ARCH Interreg Project

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

LOT N°2

STUDY INTO THE POTENTIAL OF NEW REMOTE SENSING TECHNOLOGIES FOR MONITORING NATURAL HABITATS AND BIODIVERSITY IN THE NORD-PAS DE CALAIS AND KENT CROSS-BORDER REGIONS

Mission 4 report
« Sampling of pertinent technologies and related services »

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- Partners:

Comité de pilotage ARCH		
Country	**Organisation**	
France	Mrs Cécile LECLAIRE	Conseil régional Nord Pas de Calais Direction de l'Environnement
United Kingdom	Mrs Laurence GUEDON	Kent County Council ARCH Planning & Natural Environment

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

Partners	
Country	**Organisation**
France	EURISY

- Document

	Contractors	Names	Date
Authors	SIRS	Sébastien Delbour	2012/11/12
Contributions	SIRS		
Proof-reading	SIRS	Pascal Versmessen	2012/11/12
Validation	SIRS		

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Abbreviations list

ARCH	Assessing Regional Changes to Habitats
ASP	Agence de Services et de Paiement
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 (Information spatiale et Développement Durable)
GMES	Global Monitoring for Environment and Security (Programme européen de surveillance de la Terre)
HR	High Resolution
KCC	Kent County Council
LUCAS	Land Use/Cover Area frame Statistical survey
MIR	Mid 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	Arial Photography
API	Arial Photography Interpretation
RE	Red-Edge
RGF	Réseau Géodésique Français
GIS	Geographic Information System
SIRS	Systèmes d'Information à Référence Spatiale
VHR	Very High Resolution
IP	Image Processing
MUM	Minimal Unit Mapped
XS	Multi-Spectral

Introduction

At the end of the first three missions, the idea of a complete ARCH map update from a single remote sensing package has been abandoned. However, the remote sensing and the associated technologies/methodologies enable us to envisage potential solutions in order to support the habitats map (and its update) on themes or specific elements.

Thus, four specific components have been agreed 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

These components' objectives in the framework of mission 4 are to test the potential solutions within each of components, to study their technical feasibility, and to keep those able to technically answer to the demand. The operational feasibility of these potential solutions will be studied (mission 5) and scenarios of "updates" for the ARCH habitats will be established for the selected solutions.

This document summarises this mission 4 report which approach successively:

- general considerations on potential solutions (the criteria which have enabled the selection of the most pertinent and most judicious solutions for each "update" components, the different approaches and the different data families),
- the considerations on the analytical framework (availability and data acquisition and evaluation criteria of potential solutions)
- the results for each component, as well as the conclusions agreed in consensus during the cross-border workshop on 20 January 2012.

1. Potential solutions

1.1. Definition and selection criteria

A potential solution includes one type of remote sensing data (sensors used) and one method or approach for extracting the information at the start of the data, so that both of these components have the quality and characteristics necessary to provide the information needed.

Within the families of sensors, we find typically: the aerial photography, the satellite imagery such as the Very High Resolution (VHR), the High Resolution (HR), the Medium Resolution (MR), the Low Resolution (LR), the LIDAR and the RADAR. The pertinence of each of these families will be explored in line with the expected demands.

Whichever sensor is chosen for the analysis, the image processing can be carried out to extract the useful information from the data. In particular, in our case, this information corresponds to the homogeneous classes from the natural habitat and biodiversity. As today, two operational methods enable us to segment the satellite images, such as the CAPI and the automated classification methods, within which we find the unsupervised, supervised or object orientated classifications. Paired with field surveys and external data, they enable, for example, the mapping of habitats.

The selection of potential solutions criteria is therefore envisaged depending on the approaches for the information extraction and the sensors used. The criteria selected are as follow:

- The Development and Maturity Phase of the envisaged approach
- The Technical Transferability and the adaptability of the approach to the ARCH context:
- The level of uncertainty
- The availability of the data

1.2. Thematic approach

If not using a quantitative approach (only based on radiometry – per pixel comparison), by lack of coherence between the images, a thematic approach is adopted. This is working with the themes that can be compared between two images within time and within space. The diverse thematic approaches selected are:

- the per-pixel unsupervised automated classification (pixel grouped in “classes” on the basis of their spectral signature)
- The per-pixel automated supervised classification (a set of training data needs to be defined and put in place on which the algorithm will be based to order the pixels)
- The object orientated classification (algorithm taking into account the shape and texture of the object in complement to the spectral information, method which can be exploited only on a reduced classification)
- The threshold method, spectral bands or neo-channels (per pixel classification method unidimensional parallepipedic”
- The Numerical Ground Model analysis (especially indicated for the identification of dune slacks)
- The Photo Interpretation (logical approach based on a visual analysis of images

These thematic approaches are exploited according the needs expressed in each component.

1.3. Considerations on the data families

The aerial data, the Very High Resolution (VHR) and High Resolution (HR) satellite images propose the best spatial resolutions in order to meet the objectives of the identified components (resolution inferior to 20 meters). However, on the basis of the criteria discussed previously and on the basis of the mission 3 conclusions, these data cannot be considered as pertinent for each of the components and an evaluation of each of them has been necessary.

Indeed, in reality, the very fine spatial resolution of VHR and aerial data imply a too big spectral heterogeneity within an existing class or polygon. These databases are not adapted for the automated detection methods based on spectral response.

1.4. Synthesis

In summary, the approaches and following data have been selected for the test:

	Databases						Methods				
	AP	VHR	HR	MT	RE	LI	PI	Seg	Classif Pix	Classif Obj	Thre
Component 1 : rapid detection of changes											
Changes raster layer			✓	✓					✓	✓	
Vector layer of potential changes			✓	✓					✓	✓	
Component 2 : specific classes identification											
Additional spectral data: Red-Edge			✓		✓		✓				
Information on the phenology: multi-temporal databases			✓	✓			✓				
Slacks						✓		✓			
Component 3 : Evolution within a specific habitat class											
Scrub on grassland	✓	✓								✓	✓
Slacks						✓					✓
Component 4 : Automated cartography of specific classes											
Vegetated shingles	✓	✓								✓	✓
Ambleteuse swards	✓									✓	

Table 1: synthesis of selected solutions

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

2. Analytical framework

2.1. The data

Within the framework of mission 4 the idea was carry out the tests using data free of charge. Within the framework of mission 4, the geographical coverage was to be as exhaustive as possible (especially in the view of the detection of the potential habitat transfers at a regional scale).
However some tests have not been carried out due to the length of time and the difficulties encountered in acquiring the data due to the administrative procedures and the slowness of its delivery. The following table specifies the data used:

	Résolution spatiale	Nombre de bandes	Couverture	Année	Multi-temporalité	Correction radiométrique	Correction géométrique	Fournisseur	Délai d'acquisition	Composante
Landsat	30 m	7	**NPdC et Kent**	**2005 et 2009**	Oui	Non	Oui	**USGS**	**0**	**1**
SPOT	10 à 20 m	3	**NPdC**	**2009**	Oui	?	Oui	**ASP**	**3 mois 1/2**	**1 et 2**
	10 m	4		**2005**	Non	Non	Non	**GEOSUD**	**1 mois 1/2**	
RapidEye	5 m	5	**NPdC**	**2010**	Non	Non	Oui	**GEOSUD**	**1 mois 1/2**	**1 et 2**
Ikonos*	4 m XS 1 m PAN	4+1	**Kent**	**2009**	Non	Oui	Oui	**E-geos**	**1 mois**	**3**
GeoEye*	2 m XS 0,50 m PAN	4+1	**Kent**	**2011**	Non	Oui	Oui	**E-geos**	**1 mois**	**3**
LIDAR	1 m		**Nord**	**2010**	Non	Oui	Oui	**Conseil Général 59**	**4 mois**	**3**
Imagerie aérienne	20 cm à 1 m	3	**NPdC**	**2005 et 2009**	Non	Oui	Oui	**NPdC et ASP**	**0**	**3 et 4**
	20 cm	3	**Kent**	**1999 et 2008**	Non	Non	Oui	**KCC**	**0**	**3 et 4**

Table 2: data used

2.2. The evaluation criteria

In order to make a judgment on the pertinence of the potential solutions kept for each component, it is necessary to define a list of the assessment criteria in order to assess the results for each test.

Two types of criteria have been used:

- The quantitative criteria: choice of the error matrix to check the potential changes observed and the global concordance percentage to verify the mapped objects. The reference/comparison data is derived, either from the ARCH habitats map, or from the photo-interpretation realised for the test

- The qualitative criteria: choice of the purely visual criteria and related to the conclusions of the photo-interpretation teams at the end of the test phases

3. Component 1 - results

3.1. General approach

In summary, the component 1 objective – the rapid identification of changes – is to investigate the different options in order to provide a « hot spot map » of changes, which will be used to guide the investigations (API or field survey). Concretely, it is a vector layer of the natural habitats potential changes.

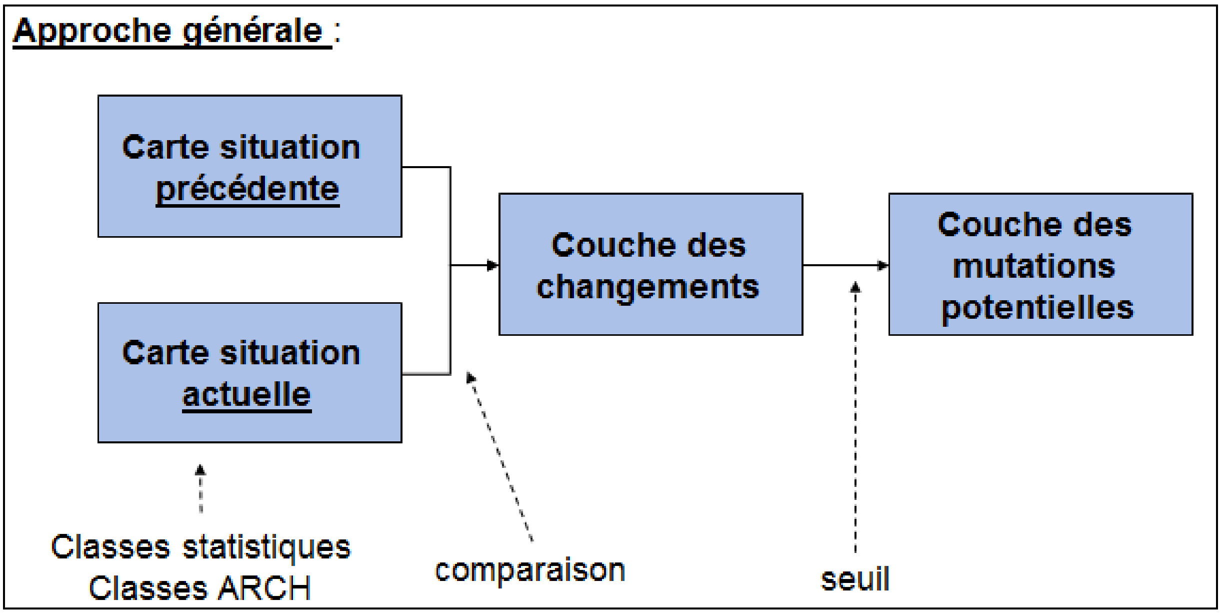


Figure 1: component 1 – general approach

The classes constituting the current and previous databases can be derived from semi-automated information extraction methodologies (statistical classification) or from the ARCH classification outcome of the activity 1 AP.
Moreover, we will see later that the intermediate product enabling the creation the vector layer, the raster layer of changes, presents a potential interest. This raster layer of changes is presented in two distinctive shapes according to the approaches envisaged. Regarding the unsupervised classification approaches (single date and multi-date) which are constituted of classes based only on radiometry, the radiometric classes are compared. The result is then a raster layer of changes of radiometric class. For the other approaches (regeneration, supervised and object), the pixels are allocated to predefined thematic classes. Thematic classes are compared. The result is therefore a thematic raster layer of changes.

We need to specify that the choice was to work on a simplified classification constituted of 12 major natural habitat families, in order to obtain viable results.

3.2. The unsupervised classification

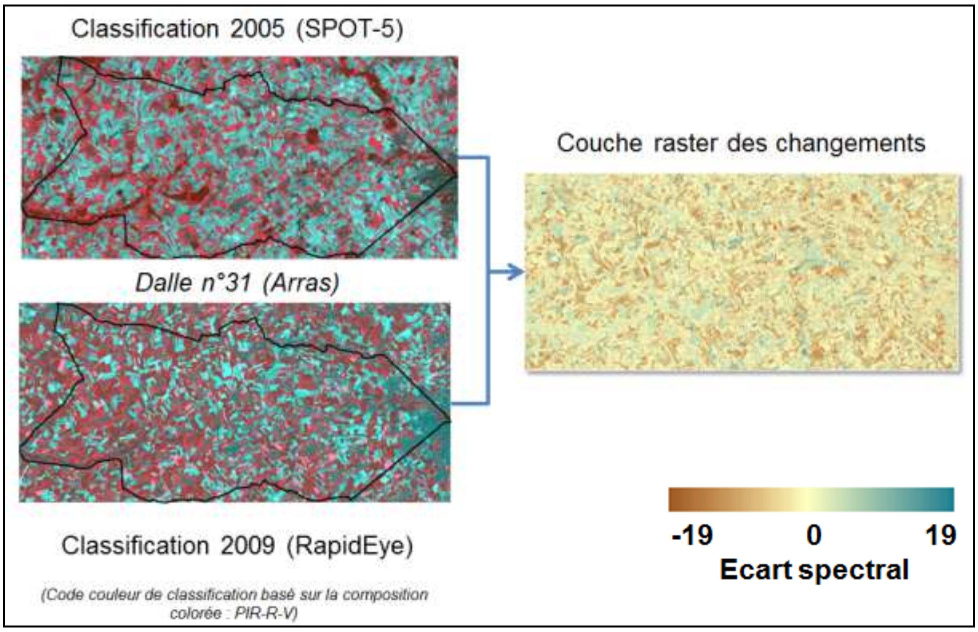


Figure 1 : unsupervised classification - setting of the raster layer of changes

Bigger the spectral distance is (in absolute value- pixels aiming to the blue or the brown colour) bigger the classes difference is between the two dates for the same pixel. In other words, there is a radiometric change between the two dates, and a potential change.

the transfer of the raster layer of changes of radiometric classes (pixel scale), to the vector layer of habitat potential transfers (ARCH polygon scale) is done by statistical analysis. The method is based on the overlay of the vectorial layer of ARCH habitats to the rastar layer of changes, the calculations of the average radiometric distance by polygon of the vectorial database and the corresponding confusion matrix. The result of this statistical analysis can be represented in an histogram.

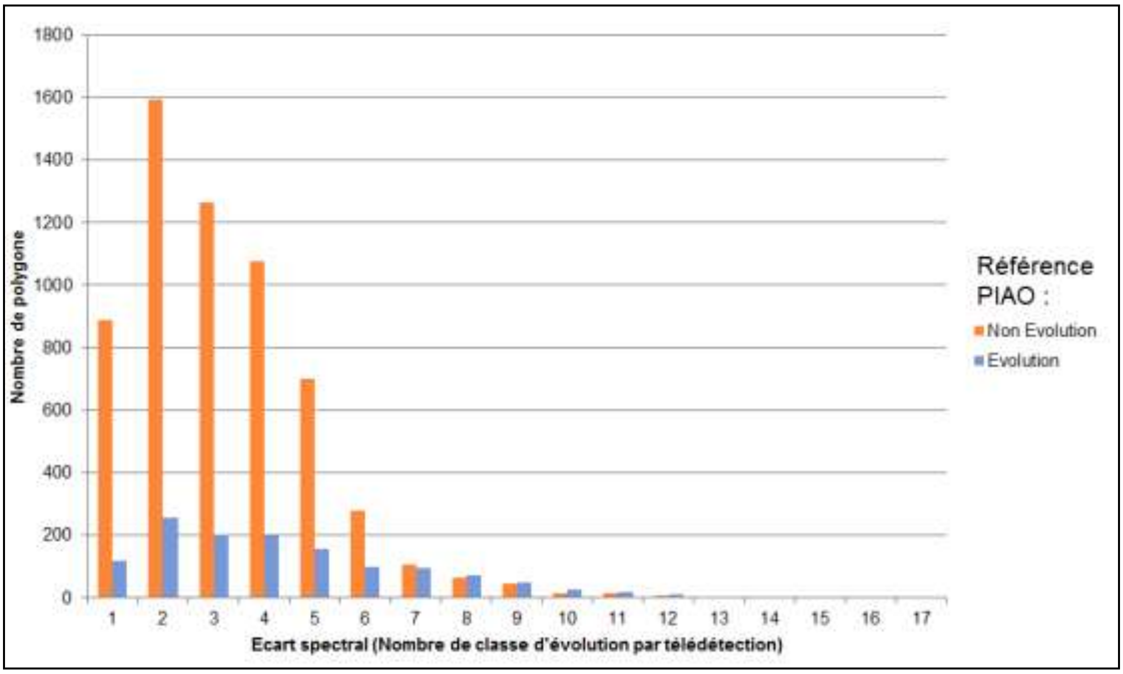


Table 3: unsupervised classification - polygons distribution according to the spectral distance

It is therefore impossible to establish a threshold and the raster layer of potential changes cannot therefore be established. The difficulties are essentially due to:

- The agricultural areas, largely represented
- The use of different satellite sensors
- The different dates and seasons (phenology problem)
- The size of the polygons

Due to these issues, supplementary tests based on the same methodology have been developed. There are classification tests carried out on the overall available bands for each sensor, statistical analysis tests (polygon proportion vs absolute number) and tests performed by masking the cultural and urban areas. Nevertheless, the results and dynamics stayed identical. The envisaged approach is not satisfactory and cannot be selected.

3.3. The non-supervised classification – the multi-temporal effectiveness

In the previous approach, one the principal difficulty was the inter-seasonal variability. The objective of this new approach, here, is the integration of the multi-temporality enabled by the satellite data to overcome this difficulty.
Unfortunately, the graphic representation of the statistical analysis leads to the same conclusion as previously, it is impossible to establish the threshold and therefore to generate a layer of potential changes.
It is regrettable not to be able to repeat the experience with a higher resolution and of better quality satellite data than the Landsat data.

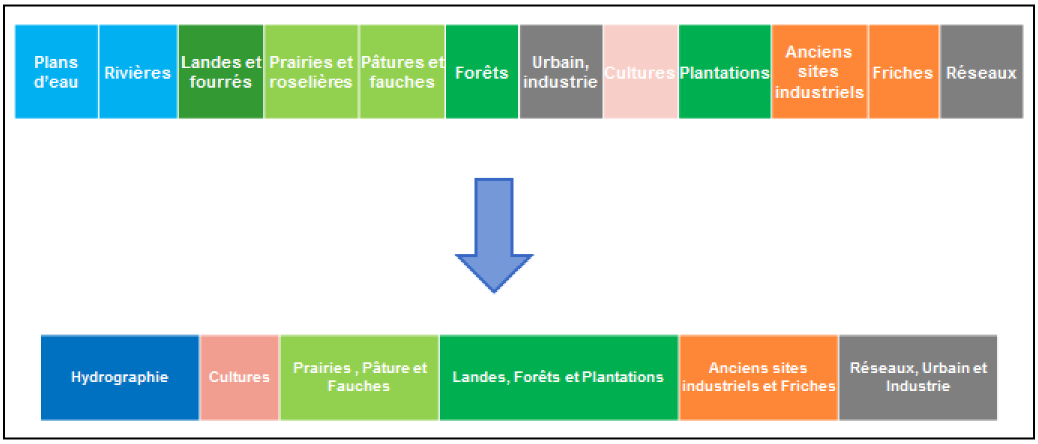
3.4. The reconstitution

The objective of the approach is the restoration of the ARCH classification. The underlying idea is to confirm (or not) if it is possible, from an unsupervised classification, to restore a thematic class. The level of classification studied is the same as previously, which are the 12 natural habitat major classes. Once the habitats maps are recreated according to the same methodology as previously, the rastar layer of thematic changes and the layer of potential changes can be put in place.

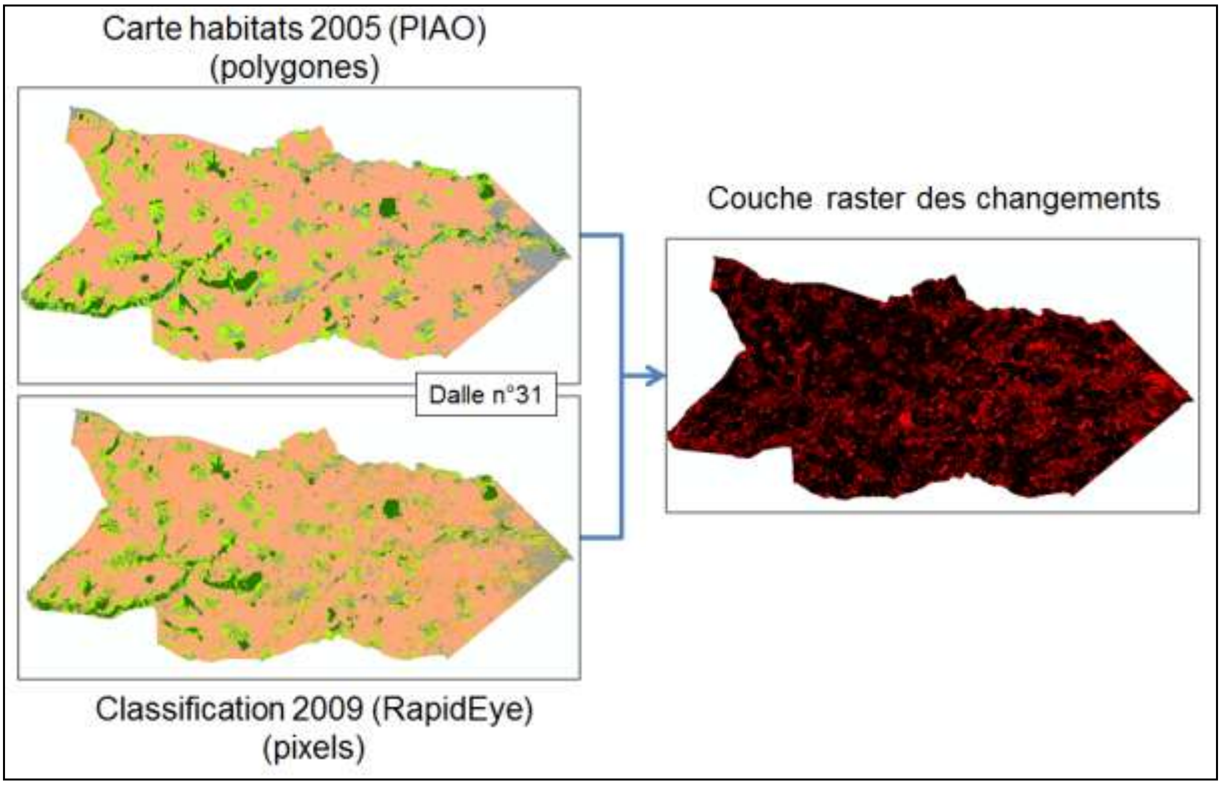
Unfortunately, the results obtained are disappointed; the levels never reach the 75%. The precision level of the restoration is clearly insufficient in order to have a sensible comparison. The thematic raster analysis of changes and the vector analysis of changes cannot be obtained. The approach cannot be kept for the remaining activity.

3.5. The supervised classification

From this approach, the classes are not only established on spectral basis anymore, but rather on thematic basis. Indeed, as shown in the previous approaches, the method established on spectral classes does not achieve the satisfactory results. It is worth noting that the tools are developed based on the simplified classification (6classes), from the conclusions of the previous approach.



Supervised classification- work nomenclature



supervised classification – establishment of the raster layer of

As the situation maps are thematic, the thematic raster analysis of changes is a per-pixel binary layer: changes (red pixels) – no changes (black pixels), unlike the previous approaches where this layer could only illustrate a spectral distance.

As for the first two approaches, it is possible to overlap the thematic layer of changes and the ARCH database. Having the number of changes pixels per polygon of the ARCH habitats map, it is possible to set a rule by which the polygon is considered as a “hot spot” of potential changes if the percentage of pixels having changed reached a given percentage. During the cross-border workshop, several percentage thresholds have been proposed 30%, 50% and 80%.

Threshold at 30%	**General Accuracy**	**User Transfer Accuracy**	**Producer Transfer Accuracy**	**Omission Transfer**	**Commission Transfer**
Single date	43%	22%	90%	10%	78%
Multi-date	50%	23%	85%	15%	77%

Supervised classification vs multi-temporal supervised classification – accuracy, omission et commission

Unlike the previous approaches, the per pixel supervised classification method enables a vectorial layer of potential habitats changes "hot spots". However this one is not unique. Different thresholds can be envisaged from which a targeted polygon is considered as potential changes "hot spot" if the percentage of pixels having changed within reaches a given percentage.
The method with the associated classification enables us to show the changes within the major habitat classes only. What is happening within these merged classes will be investigated with the API and field survey.

3.6. The supervised classification + the multi-temporal effectiveness

The approach is exactly the same; the multi-temporal aspect is added to the supervised classification in order to avoid the inter-seasonal variability. The results obtained with the per pixel multi-temporal supervised classification are similar to the results obtained with the single date classification, achieving the same results. However, these results could have potentially been better if the tests were carried out on the same tile and with images of the same spatial resolution.

3.7. The object orientated classification

This approach proposes to establish a map of actual situation with the object orientated classifications, which implies to set some classification rules. Given the complexity and the length of the task, working classification has been reduced to 4 classes (cancellation of the "hydrographic" and "fallow lands" classes). Despite this simplification, the approach explores the possibilities of extraction method by object orientated classification.

Follows the application based on the same process as previously, enabling a comparison of the results.
The results obtained with the object orientated classification are similar to those obtained with the per pixel supervised classification (single and multi date).

3.8. General conclusions

Within the framework of this «applied and pragmatic » research of potential approaches in mission 4, a whole series of tests has been envisaged, tested but not kept. Indeed, within this pragmatic framework, for some of the tests, the results have not been completely satisfactory. This does not mean that these methods cannot be successful, but a more in depth scientific research is needed. Within these approaches, there is the « spectral distribution » of habitats, based on the hypothesis that a per class type of variability exists.

Within the framework of component 1 and the rapid detection of changes, there is no unique and obvious solution. The first methods presented (single or multi date unsupervised and restoration) did not give any probing results and the vector analysis of potential habitats transfers could not be established.

Within the potential approaches, there are the single date and multi temporal per-pixel supervised classifications, as well as the object orientated classification. Following the discussions during the cross-border workshop on 20 January 2012, **the single date supervised classification** is the only solution selected. Indeed, it offers a level of accuracy similar to the other two approaches and is quite easy to put in place.

Moreover, during the discussions, it was suggested that the interim product**, the raster analysis of changes**, presented a high interest. Indeed, the majority of the operators are "GIS specialists". This raster analysis of changes brings a high number of options in order to focus, in many ways, on the updates. For example, we could just focus on one type of a given transfer. This product is therefore kept for the remaining of activity 3 and mission 5.

4. Component 2 - results

4.1. Added spectral database: *Red-Edge*

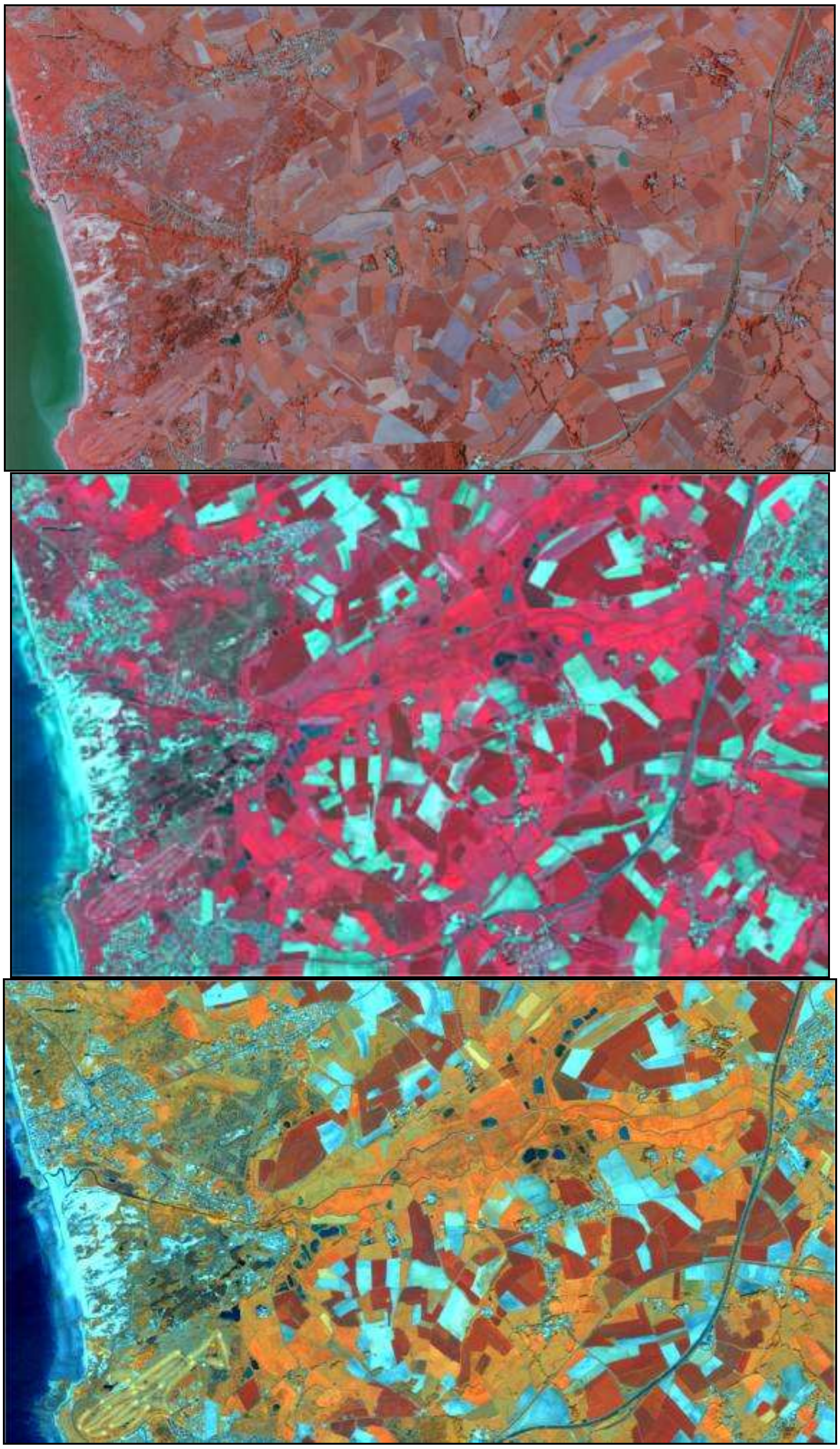
For component 2 (specific classes identification) given the needs expressed by the users and the production teams, it is more about providing new layers of information in order to assist the CAPI work, rather than a fully integrated operational approach (information retrieval method).

The approach aims then to identify and integrate new data based on tests purely visual and to evaluate their benefit in facilitating and improving the CAPI work, in the view of future database update campaigns.

The tests have been realised with the cartographic production teams from SIRS working on the ARCH project activity 1. The data and approaches used for these tests are:

- The High Resolution spatial RapidEye satellite images Exploitation of the *Red-Edge* band of the sensors for the display in false colours RGB: Close Infrared – *Red-Edge* – Red.
- Orthophotos in real and false colours (infrared), respectively for 2005 and 2009 (data used during activity 1).
- the vegetation index (NDVI and so called NDVI Humid foliar index using the mid infrared

Within all the additional spectral data tested, only *the Red-Edge* provides a significant contribution. The results presented here are therefore limited to the *Red-Edge.* The data on the indices have not been kept as the tests' results are not satisfactory.
If the Red-Edge data do not enable an automated detection of specific classes, it is an invaluable assistance for the CAPI. The Rapid-Eye data in RGB colours: PIR-*Red-Edge* – Red offers better contrasts and nuances than the compositions in real false natural and infrared colours. The comfort of work is improved and the reading is easier and more efficient. The following illustration gives an overall idea of this difference in contrast:



use of *Red-Edge* and improvements of nuances et contrasts
Above: Infrared aerial ortho – Shooting from June to September 2009 -
False infrared colours
Below : RapidEye (5 m spatial resolution) – Shooting: 03/06/2010 – Coloured composite RGB : PIR – RED – R
R

It is important to note that here the contrasts can be distinguished with the PIR composition of colours, but they are more obvious with the Rapid-Eye's.

If the contrasts are much better with the Red-Edge data, it is as well important to note the differences of spectral bands and dates. In theory, the data are not comparable. However, as the following illustrations show it, the Rapid-Eye data offers a supplementary seasonal information to the supplementary spectral information which it represents, bringing comfort and substantial efficiency to the CAPI

4.2. Informationon phenology : multi-temporal data

The use of several images over a same year facilitates the CAPI work. If at a given date, two areas can look spectrally similar, on the other hand, their phenological evolution over a period of time is different. The use of the multi-temporality enables the identification of this variability which is impossible to do with a single date (depending to the date of the shooting).

4.3. General conclusions

This component aims to enable the identification of new data and their potential combination in order to assist the CAPI work. In this way, the following data, if they are integrated within the production, are of a real contribution:

- The Rapid-Eye data in colours Red-Edge enabling to exploit a new spectral information
- The SPOT data (or all other satellites) in multi-temporal enabling the access to the phenological information

The operators have found their CAPI work to be more comfortable, efficient and robust when using the new data to assist the usual aerial photography. The interest is such that the operators, within the framework of activity 1, have integrated these elements directly into their daily work.

Finally, the satellite data enables as well, unlike the aerial photography, the access of the shooting date, crucial information for the photo-interpretation. The combination between the shooting date and the supplementary seasonal information enables us to access the phenological information.

5. Component 3 – Scrub encroachments on grasslands: results

The objective of component 3 – Evolution within a specific habitat class - is to identify how the remote sensing technologies can detect/map the specific information of a class changes.

One of the themes raised by the users (NPdC and Kent) at the start of activity 3 was the scrub encroachments on grasslands (and its monitoring). In this view, this section presents methodologies, object orientated and threshold, and applied over a test area for each of the two regions.

Whatever the database is, aerial or satellite imagery, the threshold method has not been selected, the results have not achieved probing precisions.

However, the conclusions are positive regarding the object orientated classification for the detection of scrub encroachments on grasslands which represent a number of challenges. Indeed, it is important to establish the classification rules which enable to detect the same information from one date to another one. The object orientated methodology can be then repeatable from on scene to another one, but an adjustment of the parameters is needed from one date to another one. Since the adjustment of the parameters is easily achievable and leads to better results which are then comparable, this approach is applicable for our concern.

The object orientated classification offers a good assessment of the evolution (good cartographic accuracy). The tool enables the detection and the rapid mapping, without too much effort, of the scrub on grasslands, and therefore, the evaluation of the scrub encroachment. A quantitative comparison with the photo-interpretation would be interesting. Nevertheless, since only a trend is researched in our case, an absolute accuracy is not essential.

The results enable us to envisage the creation of an intra-class « scrub » index in order to monitor the trends at a larger scale. Moreover, it seems clear that this approach could be applied to other similar problematic. In this view, after discussions during the workshop, the approach has been kept for the remaining of activity 3.

6. Component 4 - results

The objective of component 4 - the automated mapping of specific classes – is to investigate existing analysis method of aerial photography or VHR data faster than the actual API.

One of the themes chosen in this component was the “detection of changes” from aerial photography.

This theme was initially planned according to the component 1 results. The decision was made that the results were insufficient to be transferred to component 4. Indeed, the difficulties encountered in component 1 would only be aggravated if applied to aerial images, even to VHR, given the spectral variability within each class substantially higher due to the very high spatial resolution.

6.1. Vegetated shingles

Another theme chosen at the start of activity 3 by the Kent users within this component is the mapping of vegetated shingle beach. In this view, this section presents both methodologies, the object orientated classification and band threshold.

In order to detect them in an rapid and efficient manner, two methodologies have been applied:

- The object orientated classification, the interest being the high contrasts between the vegetation and the shingles
- The spectral/radiometric threshold on the bands of aerial images in order to only highlight the scrub

For each of these two methods, some tests have been carried out from the same aerial image and over the same area. The first area is used as the method setting and establishment of the parameters, the second one for a transferability/applicability test of the parameters over a new area. The test areas are the Dungeness area in Kent.

The assessment of the methods is realised from the calculation of a global concordance percentage with the KCC habitat map. This is a global concordance and not a general accuracy.

The levels of global concordance with the Kent habitats map are similar from an approach to another one (object orientated classification and threshold). The level of concordance is about 85% whichever the method is exploited. Some objects missed by the API have been mapped during the object orientated classification or the threshold method. Conversely, the methods tested do not enable the detection of some scrub. Moreover, the parameters established over a first test area can be applied on a second area without any adjustments.

Both methods enable us to map efficiently and rapidly the vegetated shingle on beaches.

6.2. Conclusions and prospects

Given the interesting results achieved above, several potential applications have been presented during the cross-border workshop on 20 January 2012, such as the mapping of the vegetation on “terril” and of the scrub on the “Ambleteuse swards”. Over the short period of time remaining for this work, and depending on the setting of the of the test area, the methodology by object orientated classification has been tested on the Ambleteuse wards.

The following methods descriptions and results are brief for a better understanding. For further details, it is necessary to refer to the appendices 11 and 12 which detail the approaches.

Following the discussions over the cross-border workshop on 20 January 2012, the object orientated classification has been selected. Indeed, with an equivalent percentage of concordance, the object orientated classification offers more interesting results, especially in terms of object outline and isolated pixels. This is a simple mapping method, accurate and rapid to set up (estimated to a few days on the overall of the Dungeness area vs 3 months for the actual Photo interpretations). It offers some excellent prospect as for the rapid detection of this class.

The methodology proposed enables us to reach a global concordance of 85% between the object orientated classification and the ARCH habitats map for the detection of scrub on the Ambleteuse swards.
The methodology based on the object orientated classification has again been tested for the detection of scrub on Ambleteuse swards, area situated in NPdC. The results seem similar, such as a level of global concordance reaching 85% with the ARCH habitat maps. This new methodology even enables more accurate outlines on scrub than the actual API. Its potential and exploitation prospects are therefore confirmed.

General conclusions

At the end of mission 4, of the test of technical feasibility and of the cross-border workshop on 20 January 2012, the potential solutions kept are as follow:

	Data						Methodology				
	AP	VHR	HR	MT	RE	LI	PI	Seg	Pix Classif	Obj Classif	Thr
Component 1: rapid detection of changes											
Raster layer of changes			✓	✗					✓	✗	
Vector layer of potential transfers			✓	✗					✓	✗	
Component 2: identification of specific classes											
Supplementary Spectral data: Red-Edge			✓		✓		✓				
Information on phenology : multi-temporal data			✓	✓			✓				
Slacks						✓		✓			
Component 3: Evolution within a specific habitat class											
Scrub on grassland	✓	✗								✓	✗
Slacks						?					?
Component 4: Automated mapping of specific classes											
Vegetated shingle	✓	✗								✓	✗
Ambleteuse swards	✓									✓	

Synthesis of the solutions kept at the end of the tests

AP : Aerial: Photography ; VHR : Very High Resolution; HR : High Resolution ; MT : Multi-Temporal ; RE : Red-Edge ; LI : Lidar ; PI : Photo-Interpretation ; Seg : Segmentation ; Pix Classif : Per-pixel Classification (supervised and non supervised) ; Obj Classif : Object Orientated Object classification ; Thr : Threshold