sensors.

Today, the only data operationally viable is the RapidEye data. The cost of the VHR WorldView-2 images is outrageously expensive. With the GEOSUD programme, an annual coverage is possible in NPdC for the next 5 years. The Kent coverage can be done a low cost.

Again, the impending arrival of Sentinel-2 let us to foresee some excellent prospective as regards to the usage of the data for the integration of the Red-Edge data in the API method. With the GMES programme, a complete coverage will be possible free of charge. The spatial resolution is however not as good (20meters) as the RapidEye data (6,5 meters).

Whatever the data is, there is no processing effort as it is an additional layer which is added to the aerial photography during the API work. Consequently, no expertise in image processing is required.

In the end, the Sentinel-2 data is, as for component 1, recommended for this product. Within the framework of mission 6 and the achievement of the tests on a demo area, the RapidEye data is recommended.

2.3. Mid Infrared layer (Component 2)

If the mission 4 tests have demonstrated the contribution of the RapidEye data in colour composites Red-Edge as new spectral information, the component 2 can however easily be extended to other spectral bands such as the Mid Infrared. Such data, if integrated in the production at the same level as the Red-Edge information, can bring a real contribution to the foliar humidity which should achieve a high thematic precision and a save production time. The possibilities to obtain such information by actual VHR/HR satellites have therefore been investigated.

Since the component 2 target is to propose supplementary data in support of the API update, the feasibility options of the « MIR layer » diverge again depending on the sensor considered. The 4 satellites offering the spectral information MIR are as follow: SPOT-5, Sentinel-2, IRS LISS-III and LANDSAT LDCM.

Indeed, as for the Red-Edge spectral information, the MIR is accessible also on airborne sensors AVIRIS type and the hyper spectral sensors type Hyperion. Again, the use of such sensors is not operational and the only viable platforms are still the multi spectral sensors.

Today, the only multi spectral satellites offering images including the Mid Infrared on the embedded sensors are SPOT-5, Landsat 5-TM and 7-ETM+ and IRS LISS-III (ref. section). If the Landsat and IRS satellites offer a too low spatial resolution (respectively 30 and 70 meters) to be operational, the SPOT-5 satellite offers interesting characteristics. However, the SPOT data is not operationally viable in terms of costs which are still high. Furthermore, the mission is ending.

In the future, the Sentinel-2 and Landsat LDCM satellites will offer the spectral band MIR enabling then the integration of the spectral information within in the API method. With the GMES programme, a complete and free coverage will be possible via Sentinel-2. The access policy to the data such as it is thought today by the NASA will enable the free acquisition of the Landsat LD/CM data. However, the spatial resolution is not as good as the Landsat data (30 vs 20 meters) and they will only be accessible with archive data: no programming will be possible.

In the end, the Sentinel-2 data is again the ideal data. Within the framework of mission 6 and the achievement of the tests on a demo area, the SPOT-5 data is recommended (free data acquired for the NPdC vial the ASP).

2.4. Multi-temporal layer (Component 2)

The different studies carried out by SIRS, whether on the mission 4 of the ARCH project or on other projects, have enable us to define an optimal configuration of the multi-temporality integrated to API. Thus, in supplement to the orthography (centimetric spatial resolution) of which shooting date is situated during the summer, the SIRS expertise recommends the use of two supplementary dates, one in the winter time (February/March), and another one in spring time (April/May). The ideal configuration requires that those two dates come from VHR satellite data of spatial metric resolution (up to 5 meters). However, one of the VHR can be replaced by a HR resolution (maximal resolution of 20 meters). A multiwindow display during the API is therefore ideal. This configuration enables the access to the phenological information of vegetal communities. The multi-temporality is therefore enabled with the use of the satellite data.

Within the VHR/HR satellites offering a spatial resolution of 20 meters minimum and enabling the acquisition of data at a regional scale over several dates, 4 sensors have been selected, that is RapidEye, SPOT-6/7, Sentinel-2 et DMCii.

Today, the only operationally viable data is the RapidEye data. Due to the GEOSUD programme, an annual coverage is possible in NPdC for the next 5 years. As regards to the coverage in Kent, this can be done at low cost. The British satellite DMCii is considered as well, despite a limited spatial resolution, the acquisition costs for a regional coverage are very low

The ideal data is again from the Sentinel-2 satellite. To a lesser extend, the RapidEye data is potentially viable. During the mission 6 test, the RapidEye and SPOT-5 data (acquired vial the ASP for the NPdC) could be used.

2.5. Scrub on grasslands (Component 3)

As a reminder, the objective of component 3 is to identify how the remote sensing can support the detection/mapping of specific information in order to qualify the trends within a habitat class. The thematic of scrub encroachments on grasslands was then identified. The objective is to assess the evolution of scrubs on grasslands.

The feasibility options differ then depending on the retrieval method used. Here are proposed the API methods and object oriented classification. Therefore, the difference is made on the processing effort. For this product, the object oriented classification enables production time to be saved and a better precision gained in comparison with the API (several people/day vs several people/month). In return, the level of expertise required for processing the images is higher. The object oriented method is however chosen for the continuation of the activity.

During mission 4, the tests have been carried out on the scrub on grasslands theme, but at terms this method can be considered for an extension of the approach to other habitats. The contribution of the object oriented classification on these new products is however to be determine and to be proven.

2.6. Ambleteuse swards (Component 4)

The component 4 objective is to investigate the existence of analysis methods of aerial photography or of VHR data faster than the actual API. The cartography of scrub on the Ambleteuse swards has been therefore suggested by the CRNPdC. The component 4 objective is to investigate the existence of analysis methods of aerial photography or of VHR data faster than the actual API. The cartography of scrub on the Ambleteuse swards has been therefore suggested by the CRNPdC.

The suggested feasibility options are: the object oriented classification and the API which is the actual mapping method used for these habitats (activity 1) which forms the comparison basis.

Thus, in the product framework « Ambleteuse swards », the object oriented classification does not contribute to save production time. Indeed, the Ambleteuse swards thematic is too targeted (area of 75 ha). Despite a better precision level in comparison to the API method, this method is not selected and the actual API is recommended. Furthermore, the level of expertise required for processing the images is higher with object classification.

2.7. Vegetated shingles (Component 4)

The component 4 has as well investigated the existence of analysis methods (aerial photography or VHR data) for the vegetated shingles thematic in Dungeness in Kent.

The feasibility options suggested are the same as previously, that is: API and object oriented classification.

In the framework of the product « vegetated shingles » the object oriented classification enables a substantial timesaving. Indeed, on such area, the API processing effort requires several people per month, and for the object oriented classification this effort requires several people per day.

In the end, for such specific habitats with high contrast, over large areas and with several shapes, the method is recommended. The timesaving counterbalances the level of expertise required for the image processing.

2.8. Conclusion

The solutions selected at the end of the a of the individual products

Table 3: feasibility options for the product "Vegetated shingles"

	Nord-Pas de Calais			Kent		
	Data	**Effort**	**Duration**	**Data**	**Effort**	**Duration**
Comp. 1 – Detection of changes	Free Sentinel-2	3 people/mth	2 months	Free : Sentinel-2	1 pers/mth	2 months
Comp. 2 – Identification Specific classes	Free Sentinel-2	~ people/day	~ days	Free Sentinel-2	~ people/day	~ days
Comp. 3 – Intra-class evolution	No additional cost	~ people/days (object class)	~ days	No additional cost	~ people/days (object class)	~ days
Comp. 4 – Auto. map	No additional cost	~ people/day (API)	~ days	No additional cost	~ people/days (object class)	~ days

3. Analysis of the operational feasibility – global map updating

The following phase considers the integration of these individual products within the global map updating process and to see:

- On one hand, which benefit we can gain in grouping/sharing the products and,
- On the other hand, which benefits we can gain in relation to their contribution for a global update of the ARCH habitat map by API

Before going into this second phase, it is necessary to review the recent progress in VHR satellite imagery, especially with the French satellites Pleiades, which enable today or in a close future, the integration of the VHR satellite data, whether it is for the achievement of natural habitats map or its update.

The solutions selected at the end of the products analysis are now integrated in the global update process of the habitat map by API. The objective is to inform and to assess the potential contribution of each service integrated to the map updating process (first estimate of an added value before the demo tests in real situation):

Table 4: synthesis of the feasibility operational analysis for a global mapping update

	Nord-Pas de Calais			Kent		
	Data	Effort	Duration	Data	Effort	Duration
CAPI-API	270 000 € (HT)	18 people/mth	6 months	N/A	31 people/mth	8 à 31 months
CAPI– VHR Pléiades	130 000 à 220 000 €	18 people/mth	6 months	35 000 £ à 60 000 £	31 people/mth	8 à 31 months
Comp. 1 – changes detection	Free	• +3 people/ mth • Tot. Ef Update: ≈	↘ Total Duration	Free	• +1 p-m • Tot. Ef Update: ≈	↘ Total Duration
Comp. 2 – Identification Specific classes	Free	• + p-day • Tot. Ef Update: ≈	↘ Total Duration	Free	• + p-day • Tot. Ef Update: ≈	↘ Total Duration
Comp. 3 – Intra-class evolution	No additional cost	• + p-day • Tot. Ef Update: ≈	N/A	No additional cost	• + p-day • Tot. Ef • Update: ≈	N/A
Comp. 4 – Auto. Map	No additional cost	• + p-day • Tot. Ef Update: ≈	↘ Total Duration	No additional cost	• + p-day • Tot. Ef Update: ≈	↘ Total Duration

Products sharing

Following the conclusions of the individual products analysis, we notice that data sharing is possible for the components 1 and 2. Indeed, they both rest on the Sentinel-2 data which enables the access to the Red-Edge, MIR spectral information, to the MT information and to the implementation of the layer of potential habitat changes. In terms of data, these two components do not imply extra costs.
As well as sharing the data used for API (whether it is the AP or the VHR satellite) the implementation of the components 3 and 4 is considered. In terms of data, these two components do not imply extra costs.

Contribution of the components for a global update of the ARCH habitat map

The component 1 enables the identification of the areas of potential habitat changes. If the creation of the layer of potential habitat changes implies an extra processing effort, from 3 people per month in NPdC and 1 person per month in Kent, the use of the layer, which allows to work only on areas identified as potential habitat changes, contributes to reduce the total duration of the mapping update (in the end to an equivalent staffing, although the detailed evaluation depends of course of the level of changes in the field).

The component 2 implies to apply the classic API method in order to identify the changes and to map them. However, this API method is assisted by extra information layers (Re-Edge, MIR and Multi-temporal). The contribution of this supplementary data enables the reduction of the total duration of the mapping update. Indeed, this data enables a faster interpretation of the habitats due to the comfort of the work, the improved contrasts, and the thematic contribution of this data. It needs however a slight extra processing effort in order to be integrated within the process.

The component 3, whether in Kent or in NPdC, on specific and targeted classes (which can be other than the sole scrub on grasslands), implies a supplementary processing effort (a few people per day). However, this component is not entirely within the framework of the habitat map updating since we are looking to detect intra-class information. Therefore the method developed does not enable the reduction of the effort and duration of the mapping update without increasing the total number of staff. Moreover, it does not imply extra cost in terms of data since the object oriented classification is implemented on the data used during the map updating (whether it is the AP or VHR).

The component 4 enables the automation of the mapping of habitat specific classes. Initially tested and validated on the vegetated shingles, this component is, at terms, transferable to all habitats with high contrast. Then production time can be saved and therefore the total duration of the map updating is reduced without extra data cost since the acquired image for the update is used in this approach. It implies however extra effort of a few people per day.

4. Update scenario / « Brief »

The objective is now to suggest a scenario, or a brief, which includes a general approach for the habitat mapping update and not just individual methods on specific themes. This scenario should be able to reduce to the minimum the necessary API for the update by integrating the supporting elements identified in Missions 4 and 5 (all 4 components). Furthermore, the scenario will incorporate supplementary approaches which will enable us to benefit totally from the satellite data which should be available soon.

As the products related to component 3 refer to the evolution within one class, we will define two services:

(a) A global map updating supported by spatial remote sensing
(b) An evaluation of the scrub encroachments evolution

4.1. Global map updating supported by spatial remote sensing

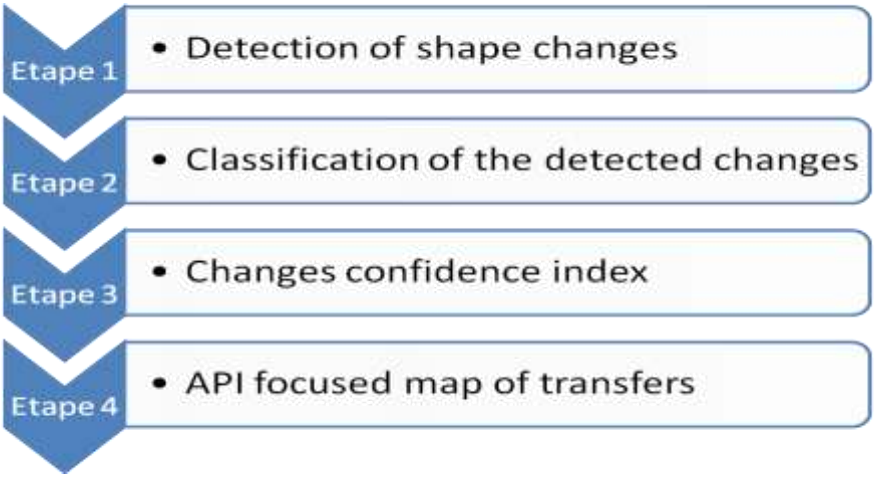
4.1.1. Definition of the expected product

Below, the definition of the expected product in this first service:

Tableau 5 : Natural habitats mapping update service specification

Product	Product Properties	Specifications
Natural Habitat Map Updating	UMC / Spatial resolution	< 100 m²
	Geometric precision	2 m
	Coordinates systems	National System
	Geographical area	Regional (Kent / NPdC)
	Legend	ARCH cross—border classification
	Thematic Precision	> 85%

4.1.2. Methodology (four phases)



In this scenario, the database is the aerial photography and/or the VHR satellite data over the whole area to be mapped.

The cross-border ARCH classification (classification based on the « common classification », (ref activity 1 of the project) will be used in order to ensure the compatibility of the methods on both territories. This classification will be adapted over the first three phases in order to optimise the results. Thus, some classes will be grouped, groupings realised according to the spectral similarity of the habitats.

Phase 1. Detection of the shapes changes

The detection of the shape changes aims to detect the potential changes and to update the objects outlines of the database.
The update is achieved by independent segmentation of the tiles and tiles fragments from the 2005 ARCH database to update.
This phase derives from the results of the previous missions (component 3 and 4), the implementation of changes detecting tools and of the object oriented.

Phase 2. Changes typifying

When the Phase 1 identified only the shape changes (potential changes), the Phase 2 concerns the classification of these changes in terms of changes types (transfer from one class to another one).
Highlighted by the targeted data during Mission 5, (that is the VHR satellite imagery of spatial resolution less than 5 meters over several dates), the phenological monitoring was achieved in order to characterise the potential changes.

Phase 3. Changes confidence index

This phase will qualify the level of confidence of the changes maps obtained and their types.

The method adopted previously in Mission 4 within component 1 suggested a binary index (in 2 classes: “change” and “no change”) to detect rapidly the land cover changes. The concept is here extended to provide a confidence index (or uncertainty) in relation to the detected changes and their types, which will enable the user to prioritise the changes areas on which to focus depending on the confidence level of their detection. The achievement of a binary map is however achievable according the same threshold system presented in component 1. The confidence map contributes to a better reading to the changes map.

Phase 4. Mapping focused on the habitat changes by API

Based on the products issued from the phases 2 and 3, the operator will apply a classic API on the areas of potential habitat changes detected in order to validate or not these changes. This API is assisted by supplementary information layer defined below (and as identified during component 2):

→ Red-Edge
→ MIR
→ Multi-temporal

4.1. Evolution of scrub encroachments

4.1.1. Definition of the expected product

The objective is to obtain an estimate of the trend on scrub encroachments (%) between two considered dates. As today, the only class on which this information is created is “grasslands”. In this scenario, the database is the aerial photography.

Tableau 6 : scrub encroachments service specification

Product	Product Properties	Specifications
Scrub on grasslands	Image type	Aerial/ Optic VHR
	UMC / Spatial resolution	≤ 100 m²
	Geometric precision	2 m
	Image acquisition	1 coverage
	Coordinates system	National
	Geographical area	Regional (Kent/NPdC)
	Data retrieval method	Classification objet
	Legend	Scrub and grasslands
	Thematic precision	≥ 85%

4.1.2. Methodology

On the areas identified as potential habitat changes (see above), and within which the supervised classes for the scrub encroachments, the approach “automated mapping on high contrast class” over the two dates in between which the evolution has to be assessed.

The calculation of the trend is made by the report of the total surface area of scrub encroachments between the two dates.

Sur les zones identifiées comme mutation potentielle d'habitat (voir plus haut), et au sein de celles-ci pour les classes surveillées pour l'embroussaillement, on applique l'approche « cartographie automatisée sur classe à grand contraste » sur les deux dates entre lesquelles l'évolution est à évaluer.

Le calcul de la tendance se fait en faisant le rapport de la superficie totale d'embroussaillement entre les deux dates.

Conclusion

In Mission 6, the scenario will be tested in operational mode on the demo areas, one in Kent and the other one in Nord-Pas de Calais. This operational test will enable us to evaluate the added value of the proposed scenario by comparing the test results with those of the "standard" update approach by API
Following the operational feasibility analysis achieved in Mission 5, this data has been selected and targeted. It is composed of colour and/or infrared aerial photography providing a sharp spatial resolution, and temporal series RapidEye and SPOT allowing a monitoring of the phenologic cycle of entities in order to better characterise them.

At the end of this Mission 5, we have then a potential scenario of integration of remote sensing in the habitats mapping update process.
This operational test will give the opportunity to assess the accuracy of the product obtained as the phases go along, and the added value (technical/thematically and operational) of the proposed scenario by comparing the test results with the "standard" mapping update by API.