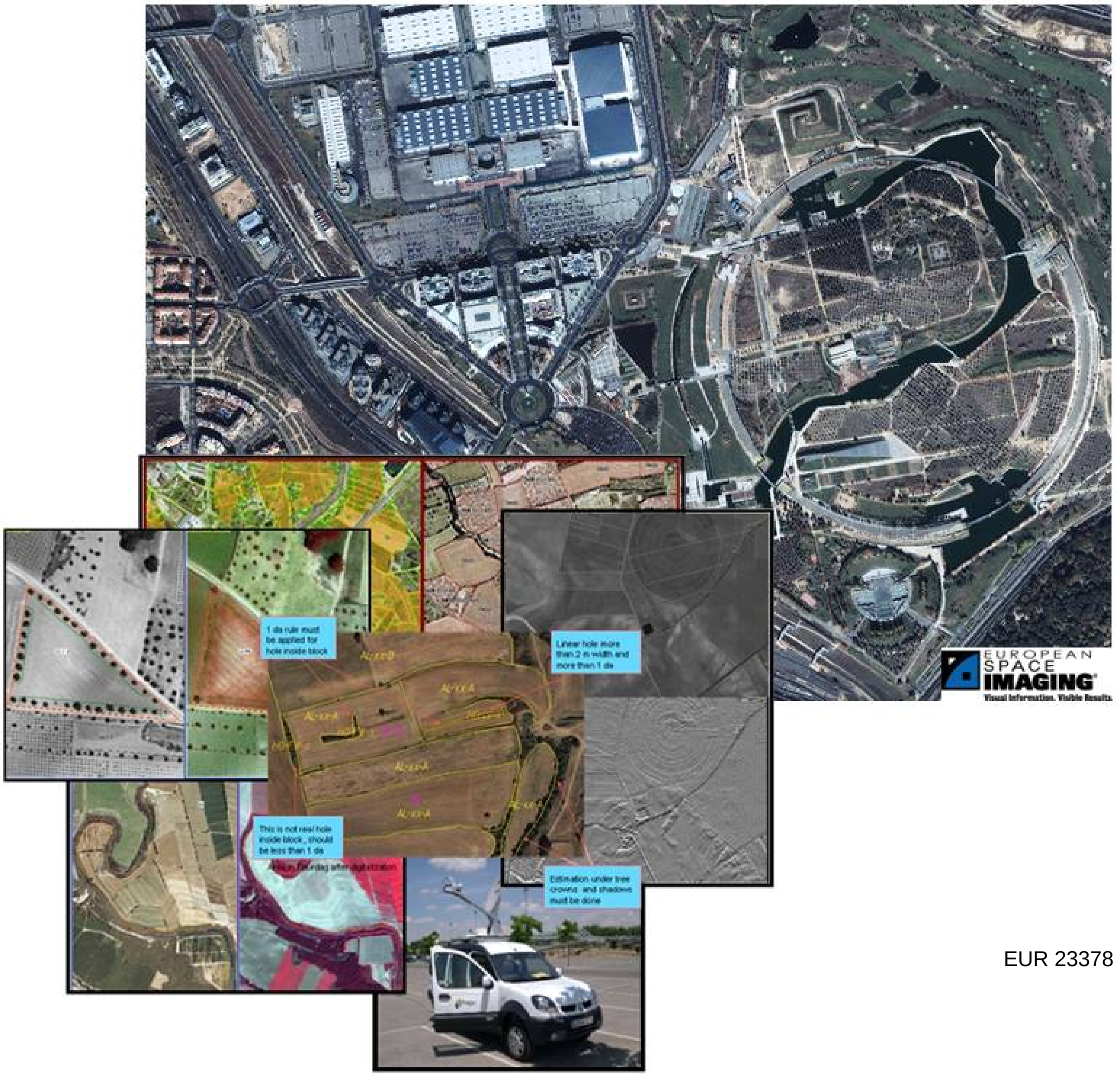
JRC Scientific and Technical Reports

Geomatics in support of the Common Agricultural Policy

Proceedings of the 13th MARS PAC Annual Conference, 2007
Palacio de Congresos, Madrid 12th-14th November 2007

Edited by: Philippe Loudjani, Simon Kay, Paolo Pizziol, and Andrew Rowlands



EUR 23378 EN - 2008

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AGRICULTURE Ref.: JRC IPSC/G03/P/JDE/plo D(2008)(9504)

JRC45567

EUR 23378 EN
ISSN 1018-5593

Luxembourg: Office for Official Publications of the European Communities

Printed in Italy

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Contents:

Conference Abstract

The 2007 Annual Conference was jointly organised between the GeoCAP (former MARS PAC) action of the Joint Research Centre (Ispra, Italy) and the Spanish Paying Agency (Fondo Español de Garantìa Agraria,FEGA), part of the Spanish Ministry of Agriculture, Fisheries and Food.
It covered the Control with Remote sensing Activities as well as technical aspects of Land Parcel Identification Systems (LPIS) and ortho-imagery use in all the CAP management and control procedures. The conference was the 13th organised by GeoCAP to review this important and still growing area of technical activity, in support of the Common Agricultural Policy implementation.

The conference was structured into three days - 12th, 13th, and 14th November. The first day was dedicated to showcasing the Spanish use of Geographic Information in various policy areas linked to the CAP; the last two days were focussed on technical and scientific presentations related to the Control with Remote Sensing programme, SDI (Spatial Data Integration) in IACS, LPIS and parcel measurement.

Over 500 participants form more than 30 countries attended the Conference.

The presentations made at the event have been made available on line, and this publication represents the best presentations judged worthy of inclusion in a conference proceedings aimed at recording the state of the art of technology and practice of that time.

Acknowledgements

The editors of this publication, as well as all team members of the GeoCAP action, would like to express sincere thanks to the *Paying Agency* of the Spanish Ministry of Agriculture, for both material and logistical support in the organisation and hosting of this successful and popular meeting. Many persons from the Spanish administration were involved (Mrs. Isabel ENCINAS GONZALES, Mr. Vicente FORTEZA DEL REY, Mr. Francisco MONTERO LABERTI …), without whom the conference could not even have taken place. We would like to specifically thank Mr. Fernando Miranda (President of the Spanish Farming Guarantee Fund (FEGA)), for his deep involvement.

We would also like to thank the presenters for agreeing to submit their work as papers, as well as to the review committee for contributing their valuable time at the meeting to identifying those most suitable for publication.

Peer review process and committee

Up to the 11th Conference, MARS PAC has produced "proceedings" gathering the slides of all presentations made at the annual conference. In 2006 however, it was decided to go one step better and to produce a restricted set of papers, selected by a peer review committee during the conference. Moreover, it seemed worthwhile to start making a more ambitious historical record of the information presented, with real proceedings that collects the more interesting scientific and technical work undertaken by the stakeholder community represented at the conference.

It was decided, therefore, to encourage better quality presentations by selecting the best ones with the possibility of including a conference-style paper in a special JRC publication.

The first peer reviewed proceedings have been produced for the 12th MARS PAC annual Conference that was held in Toulouse (France) in 2006 *(MARS Ref: JRC IPSC/G03/P/SKA/asi D(2007)(8503), PUBSY JRC 40462, EUR 22160 EN*).

To achieve credibility on this publication, a peer-review committee was assembled, mostly external to the JRC. This committee members organised themselves to attend the technical sessions of the conference, and decided upon the short list of presentations for publication.

The proceedings here are a result of that shortlist, and the conference organisers and the editors are grateful to the assistance provided in reviewing the presentations in the short time frame available.

The Peer Review committee members were:

- Mrs. Lucie SAVELKOVA, National Paying Agency, Czech Republic
- Mrs. Maria Angeles SEGOVIA GALIANO, Tragsatec, Spain;
- Mr. Gàbor CSORNAI, FOMI, Hungary;
- Mr. Rafael GARCIA RODRIGUEZ, Polytechnic University of Madrid, Spain;
- Mr. Axel HEIDER, Ministry of Agriculture, Germany;
- And Mr. Philippe LOUDJANI (Chairman of the Committee), Joint Research Centre, European Community.

1st Plenary session:

INTEGRATION OF THE SIGPAC MAINTENANCE IN THE MANAGEMENT AND CONTROL OF AREA BASED AIDS IN CATALONIA

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KEY WORDS: IACS, LPIS, geomatics, GIS, remote sensing, Landsat satellite, LIDAR, CASI, DMC, GNSS, PDA, pocket PC

ABSTRACT

The management model for the area-based subsidies (Annex l, Council regulation (EC) 1782/2003) in Catalonia integrates different management tools. These are farmers' declarations, subsidy applications, check and payment procedures, and the maintenance of a geographical information system (SIGPAC[1]). This integrated model aims to ensure agility and coherence for the system and involves, through the whole process, the utilisation of a network of interconnected applications based on SIGPAC data.

Hence, farmers' declaration process, which takes place through external agencies, feeds the payment and management process, the check process and the SIGPAC updating process.

The area-based subsidies checks, both administrative and on-the-spot, are centralized by a single application, which provides information to the management and payment applications, in accordance with legal requirements for every specific subsidy.

SIGPAC updating management outcome directly acts on both administrative checks and on-the-spot checks. Thus, that outcome is taken into consideration for validating eligibility checks.

Finally, it is important to mention that new technologies have been implemented to perform on-the–spot checks. On the one hand, the use of combined pocketPC devices and GNSS is a growing trend in making such checks. On the other hand, remote sensing techniques, including the use of LIDAR and CASI sensors, are deployed at an experimental stage.

1. INTRODUCTION

Implementation of SIGPAC[1] (Geographic Information System of Agricultural Parcels) has been carried out as an opportunity to optimize our aids management and control system.

The main lines for that modernization have been:

I. Integration of processes and data flow within the IACS[2] (Integrated Administration and Control System).
II. Technological innovation to achieve a high degree of efficiency.

This document focuses on three essential topics: a) the single application, b) The IACS-related controls, and c) SIGPAC maintenance, and also the way these three issues interact.

They are presented through the management applications the system uses, which are: (Figure 1):

- DUN (Declaración Única), through which farmers generate the *Single Application*.
- CON (Controles); which is fed by DUN's Single Applications, contains the management tools for the IACS-related controls.
- ASI (Actualización del Sistema de Información Geográfica); also fed by DUN, developed for the management of SIGPAC annual update. There is a permanent feedback between ASI and CON.

[1] SIGPAC; LPIS (Land Parcel Information System) regulated in Spain by Real Decreto 2128/2004

[2] Commission Regulation (EC) No 796/2004 of 21 April 2004 laying down detailed rules for the implementation of cross-compliance, modulation and the integrated administration and control system provided for in of Council Regulation (EC) No 1782/2003 establishing common rules for direct support schemes under common agricultural policy and establishing certain support schemes for farmers.

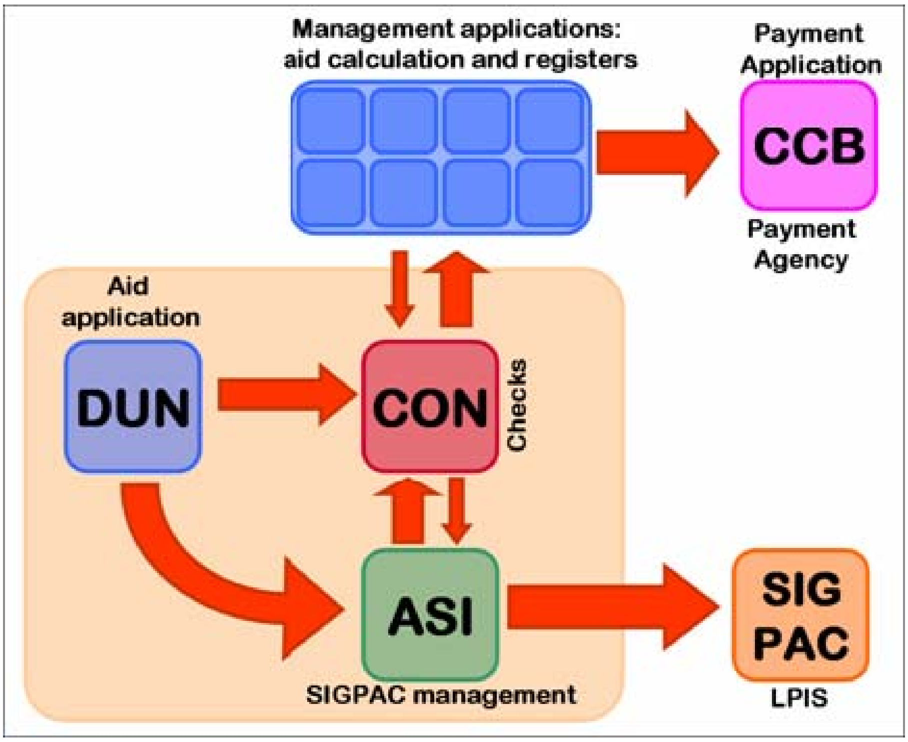

Figure 1 – Data flow: Aid Application (DUN), Aid Control (CON), and SIGPAC Management (ASI).

The main efforts for technological innovation and for modernizing the system have been spent on geomatics; GNSS (Global Navigation Satellite Systems) and pocketPC devices, remote sensing techniques, and a generalized integration of GIS tools in most of processes.
In particular, remote sensing is being used in both IACS-related controls and SIGPAC modification claims; GNSS and pocketPC devices are being used for both on-the-spot checks and SIGPAC modification supervisions, fully integrated in both CON and ASI procedures. As part of the same goal, an efficiency policy is undertaken to only consider cost-benefit appropriate decisions in the use of such techniques.

2. SINGLE APPLICATION (DUN)

Over 65,000 farmers' single applications are submitted in Catalonia annually. Most of these applications are delivered through 45 external agencies with over 1,000 offices distributed over the region. Farmers may also fill in the application by themselves but this option is only considered by a minority.

2.1. THE APPLICATION

DUN has been developed in Power Builder. All data and applications are stored on the local PC except SIGPAC data, which is provided by the public administration's servers, via Internet. This permanent access to the servers enables the administration to check the version of every client application and oblige them to update if necessary.
Details of last year's declaration are sent to the farmer at the beginning of the current declaration period. The data is sent along with complementary data such as the farmer's revenue data, Social Security contributions, previous aids, etc. The data are collected from other administrations or departments in order to reduce the number of documents to be provided by the farmers.

Applications are submitted by telemetric procedures and security is guaranteed by digital signature.
Geographical information is managed through the application 'Croquis', which has been developed by TRAGSATEC[3]. Croquis and DUN are fully interconnected and the data flows via xlm files. Geographical information remains in digital format all along the process of data treatment and control.

2.2. MANAGEMENT

DUN has three main parts: farm holding, farmland activity and livestock activity. An additional screen is displayed by DUN at a previous stage where compulsory proceedings are pre-selected to ensure the consistency of the declaration and to enable security mechanisms, such as blocking options or warning messages.
A list of necessary documents is released in each case as a result of filling in all the data requested by DUN, and the farmer is asked to provide them along with the declaration itself.
DUN has been integrating other processes and has become the main channel for administrative communication apart from including the aids of the Single Application. Its scope, in terms of management and administrative procedures, includes:

- Single application[4].
- Rural development[5]; Setting up of young farmers, Modernisation of agricultural holdings, Natural handicap payments in mountain areas and payments

[3] TRAGSATEC belongs to TRAGSA Group; www.tragsa.es
[4] Annex I, Council regulation (EC) 1782/2003 of 29 September 2003 establishing common rules for direct support schemes under the common agricultural policy and establishing certain support schemes for farmers and amending Regulations.
[5] Council Regulation (EC) No 1698/2005 of 20 September 2005 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD).

in other areas with handicaps, agri-environment payments, Nature 2000 payments and use of advisory services.
- Other proceedings such as SIGPAC updating, etc.

Mechanisms for validation at a parcel level have been possible after SIGPAC deployment. On the one hand, such validations have enabled the identification of non-existent parcels when they have been wrongly declared and also the identification of overestimated surface; on the other hand, the crop being declared is validated by the parcel's SIGPAC current land use. A SIGPAC modification application is generated when the resulting validation is negative and the farmer perseveres in the product declared. SIGPAC modification application is accompanied by a warning message informing the farmer that a negative resolution may produce administrative penalties. Those penalties would be calculated according to the type and amount of the undue aid being claimed.

3. AID CONTROL (CON)

These computer application functions apply to area-based aids and farm holding aids, as mentioned in 2.2., the need for this new computer application is the growing complexity of the whole set of controls to be performed and their interdependence.
Control activity is performed under CON management:

- Document checks; CON points out which documents have to be controlled for each file. It produces claim letters as well as notification follow up;
- Administrative checks; Cross-check results are visualized simultaneously and may be managed with a higher degree of efficiency and consistency;
- On-the-spot checks; Control reports are produced on a large scale, containing all the applications to be controlled. The control reports are generated either as paper documents or pocketPC files. Additional information is provided such as location maps or detailed information for each parcel. On-the-spot checks results are transferred into CON via saving the pocketPC files;
- Cross-Compliance checks. Specific control reports containing cross-compliance elements are generated. These documents are created according to the parcel's characteristics and their location, and they are customized with the relevant elements applying for each distinct farm holding;
- Commitment checks. They are specific for every farm holding in the context of rural development;
- Check list; they have been unified for aids having common checks. The user and date of each action done is automatically registered.

4. SIGPAC MANAGEMENT (ASI).

SIGPAC deployment in Catalonia had two initial goals: compliance with EU regulations and the creation of a high quality, farmland-oriented GIS available to all. The strategy adopted in 2004 consisted of making SIGPAC widely known and accessible, especially among farmers. The definition of mechanisms for SIPAC updating was also a priority, in accordance with INSPIRE[6] (2007).

[6] Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE)

A simple procedure for claiming SIGPAC modifications through DUN has had, as a consequence, an important amount of such claims. Therefore, some validation mechanisms have been designed to absorb that amount within each campaign so that the results can be incorporated in the following year's SIGPAC data.
SIGPAC content is publicized by three major channels:

a) An internet viewer (Visor flash) depending on FEGA[7] servers (http://sigpac.mapa.es/fega/visor/).
b) A full integration of Croquis with DUN.
c) A downloadable report for each farm holding containing SIGPAC geographical and text data, and cross-compliance data, all based on the previous campaign declarations.

4.1. PROCESS MANAGEMENT

SIGPAC provides a single version of its data throughout the year (from January to December) to the general public.

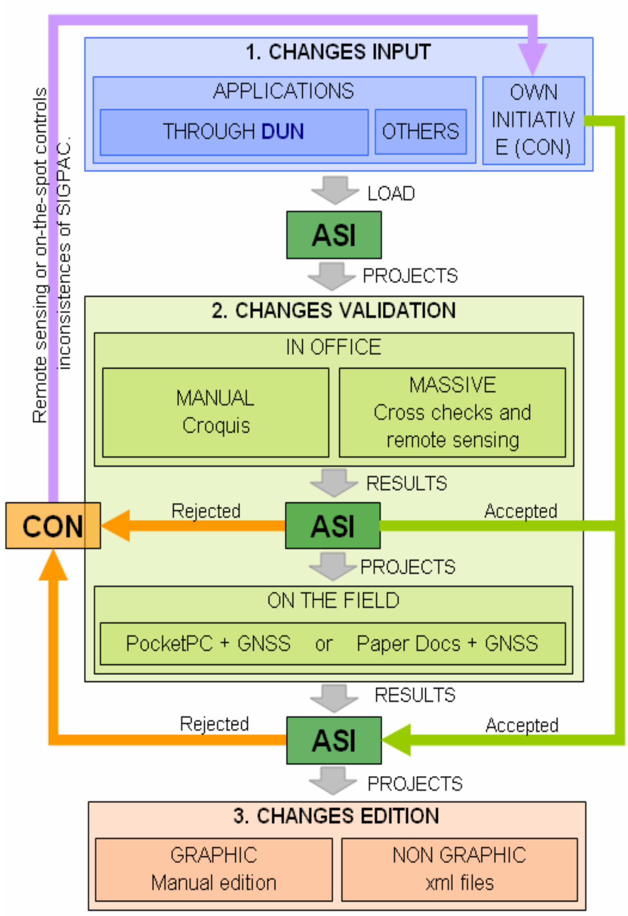

Figure 2 – Data flow inside ASI, and between ASI and CON.

SIGPAC modification files loaded to ASI mainly come from farmer's claims via DUN. ASI transfers the claim results to CON when such modifications affect aid applications, and CON transfers these results, in turn, to the specific aid management application. Hence, these results are taken into account for calculating the amount to be conceded or penalized within that campaign.

[7] Fondo Español de Garantía Agraria; is an autonomous organism linked to the Department of Agriculture of Spain

If the result of on-the-spot checks or remote sensing analysis produces contradictory outputs in relation to the current SIGPAC land use, an automatic request for SIGPAC modification is generated. This request is filed as an Administration own-initiative petition and makes the data flow run in the opposite direction, that is to say, from CON to ASI. These kinds of requests are introduced in ASI accompanied by the Administration's resolution, as they have already been checked (Figure 2). Therefore, these requests are transferred to the edition stage to make the modification being executed.
If modifications do not involve changes in the parcels' geometry, an xml file containing the new parcels' values is sent to the FEGA servers; if they do, parcel edition is performed manually. However, since this is an important time-consuming task, TRAGSATEC is developing a tool to make those vector changes possible in an automated way.

4.2. THE APPLICATION

ASI has been developed using J2EE. Its most distinct element is that the results of the validations are not introduced directly in ASI. Modification files are transferred to many different tools like Croquis (Fig. 3), Compe PRO (pocketPC), Microsoft Office, SIGPAC publisher and ArcGIS, for its validation. These applications communicate with ASI mainly through xml files, and the results are sent back to ASI once they have been validated. ASI acts as a file management system and mainly controls the status of modification requests during the validation process.
ASI enables a versatile choice for file selection and further clustering into ASI validation projects. A specific modification request belonging to an ASI project becomes blocked and cannot be manipulated by any ASI user, except within that ASI project. Once the modification requests within a project have been reviewed and a resolution has been issued, ASI assigns a new status to them so as to be ready for edition. If, for some reason, some modification requests have not been able to be concluded, they become unblocked again, so that they can be selected for a new ASI project. This happens typically when an office validation project is set but a field check is crucial for some cases. Thus, once a modification claim has become part of an office validation project, it can only be accepted again in a field validation project.

4.3. VALIDATION

Modification requests are validated as much as possible through automated procedures. These procedures include vector analysis, database analysis and remote sensing analysis as they are the most efficient cost-benefit means for these kinds of validations. However, if these techniques are not sufficient to take a decision, photo-interpretation is adopted to try to solve the request. Furthermore, when photo-interpretation does not guarantee either that goal, field validation becomes the only solution. In those cases, field validation projects are set and on-the-spot checks are performed, preferably using GNSS and pocketPC devices.

4.3.1. OFFICE WORK

Once an ASI project is created, Croquis is activated by ASI and the project data is transferred, so both text and vector data are visible in Croquis and a spreadsheet-like matrix is displayed enabling the user to input the validation results. The most recent orthophotos available are loaded to make possible photo-interpretation and, sometimes, other geo-referenced data, typically produced by remote sensing analysis (soil moisture, detection of specific crops, etc.). (Figure 3)

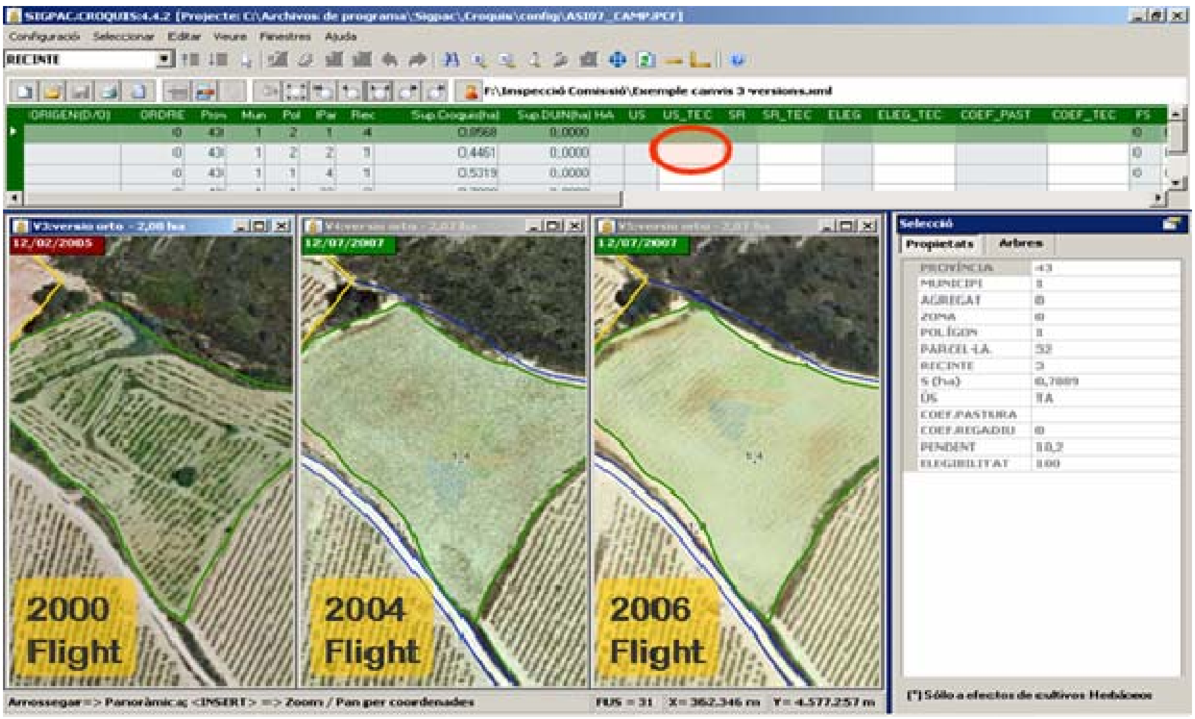

Figure 3 – Reviews in office by use of photointerpretation. In this case (campaign 2007) the farmer requests a change to Vineyard (VI) in a parcel enclosure that was consisting in SIGPAC as arable land (TA); in the image of 2006 a young vineyard is observed, so annotating the code VI in the grid (cell with circle) the process remains resolved and goes on to edition.

4.3.2. REMOTE SENSING - SURFACE CONTROL.

A high number of modification claims were expected during 2005 (and finally happened) so a special validation process was developed in order to attend such a large amount. It consisted of a supervised classification of Landsat images, made by the Univ. Autònoma de Barcelona (http://mediterrani.uab.es/web) collaboration with the Government of Catalonia's Department of Agriculture.

The method had four steps: 1) Creation of a mask which discriminated farmland from the rest of land uses to reduce spectra variability; 2) Definition of spectral signatures of the crops to be classified through training areas; 3) Satellite image classification; 4) Review of modification claims using the results of Landsat classification (Figures 4 and 5).

Two main conclusions can be drawn from this experience:

- The method succeeded in classifying parcels concerned by modification requests when bigger than 1 ha and with a more or less regular a shape. However, the fact that spatial resolution was 30 m made it not suitable for smaller parcels, which are common in Catalonia. So far, higher spatial resolution images are not considered as an alternative, due to their cost.
- Considering that over 80% of Catalan farmland is have parcels over 1 ha, that method is regarded as an appropriate one for making a periodical general review of SIGPAC. This method would reduce the overall cost of this operation in relation to other procedures.

Figure 4 – Left side, sample of mask of non agricultural surfaces (areas not shaded in orange) issued from the proper information of SIGPAC. Right side, sample of plots of the area of training, obtained with a selection of 70.000 plots declared by the farmers in the previous campaign (2004).

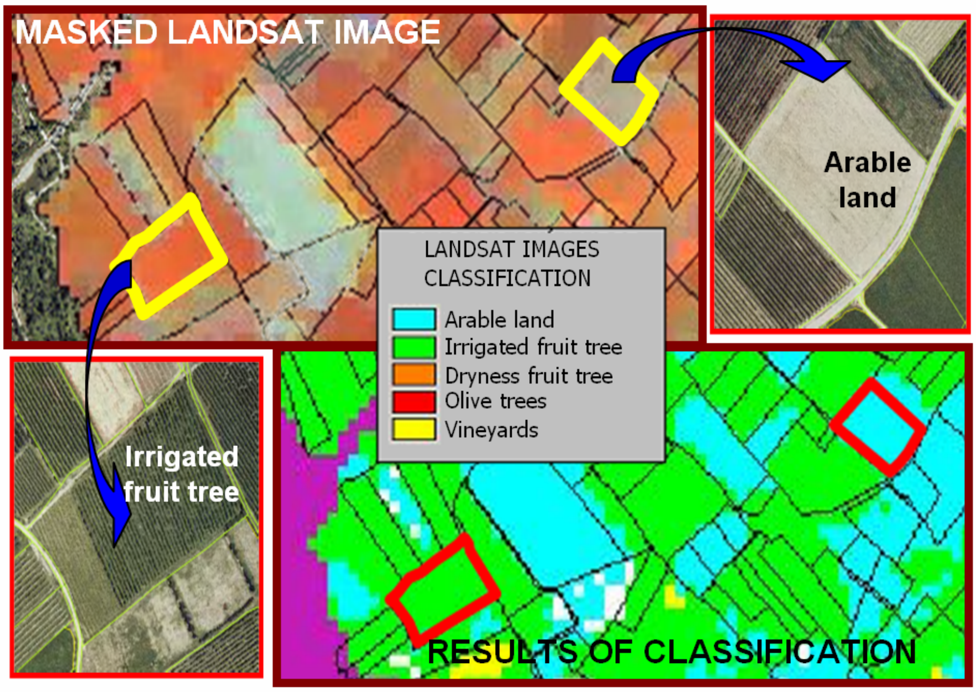

Figure 5 – Sample of the results of the Landsat image classification.

4.3.3. TREES CONTROL

The most complex tasks regarding both SIGPAC maintenance and updating have to do with trees (olive trees and nuts trees). Differentiating species by photo-interpretation is a major difficulty so most of times field work is required to validate and locate trees with an acceptable accuracy.
In 2007 a pilot experience was carried out in collaboration with the Institut Cartogràfic de Catalunya (www.icc.es) for that purpose. Species classification and tree location techniques were tested using airborne sensors. The main phenologic circumstance supporting tree classification was the fact that olive trees (*Olea europaea*) and carob trees (*Ceratonia siliqua*) are evergreen trees, whereas almond trees (*Prunus amygdalus*) are deciduous.
Minimum expectations consisted of using winter tree classification to support photo-interpretation; the highest expectations ones were using this technique to automatically identify and accurately locate trees.
The used sensors and the images obtained to carry out the tests were the following ones:

- LIDAR laser; with a square meter resolution. Flight realized in January.
- CASI hyperspectral sensor; configured to register 19 channels in the visible and infrared nearby spectrum and with a spatial resolution of 2x2 meters. Two images were obtained, in March and July.
- DMC, digital camera; resolution of 25 cm. Two images were obtained also, in January and July.

The test was carried out in a zone close to Tarragona with olive trees, almond-trees and carob-trees (Figure 6). For olive trees and almond-trees the recognition successes were slightly over 90 %, whereas in carob-trees they were quite lower. Classification errors for olive trees and almond-trees are imputed to the uncertainty that generates the carob-tree in the training samples for classification.

The results are considered to be good but not accurate enough. However, the zone with a major volume of requests of modification of trees is the south of Lleida's province, where there are no carob-trees.

4.3.4. ON-THE-SPOT

SIGPAC updating on-the-spot checks may also be performed using GNSS (Global Navigation Satellite Systems) and pocketPC devices. Time efficiency has been doubled, using this technology.

5. FINAL COMMENTARY

One of our main goals is the pursuit of both maximum efficiency and efficacy, as it is for any modern Administration, beyond our liability in strictly accomplishing European regulations derived from EU's Agricultural Policy. Our strategy has consisted in understanding that LPIS deployment was a unique opportunity to settle a powerful information system for the agricultural sector, not only a mere obligation. This information system must become a tool to offer the best possible service to both the agricultural sector and our citizens, at the same time that EU regulations are fully fulfilled.

Our model for the IACS management, which has been briefly presented in this article, is the result of several years of dedication of a group of widely experienced professionals. The enthusiasm which leads us to share this experience is not bigger than our interest in knowing other initiatives which may help us achieve a growing improvement. Thus, we welcome all organizations which may be interested in our model, following this Conference's goal for exchanging experiences.

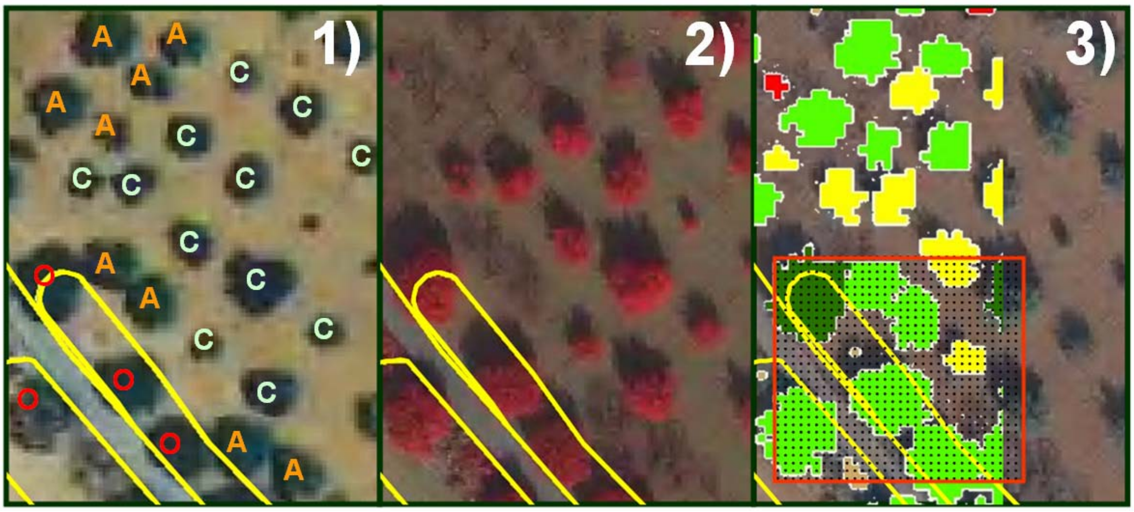

Figure 6 – 1) DMC image (RGB), 50x50 cm pixel resolution, June 2006; **O**-Olive trees, **A**-Almond-trees, **C**-Carob-trees. 2) DMC False color (RG+IR) image, 25x25 cm pixel resolution, January 2007. 3) Tree canopy located by LIDAR, seen over a DMC image (RGB) 25x25cm pixel, July 2007. Inside the red square, a sample of laser impacts, 1x1 meter.

Session T2: New guidance on checks of areas for 2008

ASSESSMENT OF THE EFFECTIVENESS OF RISK ANALYSIS

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KEY WORDS: Risk analysis, assessment of risk criteria, CART, CAP area based subsidies, on-the-spot checks

ABSTRACT:
Each year the member states of the European Union select a sample of the claims for CAP subsidies in order to check them on the spot. A large part of this sample has to be selected on the basis of risk analysis, using the results from the on the spot checks of the previous years. This paper presents a method based on CART algorithm for determining the risk factors to be used in the selection of this sample. As an example, the CART algorithm was applied to the results of the Italian on the spot checks of campaign 2005 in order to identify the factors that best predict either the amount of aid not paid or the percentage of claims with anomalies.

1. Introduction

Every year, about 8.5 million farmers[8] lodge claims for area based subsidies in the frame of the Common Agricultural Policy. Member States (MS) have to select a sample of at least 5% of their claims in order to check them On-The-Spot (OTS). At least 75% of this sample is selected on the basis of a risk analysis, the remaining part being selected randomly. The rationale for the random sample is to provide the background rate of anomalies, i.e. a reference for analysing the quality of the risk analysis (article 27 of Regulation (EC) no 796/2004). Up to 2007, the regulation listed the risk factors to be taken into account in the risk analysis (e.g. amount of aid, number of claimed parcels, changes from the previous year, finding of checks made in past years…). As from 2008, MS are free to use the risk factors they think are the most appropriate for their situation. In practice, the regulation requests MS to assess the effectiveness of their risk analysis, i.e. to establish the relevance of risk factors by comparing the results (anomalies) of the risk based and the random samples. This assessment of the risk factors has to be performed annually using the results of the OTS checks.
The objective of this paper is to propose a methodology for assessing the risk factors based on a Classification and Regression Tree (CART) algorithm. The proposed approach is illustrated using the Italian OTS checks results from the 2005 campaign.

2. Comparing the risk based and the random samples

In order to decide whether a risk factor is efficient at picking claims with (important) anomalies, a decision criterion is needed. Different decision criteria could be used to assess "risky" claims as well as to compare the random and the risk based samples:

(a) At claim level, the existence of an anomaly (discrepancy between the claimed area and the area determined by the inspector above e.g. 0 or 3%); at sample level, this yes/no criterion converts into a % of claims with anomaly;
(b) the percentage of area not determined i.e. the total area not found over the total claimed area; this criterion may be computed at claim level as well as at sample level;
(c) the total amount of aid not paid over the total aid claimed; this criterion may be calculated at claim level or at sample level;

Criterion (a) considers the presence of anomalies without taking account of their importance in terms of area "not found" or amount of aid; as in general smaller claims are more likely to present more anomalies, this could orientate the risk analysis towards the selection of small claims where anomalies usually result in the recovery of small amounts of aid. In contrast, criteria (b) and (c) consider the importance of the discrepancy between the claimed and the determined areas. The difference between criteria (b) and (c) is that criterion (c) takes account of the penalty applied to discrepancies above the thresholds set in the regulation (i.e. the payment is not only function of the area determined but may be reduced or even cancelled by penalties).

The following figures derived from the 2005 OTS checks statistics provided by the 25 MS illustrate two ways of comparing the results of the random and the risk based samples: using the percentage of claims with error or the percentage of area not determined in a sample.

According to the 2005 statistics, the percentage of claims with anomaly in the random sample ranges from 10 to 90% with an average of 27% at EU level[9] (cf. Figure 1). It should be stressed that for LU and MT, the random sample contains less than 100 claims, viz. 27 and 55 claims respectively.
In contrast, the area not determined (which corresponds to the aid unduly claimed) ranges from 33% to 0.2% with an average

[8] In the EU 27 i.e. since 2007 (in the EU 25, there were about 5 millions claims in 2004 and 2005, which grew to about 7 millions in 2006 due to the entry of olive farms in the area based subsidy schemes).

[9] Total number of claims with errors over total number of claims (when aggregating all random samples)

of 1.3% at EU level (Cf. Figure 2). Out of the 25 MS, three were found above 5% of area not determined whereas 17 appeared to below 2%.

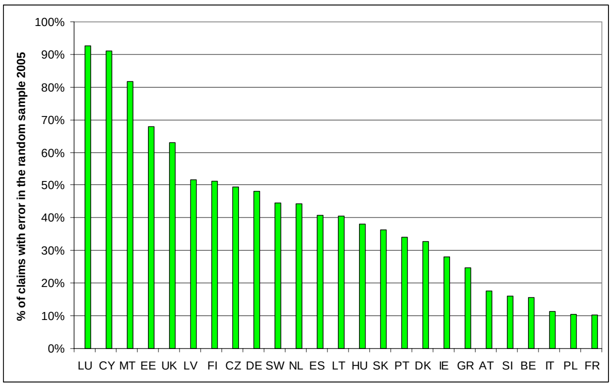

Figure 1: percentage of claims with error in the random sample checked OTS during campaign 2005, by MS.

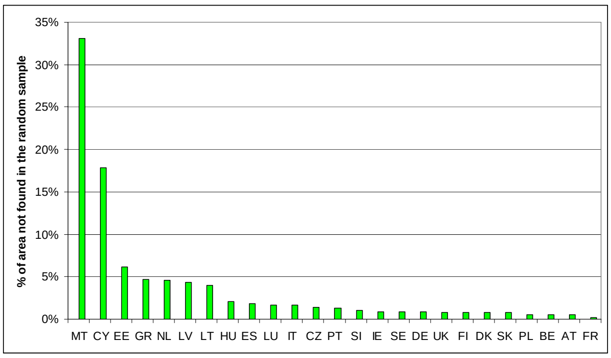

Figure 2: percentage of area not determined in the random sample, by MS (OTS checks results 2005).

Figures 3 and 4 compare the random and the risk based samples on the previous two criteria.
The difference in the percentage of claims with error between the risk based and the random samples ranges from 47% to -14%. A few MS appear to have a higher percentage of claims with anomalies in the random sample than in the risk based sample (Cf. HU, UK, NL, IE, LT on Figure 3).

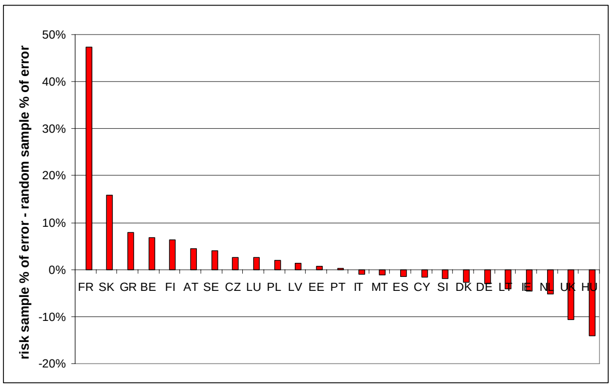

Figure 3: Difference in the percentage of claims with error between the risk based and the random samples, by MS (OTS checks results 2005).

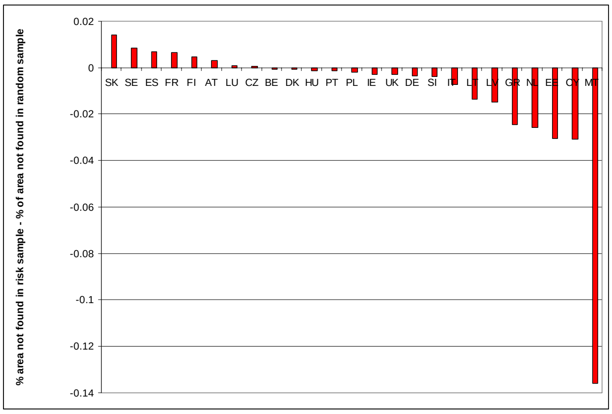

Figure 4: Difference of percentage of area not determined between the risk based and the random samples, by MS (OTS checks results 2005).

If we compare the risk based sample and the random sample in terms of area not determined, we observe that in nearly half the MS, the percentage of area not determined is larger in the random sample than in the risk based sample, which suggests that the risk analysis should be revised.

3. Determination of risk factors through CART algorithm

In order to identify the most appropriate risk factors with respect to a decision criterion, a decision tree technique based on Classification And Regression Tree (CART) algorithms is proposed (Breiman et al., 1984, Steinberg and Colla, 1995).
The principle of CART algorithms is to classify the population of claims into classes as homogeneous as possible with respect to a target variable, e.g. the % of claims with anomaly or the amount of aid not paid. Two main algorithms are commonly used: CART and CHAID (CHi square Automatic Interactive Detection). The main differences between these two algorithms are the following:

- CHAID is restricted to categorical variables (i.e. continuous variables have to be recoded into categories prior to the analysis) whereas CART uses categorical as well as continuous variables.
- CART splits a dataset into 2 groups that maximize the homogeneity of the 2 child nodes with respect to the target variable using the within node variance for continuous data or an impurity index for categorical data, whereas CHAID partitions the dataset in at least 2 groups by maximizing the between group differences. These differences are measured through a Chi2 statistics on the target variable.

The algorithms are recursive, i.e. applied on each child node created. The creation of child nodes is stopped when the tree reaches the depth fixed by the analyst or the class population is below a threshold fixed by the analyst. The result of the analysis is a tree with as many classes as terminal nodes. All nodes (i.e. classes) are characterized by a value of the predicted target variable, in our case the % of claims with anomalies or the average aid not paid.

4. Example on Italy 2005 data

At the request of the Italian Authorities, the CART method was tested on the claims checked OTS by the Italian Paying Agencies in 2005. The random sample of claims (12 304 claims) was used for assessing the risk factors as it was considered to be representative of the whole population of claims. Because the risk based sample (about 58 000 claims) only contained particular categories of applications as a result of the selection made, it was discarded not to bias the assessment of the risk factors. In other words, if as a result of the risk analysis, only claims from regions A, B and C are selected for OTS checks, the analysis of this risk based sample will omit claims from regions D, E and F and may therefore not identify risky claims and factors from these regions.

The attributes of the 12 304 claims (actually crop groups) provided were the following:

- the type of crop group (SPS, durum wheat, protein crops, rice, nuts, energy crops and "art 69" of reg. 1782/2003);
- whether the claim was new (with respect to the previous 3 campaigns) or not;
- whether the claim was checked in the previous 3 campaigns or not;
- For claims checked in the previous 3 campaigns, whether the discrepancy found was above 10% of the group area or 5 ha, or not;
- the total value of entitlements of the farm categorized in 3 classes: below 1000€, between 1000 and 5000€ and above 5000€;
- whether the claim was lodged with external support or not;
- whether it was lodged after the deadline or not;
- whether there was an error related to the LPIS or not (wrong LPIS id, area claimed above the maximum LPIS area or the maximum eligible area);
- whether the claim was close to or above the maximum bovine density in 2004 or not;
- whether the number of animals was between 200 and 500 or not;
- whether the claim fell in a commune to be checked with RS in the current year (2005) or not;
- whether the claim requested an access to the national reserve of entitlements or not;
- whether more than 40 parcels were claimed or not;
- whether the claim contained the following crop groups or not: rice, hemp, nuts, certified seeds, dry fodder.

In total, 23 attributes or potential risk factors were considered for each of the 12 304 crop groups. The macro region (NUTS 1 level) was also considered in the analysis as a potential risk factor. As all potential risk factors were qualitative variables, the CHAID algorithm was selected. A maximum depth of 5 child nodes and a minimum number of 100 claims per node were set.

In order to identify the risk factors that best discriminate claims with anomalies, two potential target variables were used:

- the outcome of the 2005 OTS check in terms of area discrepancy; this outcome was recoded into 0 for no discrepancy or discrepancy below 3%, and 1 for discrepancy above 3%
- the outcome of the 2005 OTS checks in terms of aid not paid, actually the difference between the requested aid and the determined aid;

5. Results and discussion

The results of the classification using the amount of aid not paid as target variable (i.e. decision criterion) are shown in Figure 5 and Table 1 while Figure 6 and Table 2 display the results of the partition based on the percentage of claims with anomaly (i.e. discrepancy above 3%).

With the amount of aid not paid, the first discriminating criterion appears to be the entitlements value: the average aid not paid amounts to 38.7€ for farms above 5000€ of entitlements against 7.7€ for farms below 5000€ (Figure 5). This higher amount of aid not paid for larger farms compensates for their lower percentage of claims with anomalies (7.4% against 10.2% for claims below 5000€), which shows the importance of the decision criteria on the partition. It should be underlined that the average of 38.7€ is the result of a mean between many claims with no anomaly and a few claims with aid not paid of hundreds or thousands Euros.
The partition tree (Figure 5) shows the subsequent criteria identified by the algorithm:

- Among the "large" farms (with entitlements above 5000€), those requesting entitlements from the national reserve (class 1) appear to be more risky than those which do not (classes 2 and 6).
- Among the small farms, the claimed crop group appears to be the most discriminating factor, with a higher amount of aid not paid for nuts claims (class 3).

Class 1 (entitlements>5000€ and request for access to the national reserve) appears to have the highest average amount of aid not paid (105€) but also by far the highest standard deviation (1219€), which indicates a high heterogeneity within the class in terms of aid not paid. Actually two claims with 18,500€ and 8,000€ of aid not paid respectively strongly influence the average aid not paid, which suggests that the results of this class could be instable.

The introduction of the NUTS1 region as attribute of the claims led to the partition of class 6 into two subclasses (Figure 5): the north-east, north-west and islands appear to be higher risk with an average aid not paid of 33.6€ (151€) against 12.7€ (58€) for the south and Centre.

The partition shows also that the vast majority of the claims (80%) is in the two lower risk classes (with 8 and 4€ of aid not paid, on average).

Using the percentage of claims with anomaly as target variable the crop group appears to be the first discriminating factor: claims for nuts appear by far to have the higher proportion of anomalies with 39% of the 356 claims, followed by the protein crop group (22% of the 225 claims), durum wheat and art. 69 (with nearly 14% of the 5678 claims) and last, the SPS and rice crop group (3.7% of the 6045 claims, of which 6019 SPS).
Among the claims for durum wheat and art 69 checked OTS in 2005, those checked by the classical method (based on archive orthophoto and a field visit) appear to have a higher proportion of anomalies (14.8% of the 5104 claims) than those falling in the remote sensing zones (6.3% of the 573 claims). There is no obvious explanation to this difference as in both types of OTS checks, the crop was checked in the field. Regarding the claims for durum wheat and art. 69 which were checked with the classical method, those from the north-west appear to have the highest proportion of anomalies (23.2% of the 332 claims) followed by the south and islands (15.3% of the 3658 claims), the centre (11.5% of the 826 claims) and the north-east (7.3% of the 288 claims).

From a financial point of view, identifying the types of claims for which the aid not paid is the highest is the criterion that best protects the European Agricultural Guarantee Fund. It is recommended to use as many attributes as possible to characterize the claims as the CART algorithm was designed to manage hundreds of variables.

Once the risk factors have been identified, a sampling plan needs to be designed. A first strategy could consist in sampling only the classes identified as high risk (provided that these classes are large enough to complete the risk based sample, which is not the case in the Italian example). However, farmers claiming a particular aid (e.g. the nuts aid) may appear as high risk in the sample due to a particular difficulty; in this example, the declaration of a nuts orchard area. Since this difficulty may be overcome (e.g. by supplying the official area of the nuts orchards to farmers), it is advisable to sample each class of risk, with higher rates in the high risk classes, as the risk factors identified depends on the OTS checks sample used and may change from one year to the other.

6. Conclusions

This paper proposed a method for identifying the risk factors for the selection of the OTS check sample. The method, named CART, consists in classifying the claims checked OTS in a previous campaign into classes as homogeneous as possible with respect to a decision criterion. As much as possible care should be taken to select a representative sample of OTS checks so as to cover all possible types of claims. It is recommended to use as many attributes as possible to characterize the claims. As for the decision criterion, i.e. the variable used by CART for discriminating the claims, the area not determined or the aid not paid can be considered to be the criteria that best protect the European Agricultural Guarantee Fund by comparison with the proportion of claims with anomalies.

7. References

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Steinberg, Dan and Phillip Colla. CART: Tree-Structured Non-Parametric Data Analysis. San Diego, CA: Salford Systems, 1995.

Class (terminal node)	% of claims with anomaly	Average aid not paid (€) and standard deviation	Number of claims
1. Entitlements > 5000€ & request for access to national reserve	5.5	104.9 (1219)	274
2. Entitlements > 5000€, no request for access to reserve, max eligible area of reference parcel exceeded	8.6	44.7 (240)	430
3. Entitlements < 5000€ & nuts claim	38.9	43.8 (108)	344
4. Entitlements < 5000€, no nuts, discrepancy>10% or 5 ha in the previous 3 campaigns, max eligible area exceeded	15.2	37.7 (130)	66
5. Entitlements < 1000€, no nuts, no discrepancy>10% or 5 ha in the previous 3 campaigns, more than 40 parcels subsidized	13.5	26.0 (159)	104
6. Entitlements > 5000€ & no request for access to reserve & max eligible area not exceeded	7.4	19.9 (101)	1101
7. Entitlements < 5000€, no nuts, discrepancy>10% or 5 ha in the previous 3 campaigns, max eligible area not exceeded	13.5	11.0 (42)	133
8. Entitlements between 1000 and 5000€, no nuts, no discrepancy>10% or 5 ha in the previous 3 campaigns	8.1	8.0 (82)	4871
9. Entitlements < 1000€, no nuts, no discrepancy>10% or 5 ha in the previous 3 campaigns, less than 40 parcels subsidized	10.0	4.1 (27)	4981

Table 1: results of the CART algorithm applied to the random sample of 12 304 crop groups checked OTS in 2005 using the amount of aid not paid as target variable. The nine classes are displayed by decreasing amount of aid not paid. The percentage of claims with anomaly (i.e. discrepancy above 3%), the standard deviation of amount of aid not paid and the number of claims per class are also shown.

Class (terminal node)	% of claims with anomaly	Average aid not paid (€)	Number of claims
1. Nuts & max eligible area of reference parcel exceeded	50.3	55.3	153
2. Nuts & max eligible area not exceeded	30.5	37.0	203
3. Durum wheat (title IV) and crops claimed for art. 69, commune not checked with RS in 2005, NW	23.2	9.9	332
4. Protein crops	22.2	8.7	225
5. Durum wheat (title IV) and crops claimed for art. 69, commune checked with RS in 2005, new claim	18.3	14.4	71
6. Durum wheat (title IV) and crops claimed for art. 69, commune not checked with RS in 2005, south and islands	15.3	8.6	3658
7. Durum wheat (title IV) and crops claimed for art. 69, commune not checked with RS in 2005, Centre	11.5	4.3	826
8. SPS & rice, no request for access to reserve, discrepancy>10% or 5 ha in the previous 3 campaigns	9.1	36.8	121
9. Durum wheat (title IV) and crops claimed for art. 69, commune not checked with RS in 2005, NE	7.3	2.1	288
10. Durum wheat (title IV) and crops claimed for art. 69, commune checked with RS in 2005, claim not new	4.6	1.9	503
11. SPS & rice, no request for access to reserve, no discrepancy>10% or 5 ha in the previous 3 campaigns	3.8	11.3	5099
12. SPS & rice, request for access to reserve	1.9	36.0	825

Table 2: results of the CART algorithm applied to the same random sample using the percentage of claims with anomaly (i.e. discrepancy above 3%) as target variable. The classes are displayed by decreasing percentage of claims with anomaly. The average amount of aid not paid and the number of claims per class are also shown.

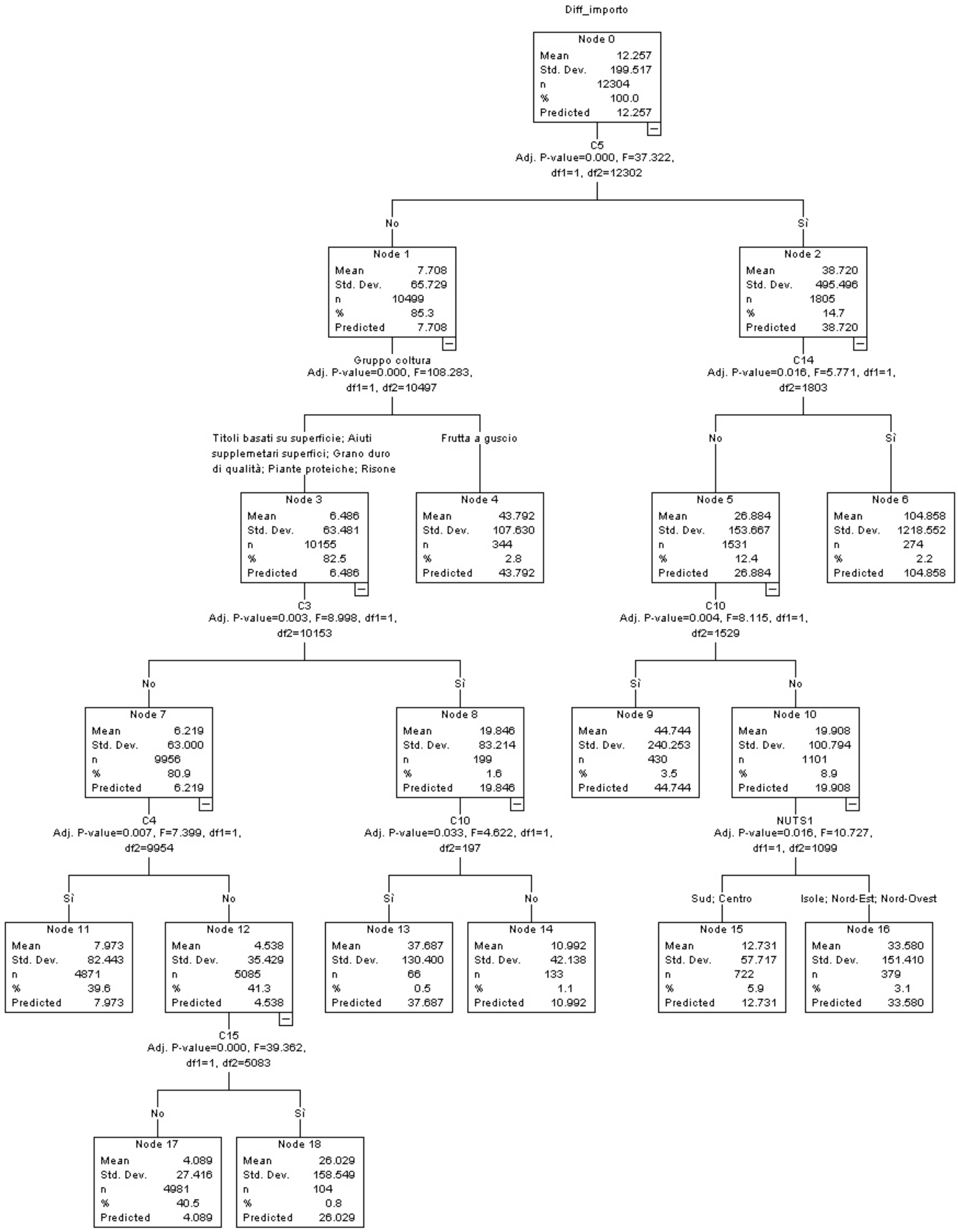

Figure 5: Partition tree obtained with the target variable "amount of aid not paid", a maximum depth of 5 nodes and a minimum number of 100 claims per node (i.e. the partitioning stops for nodes with less than 100 claims).

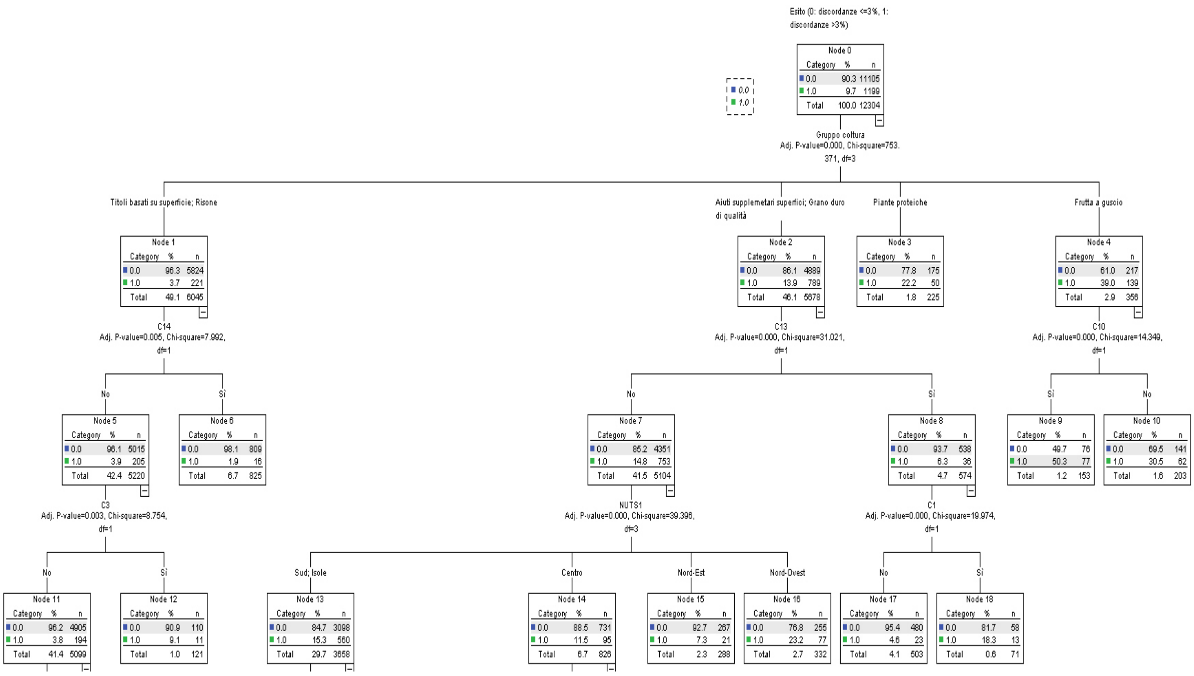

Figure 6: Partition tree obtained with the target variable “percentage of claims with anomalies”.
The criteria not described in Figure 5 are:

- C1: new claim (with respect to the previous three years).
- C13: farm falling in a commune checked with RS in 2005

Session T3: GAEC control with remote sensing

SEMI-AUTOMATED EXTRACTION OF LANDSCAPE FEATURES FROM VHR SATELLITE DATA

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KEY WORDS: landscape features, GAEC, monitoring, satellite data, OBIA

ABSTRACT:
The aim of the study was to prepare a methodology for vegetation Landscape Features (LF) delineation in order to aid monitoring of these phenomena. This was achieved by applying two very distinct approaches. Firstly, a manual approach for which very high resolution images (Ikonos) was applied for manual extraction through digitising. Secondly, an automatic approach (object-oriented image analysis) in which the same very high resolution images for the development of an automatic protocol were used. Both approaches were consecutively compared and a measure of agreement was calculated. The results from manual approach were used as reference data for comparison. The LFs selected for mapping included scattered vegetation units: groups of trees, solitary trees, shrubs and hedgerows.
The user's accuracy of the final automated object-oriented classification results amounted to 81% while the producer's accuracy amounted to 74%, indicating a good agreement between both methods. The overall accuracy was 98 %. The developed methodology of automatic (semi-automatic) classification of LFs was further on applied to other larger data sets (area of 10 x 30 km) to evaluate applicability in the monitoring tasks.

1. INTRODUCTION

Landscape features (LF) can be defined as non-productive parts of agricultural landscape with ecological value. In this study we have limited the methodology procedures to mapping only scattered vegetation landscape features as trees, groups and solitary trees, shrubs and hedgerows. These features are characteristic for different landscape types – their morphological characteristics and spatial distribution closely relates to long-time agricultural utilization of the landscape. LFs keep many ecological processes running in the landscape (e.g. microclimatic processes), serve as birds and animals habitats etc., are tightly connected to other parts of landscape, are important for soil erosion protection and also have esthetical value. LFs ecological functionality depends particularly on their amount, spatial distribution within landscape, specious structure and quality. Requirements on LF optimal characteristics are different for diverse landscape types. Some of the aspects of scattered green vegetation in the landscape in relation to CAP for the Czech Republic are described in Cerna et al. (2006). Conceptually, the LFs can be divided into point, linear and areal feature categories. However, in practical work, it proved to be very problematic typology as these categories tends to overlap and their strict separation is subjective (DAIFOR report, 2006).
LFs were largely removed and destroyed due to collectivization processes in state agriculture during the mid-20th Century in the Czech Republic. In contrast to landscape values conversion, high amount of arable land and rising agricultural production were the only priorities for the state agriculture. The need of LFs conservation appears as an issue again as late as after 1989.
Landscape features become increasingly important in view of habitat restoration or protection for fauna and flora, biodiversity and landscape structure indicators (Council Regulation EC No. 1257/1999 of 17 May 1999 on support for rural development from the European Agricultural Guidance and Guarantee Fund). Retention of Landscape Features (wood, hedges, isolated trees, etc.) has been selected by many of EU countries as GAEC. This highlights the need of monitoring methodologies to be developed.
Likewise in other European countries, there is a need to have reference spatial data layers of LFs, like the LPIS used for productive parcels, to perform effective monitoring and control of the features. Due to geographical character of LF phenomena remote sensing is the most effective way of detecting and monitoring LFs. Because of LFs small dimensions, only very high resolution data like aerial photographs or VHR satellite data are suitable for LFs extraction. There already exist case studies on mapping of LFs, either by visual photo-interpretation or by automatic procedures. Manual editing proves to be largely labour demanding and so costly. Pixel based image classifications are not appropriate for such a task due to very high spectral heterogeneity of LFs. The other option is to use object-oriented image analysis (OBIA) allowing complex description of the phenomena.
Object-oriented image analysis follows the concept that important semantic information necessary to interpret an image is not represented by single pixels, but by meaningful image objects and their mutual relationships. This method is based on initial image segmentation and consecutive object-based classification. The goal of image segmentation therefore is to derive meaningful image objects related to the features that should be extracted from the satellite/airborne images. This is especially important when dealing with highly textured very high resolution data types like VHR satellite images. Next important feature of OBIA is that the classification model allows combine spectral, textural, shape and contextual properties in a manner that to some degree emulate human visual interpretation.

The objective of the study was to develop and evaluate methodology for automated or semi-automated LFs extraction. This included initially definition of detectable LF from satellite images like Ikonos, extraction of reference spatial layer of LFs by visual interpretation and calculation of basic statistics. The next steps were to develop the methodology based on OBIA principles using object-oriented fuzzy classification (Benz et al., 2004), compare the results with reference data layer, assess the classification accuracy and test the transferability of the classification model.

2. MATERIALS & METHODS

IKONOS 1-meter panchromatic and 4-meter multi-spectral data acquired during vegetation season were the basic data source for this research. To incorporate the advantages of a very high spatial resolution (1 m), the panchromatic band was used in the classification. This enabled to use the Ikonos data for mapping at tree scale spatial level.

Apart from raster data, additional vector layers - ZABAGED (Fundamental Base of Geographic Data) – including land-use information useful for urban and forest areas masking, and LPIS (Land Parcel Information System) – with information about agricultural management – were incorporated in some steps of the LFs extraction process.

To obtain basic LFs characteristics overview in different agricultural types of landscape, two 10 x 10km square-shaped study areas with diverse agricultural management were tested. The first study area is located in lowland, Polabí region, with large amount of arable land intensively utilized by agriculture. The second area characterized by extensive agricultural treatment with predominant pastures and multiple forests is located in Krkonoše foothill region.

The first aim of the analysis was to define landscape features recognizable from VHR satellite data. From the first view of the images, it is obvious that not all types of LF are clearly detectable. It is almost impossible to detect balks or hollow walls without trees and shrubs, especially when they are surrounded by grasslands. In contrast, woody vegetation units are clearly visible on Ikonos images. Therefore the research is focused on remote sensing detectable LFs - scattered vegetation units in landscape. Initially, possibilities of LFs manual extraction were explored. The idea behind manual extraction was to gain an overview about LFs characteristics in extensive and intensive test areas as well as to create reference layers for consecutive automatic analysis results evaluation. Therefore visual interpretation has been done using Ikonos VHR data for both intensive and extensive agriculture areas. From resulting layers basic statistical stocks and spatial characteristics were derived.

In the first step of developing automated classification procedures, it was necessary to mask the urban and forest areas that include objects of the same or similar properties. Initially, land-use information from ZABAGED vector layer was used but update of the layer was necessary too. Automatic extraction process was performed using Definiens 5 Professional and later Definiens Developer 7 software. Multiresolution (Baatz and Schape, 2000), quad-tree and spectral difference segmentations algorithms were used. Feature Selection Tool and discrimination analysis helped to select suitable features (spectral and textural) for the classification. In order to obtain more image information, NDVI texture based on co-occurrence (Haralick, 1973); homogeneity with 3x3 kernel on the NIR band and detection of edge; Sobel edge filter on the NIR band pre-computed in PCI (per-pixel) were added (figure 1). Because of LF objects high spectral heterogeneity, the importance of textural measures for LFs automatic extraction was significant. The approaches of detecting trees from VHR images using combination of spectral and textural information are described in e.g. Zhang (2001) and Zhu et al. (2003).

Figure 1: False colour composite IKONOS, Haralick homogeneity and Sobel Edge detector for NIR

Image objects created by initial segmentation were classified using hierarchical classification based of fuzzy-logic rules. Numerous resulting sub-classes were then aggregated into two main final classes applying also contextual information (like neighbourhood to or relative border to): LFs/other objects. The

process of developing classification knowledge base is graphically presented in figure 2. Post-classification included filtering of small objects (MMU: 10 m^2) and finally generalisation procedures. The generalisation of the objects was done by mathematical morphology using both closing and opening procedures with circle and square structural elements, respectively.
Measures of overall, producer, user accuracy were derived. The accuracy assessment was done within Definiens Accuracy assessment tool, while vector layer created through manual interpretation was used as a TTA mask.

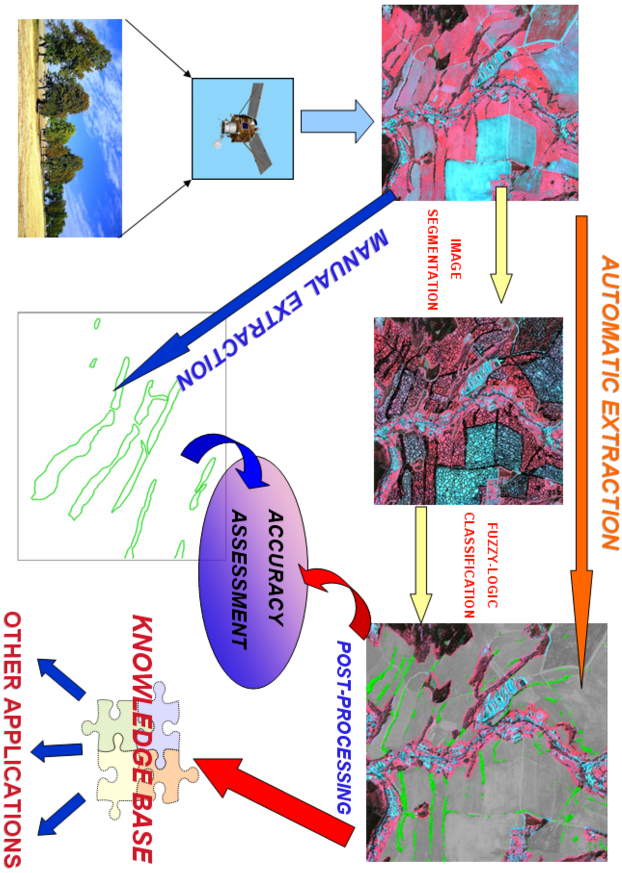

Figure 2: – Landscape features automatic extraction process

3. RESULTS and DISCUSSION

Two vector layers representing LFs for intensive and extensive agricultural area were created through manual extraction (figure 3). Resulting layers comparison shows LF characteristics dependence on type of agricultural landscape utilization. Generally, it is apparent that most LFs have linear characters. There is a small amount of single trees in extensive area, their overall acreage is negligible. Groups of trees with areal character are of sporadic occurrence. Small amount of LFs between individual holdings in intensive agricultural area seems to be fairly insufficient to protect from soil erosion of arable land.

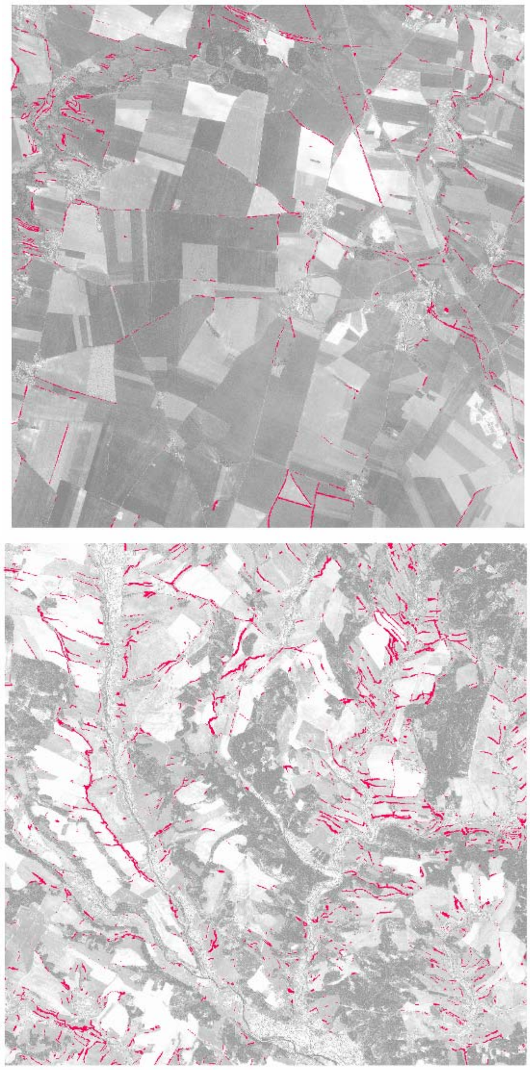

Figure 3: Spatial distribution of LFs - extensive and intensive agricultural area (both 10x10km) - comparison

For LFs in both areas, basic stocks were derived, as can be seen from the table 1. It is not surprising, that there is also significantly larger proportion of agricultural land in intensive area, number and LFs area here is less than a half of the LFs amount of extensive area. Average LFs acreage is similar for both extensive and intensive area. Low value of area medians indicates large amounts of small LFs in both test sites.

	type of agriculture	
	intensive	**extensive**
agricultural land proportion (%)	84,40	50,70
LF statistics		
number of LFs	**584**	**1266**
area total (ha)	**111,80**	**202,80**
area average (ha)	0,19	0,16
area median (ha)	0,09	0,05

Table 1: LF statistics – comparison of intensive and extensive agricultural area

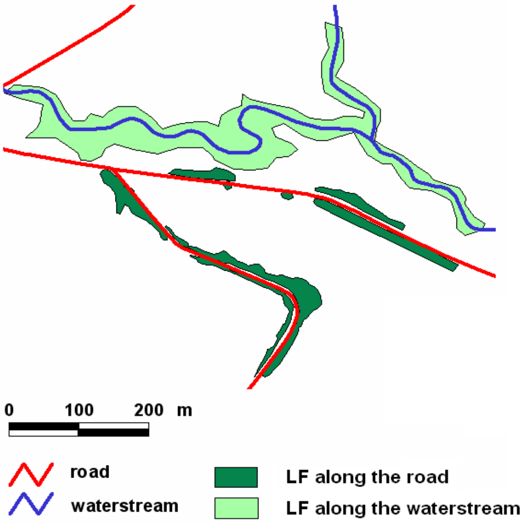

Figure 4: LF breakdown according to proximity to linear features

To provide statistics about LFs proximity to linear features like roads, water streams or railway, spatial analysis in ArcINFO was carried out (Figure 4). The basic difference between both areas was detected in the amount (and area) of LF along roads. In extensive area it is only 4% of LFs acreage, in intensive area it is almost one quarter of all LFs situated along roads.

	type of agriculture	
	intensive	**extensive**
LF along	area (%)	area (%)
water streams	**18**	**22**
roads	**24**	**4**
paths	24	29
railways	9	1

Table 2: LF breakdown according to proximity to linear features - intensive x extensive agricultural are

Another important LFs characteristic is their location according to type of agricultural land in neighbourhood. This analysis was done only for extensive area, because of insignificant number of grassland parcels in intensive area. As a reference layer, land-use classification derived from Landsat 7 was used. The results show, that most of LFs within extensive agricultural area are situated within pastures (table3).

	type of agriculture	
	% of LF area	**% of agri land**
LFs on arable land	**13,0**	**44,6**
LFs on pasture	**70,0**	**55,4**
LFs between arable and pasture	**17,0**	

Table 3: SLU breakdown according to agricultural land in neighbourhood

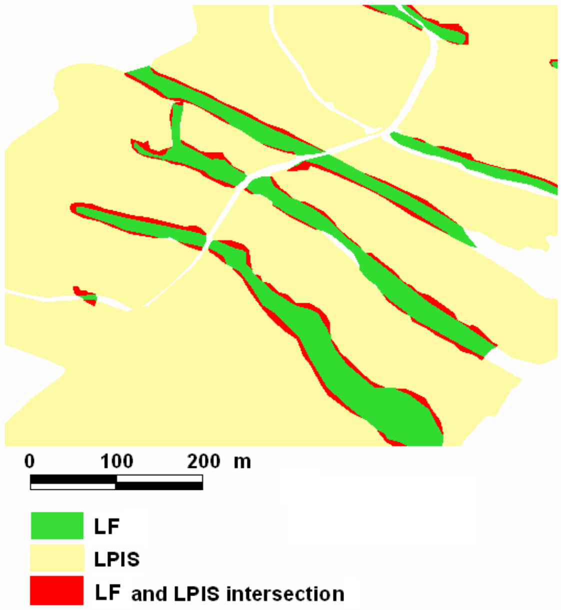

Figure 5: LF breakdown according to LPIS

The aim of the next statistic (table 4) was to investigate the spatial relationship of LFs and LPIS concerning the location. As can be seen from table 4, most of LFs are located outside the LPIS layer, sometimes near the LPIS border. The overlay is caused mainly by different delineation approaches of both layers; also tree crowns can be responsible for some delineation inaccuracy. Only about 1% of LFs area lies indeed inside LPIS layer applying 10 m buffer along the LPIS borders.

	type of agriculture	
	intensive	**Extensive**
inside LPIS (%)	**18,6**	**23,5**
inside LPIS (%) > 10m from the LPIS border	**0,6**	**1,8**

Table 4: LF breakdown according to LPIS

In order to gain a better idea on the accuracy of the above presented automatic extraction method, the classification results were compared to the manual extraction method. The method that was applied here implies a relative assessment of agreement between the basic statistics calculated by both methods. The relativity of this agreement assessment emerges from the fact that also the manual extraction method is probable prone to interpretation and classification errors. In order to test the agreement between both methods, accuracy of resulting classification was statistically assessed in Definiens SW using TTA mask overlay. Result of manual extraction was considered as a ground truth and set as a TTA mask. The area calculations based on the manual and the automatic extraction was compared through the percentage user's accuracy (agreement with manual) and producer's accuracy (agreement with manual). The producer's accuracy amounts to 74% while the user's accuracy even amounts to 81%, indicating a good agreement between both methods.
After statistical analysis, visual evaluation was also done (figure 6). There exists a good delineation of single trees as well as tree clusters, the shapes derived from the automatic process are more irregular in shape, while a human interpreter tends to generalise, there exists a good and objective delineation of all possible vegetation objects (small as well as large trees, small vegetation objects that are missed in the

manual classification). The misclassification occurred mainly within textured grass/fields, brighter parts of shrub (Figure 7) – causing gaps that needed applying cleaning procedures.

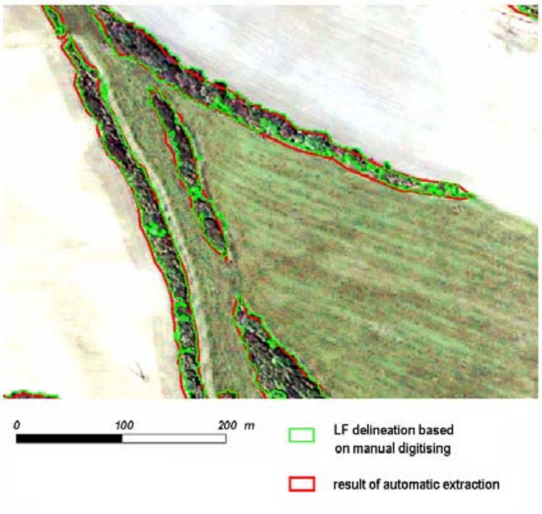

Figure 6: LF delineation as a result of manual digitising compared to automatic extraction

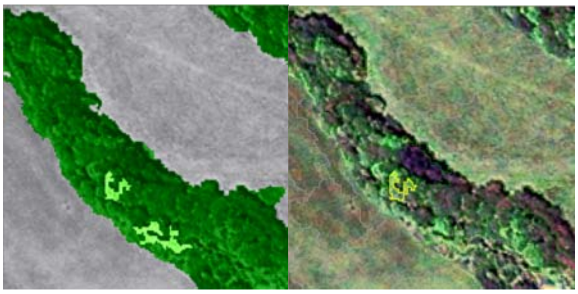

Figure 7: Misclassification – gaps inside of LF – brighter parts of shrubs cover

The generalisation procedures by mathematical morphology enhanced the classification results to similar object delineation comparable to polygons drawn by manual extraction (figure 8).

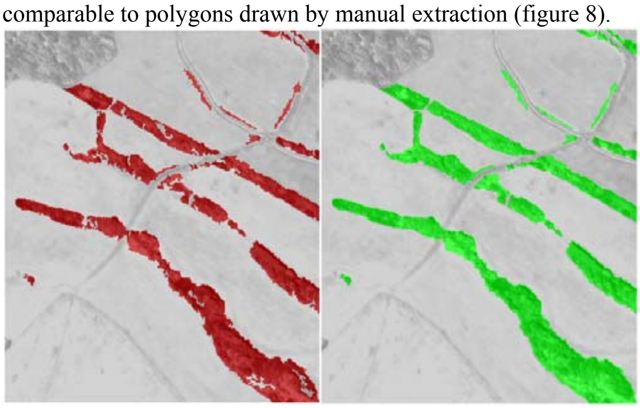

Figure 8: LF automatic extraction results generalization using mathematical morphology

Following the model development, the methodology for automatic extraction of LFs was applied to a selected foothill area of 380km2 to evaluate the methodology and test transferability (Figure 9). The classification showed that there is about 12% of LFs in the total area of the landscape. The developed methodology was then used in other countries with highly different environments like Alaba region of Ethiopia (using Quick Bird images) to test the model.

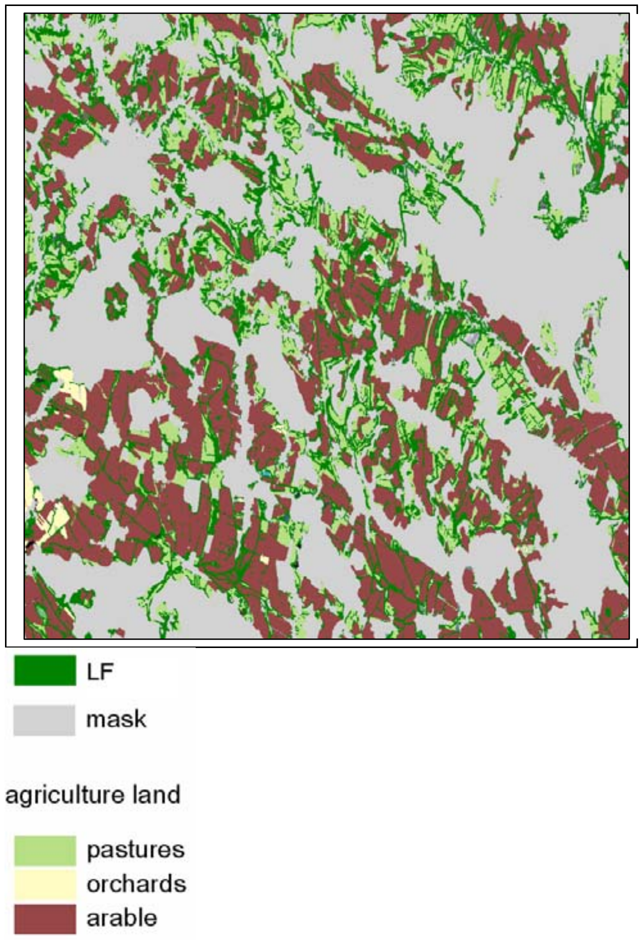

Figure 9: Automatic extraction of LF - case study: foothill region 380km^2

4. CONCLUSIONS

The method developed for object-oriented automatic landscape feature extraction showed good results, comparable to visual interpretation. Initial problems with low level of generalisation of the resulting LFs objects, given the high spectral heterogeneity of the features, were significantly improved by applying mathematical morphology. This method is suitable for classification of LFs on large areas, although the computation demand of the model is very high.

The results of the research have proven the suitability of OBIA method for LF monitoring on VHR images. Further improvements in the method are seen in the initial creation of the urban and forest mask. The definition of border between forest areas and LFs will be always problematic as well as the borders of urban areas.

For operational production, automatic pre-classification using developed method and post-classification manual evaluation and editing seem to be most appropriate approach as the users accuracy is expected to be higher than 81 %. Application of the proposed method should be further tested on aerial images that exist with full coverage of the Czech Republic.

5. ACKNOWLEDGEMENTS

The study was performed within the DAIFOR project (financially supported by the Government of Flanders under the Co-Operation Programme between Flanders and the Candidate Member States in Central and Eastern Europe) and CITT Praha frame work. The authors are grateful to JRC Ispra (EC, 2006) and Czech Paying Agency for providing data used in the study.

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Session T3: GAEC control with remote sensing

TELAER AGEA VHR SAR MONITORING SYSTEM: A REMOTE SENSING DATA INTEGRATION FOR CWRS

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KEY WORDS: airborne Synthetic Aperture Radar (SAR), Very High Resolution (VHR) SAR satellite, Controls with Remote Sensing (CwRS), Good Agriculture Environmental Conditions (GAEC)

ABSTRACT
The Italian Payment Agency -AGEA, recently acquired and is now managing the Telaer system (a Learjet and a Viator aircrafts with related ground segment), with different remote sensing sensors, ranging from optical multi-spectral and hyper-spectral to SAR band X at very high resolution. Through agreement with JRC, AGEA has been developing pre-operative feasibility tests in order to analyse the potential offered by these airborne systems, especially for SAR in the domain of land use detection, area eligibility and control of GAECs.

1. INTRODUCTION

In 2007 experimental SAR missions were planned and realized in Italy, over four AGEA Italian controlled areas. The availability of other data sources acquired jointly in the summer period of the campaign, such as farmer declarations, VHR optical satellite, on site measurements were also taken into consideration. Relevant interest was expressed for the use of high resolution (metric or better) SAR data to support the remote measurement activities concerning payment of subsidies in agriculture at farm and parcel level, sample control of the annual declarations and verification of the implementation of Cross-Compliance policies, aimed at the agro-environment sustainability. Furthermore, this data may be considered as a technical bridge with the new Cosmo Skymed satellite constellation (4 SAR satellites from the Italian Space Agency – ASI, two already in orbit), thus highlighting the involvement of Italy throughout the high resolution SAR sector, in the specific case for control in agriculture and developments relative to the new Common Agricultural Policy (CAP).

AGEA, which manages the Telaer system directly, also has optical, multi-spectral and hyper-spectral sensors available for its aircraft. These sensors, with diverse resolutions and visual fields, can provide, together with the high resolution SAR, direct and synergic contributions, for traditional CAP activities, as well as for fish farming and aquaculture, local management, civil protection, etc. Further fields of application have already been found in forestry monitoring and forest fires (National Forestry Corps of the Italian Agriculture Ministry).

This paper describes the experimental activities, realized in 2007, which AGEA considers suitable for institutional activity purposes, both at the national and at the EU level. The fulfilled activities hereafter described, mainly regard SAR data acquisitions, processing and result extraction. In addition, despite a lower level of interest for the CAP, hyper-spectral sensor recorded imagery over a sub-sample on the same zones.

In summary, starting from the institutional and operative requirements, it is now possible to start delineating for VHR SAR: geometric and thematic accuracy, work times and costs, benefits and open issues, always bearing in mind integration with the new SAR and optical satellite constellations.

2. TEST AREAS

The following figure and table describe the main characteristics of the flights carried out over the 4 zones in Italy, selected among different agronomic landscapes of the CwRS sample areas of 2007. All the zones were recorded using both configurations: SAR band X and Hyper-spectral Sim.Ga.

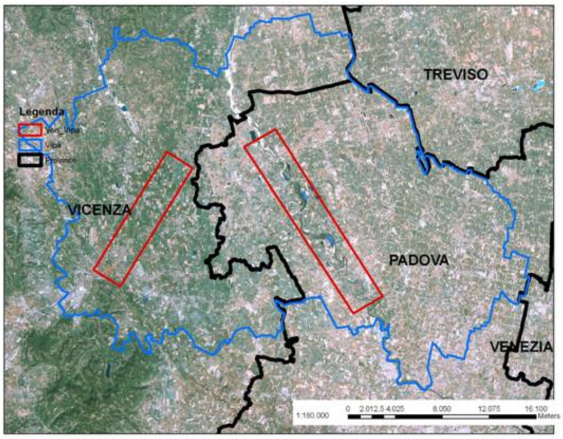

Figure 1: Example of Acquisition areas over Vicenza and Padova provinces – the blue boundaries show the 2007 samples for CwRS and the corresponding SAR flights; red limits delineate acquired hyper-spectral data

3. GROUND SURVEYS

During the summer a large amount of ground survey data were acquired. The scope was to collect ground truth information on the sample areas (randomly, but with a good and dense territorial coverage), concerning the agronomic land use, agro-environmental parameters and radiometric measurements with portable instruments, aimed at the hyper-spectral calibration. In this way, in addition to agronomic declarations, and ground surveys of negative/doubt parcels coming from the AGEA activity of CwRS, almost 300 points of ground truth and more than 60 radiometric points were acquired for setting both SAR and hyper-spectral strips. The ground truth has been also used for double checking the parcel's interpretation using SAR data.

Test:	Agriculture – CAP Controls
Aircraft:	Learjet
Sensor	SAR (AeS-1 Aero-Sensing)
Sites CwRS Italy 2007 and acquired km2	Asti (186 km2), Vicenza-Padova (848 km2), Pesaro (418 skm), Potenza (404 skm)
Mean site area	400-500 km2
Flight altitude	3500 m
Swath of each Track	2000 m
Spatial resolution	0.5 m
Temporal period	summer 2007
Ancillary data used	DEM, photo-grammetric points/monographs 0,4m; AGEA database and GIS; existing ortho-photos; satellite VHR ortho-imagery 2007; Cosmo Skymed satellite data
Trial timing	June-July-August 2007 Winter-spring 2008 for Cosmo
Expected results	operational capability evaluation; thematic and geometric accuracy; multi-temporal capacity across the agrarian year; costs and benefits relative to requirements and geographic location, Italy or EU Member States

Table 1: Characteristics of SAR through Learjet SAR: configuration and acquired km2 over the different test areas

4. DATA USED AND PROCESSING

After the complex processing activities to re-generate the single strips of the different sensor (SAR and hyper-spectral), the main ancillary data used during the tests are summarized as follows:

- Ortho-rectification activity
  - Photogrammetric points (0,4m) derived by AGEA ortho-photo building; DEMs from AGEA data – base (40m grid, Z axis accuracy 7m); existing ortho-photos from AGEA GIS and data-base
- Vector graphical data
  - Cadastral maps and single agronomic declared parcels
- Raster graphic data
  - VHR satellite ortho-imagery from CwRS 2007, false colour and pan-sharpened; mosaiked on national 1:10,000 topographic maps grid
- Alpha-numeric data
  - 2007 declarations, extracted from AGEA sample over the studied areas; farm dossiers and declared parcels
- Software and facilities
  - SITI client access with authorization, aiming at re-building and re-using the traditional operational working chain for CwRS activity (official SW used by AGEA and Contractor).

5. ORTHO CORRECTION OF SAR DATA

The ortho-rectification of SAR data was performed using an algorithm, implemented on a specific SW module, developed by AEROSENSING Company. The methodology utilizes flight stability control data (roll, pitch and true heading angles, velocities on the three axes), measured by an inertial control unit with 200 Hz of temporal sampling, combined with the aircraft positioning data, measured by a DGPS system (on board GPS receiver and on ground GPS antenna) with 2 Hz of sampling. These data were connected to GPS time and consequently to a line or a portion of the acquired tracks. Using a geocoding algorithm that links the sensor position with the geographic projection of a specific pixel of the image, and also using a Digital Elevation Model (DEM), the projected track is calculated assigning a geographic positioning to each pixel of the image.

Extremely important is the use of accurate DEMs, with spatial resolution similar to the acquired data (in the case of Telaer SAR system is 0.5 m on the ground). Unfortunately, a DEM with such resolution and accuracy are not easily available, with the exception of some local cases.

In the framework of this project, evaluation tests on DEM quality impact on SAR geometric accuracy was performed. The geometric accuracy is one of the main required characteristics for CwRS. Some SAR tracks were ortho-rectified selecting from areas with different elevation and morphology, using two DEM with different spatial resolution and accuracy:

- DEM obtained by SRTM satellite, freely available, with 90 m of grid and declared accuracy of 60 m in horizontally and 16 m in vertically;
- DEM obtained by database AGEA, provided by the same agency, with 40 m grid and accuracy of 4 m in horizontally and 7 m vertically.

Finally, DEM AGEA, the same successfully used for traditional activity in optical VHR satellite ortho-rectification, was the only one used for the reported analysis of this paper. An extension of the analysis using more accurate and precise DEM is planned.

After the ortho-rectification, some easily recognizable control points were identified, both over the SAR tracks and on a corresponding ortho-photo (optical airborne), processed with high accuracy, which can be considered as ground truth. Then, geographic coordinates of control points on the tracks (x_s, y_s) and on the ortho-photos (x_o, y_o) were measured, and the absolute distances between SAR points and ortho-photo points were finally determined (these distances can be called geometric mismatch or accuracy):

Geometric mismatch = $[(x_o-x_s)^2+(y_o-y_s)^2]^{½}$

The following graph reports the same preliminary results of this analysis: points represent mismatch between SAR and ortho-photo control points, versus the elevation of the point, considering the two different used DEM. Also an interpolated trend line is reported on the graph.

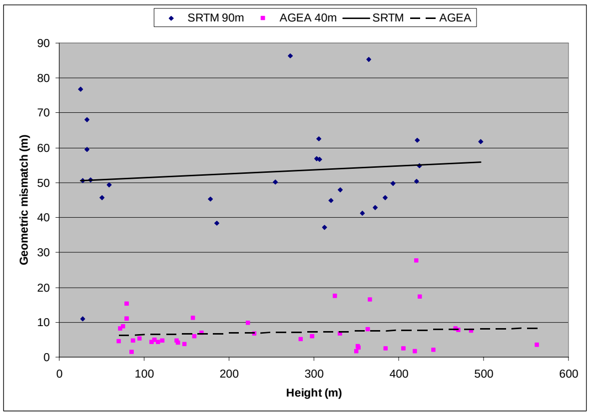

Figure 2: Ground control point geometric mismatch versus the measured point elevation for the two different DEMs (SRTM and AGEA)

It is possible to see that the impact of the used DEM is truly considerable, changing from accuracy values of about 50 m (for 90 m SRTM DEM) to accuracy values of less than 7 m (for 40 m AGEA DEM). Furthermore, it seems that, inside the elevation range considered, a notable difference of accuracy for different elevations does not come out. Probably a certain difference could be found for elevations greater than 500m, or plotting the accuracy distances versus the slope along the line of sight of the specific analyzed point (it is an on-going work).

In the following graph the dependence of the geometric accuracy on DEM spatial resolution (in the x axes) is represented, together with a possible quadratic trend line. The reported values are the mean values of the mismatch distances for each of the two DEM used (corresponding to the two plotted points).

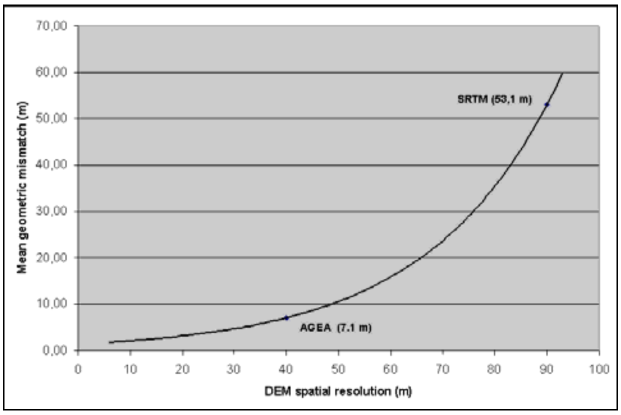

Figure 3: Geometric mismatch versus used DEMs spatial resolution. A possible exponential trend line is reported

Currently, only two plotted points are present, but it is expected to extend the analysis to other Elevation Models in order to plot a trend, particularly in the range of more accurate DEMs. Following the plotted trend line, it is possible to assume that passing from a 40 m DEM (AGEA) to a 20 m DEM, the average 7 m geometric accuracy should improve up to 3-4 m (in average, considering both flat and hilly areas). In this case, the accuracy should be better than the expected one requested (5 m RMSE) for the satellite data used in CwRS, such as Spot 5 supermode and /or Formosat 2.

Another approach of our analysis consists of the decomposition of the geometric error into its along and across track direction. Starting from the reconstructed trajectory followed by the aircraft during the acquisition, it was possible for each track to calculate a new reference frame with the two parallels based respectively in the acquisition direction (along track dimension) and in the line of sight (cross track dimension). Through this new point of view the two most important causes of geometric error can be isolated: the impact on the geometric mismatch of DEM lack of precision (cross track component) and timing delays introduced during the data acquisition (along track component).

On the next two graphs the two components of the geometric mismatch are represented. As it is possible to note, the results are in line with what can be expected: the DEM accuracy has an impact only on the cross track error (the compensation of these effects through two different correction algorithms is an on-going work).

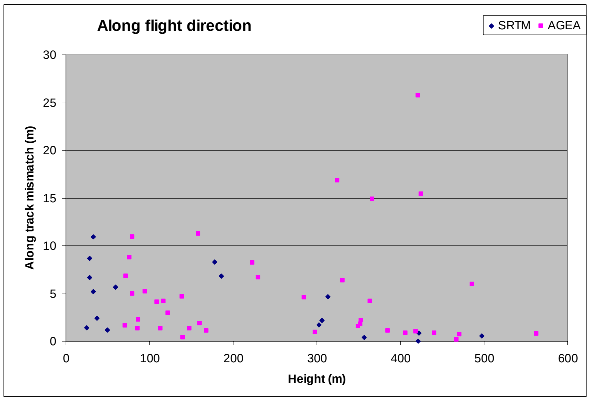

Figure 3: Along track dimension of the geometric mismatch versus the measured elevation of the GCPs used

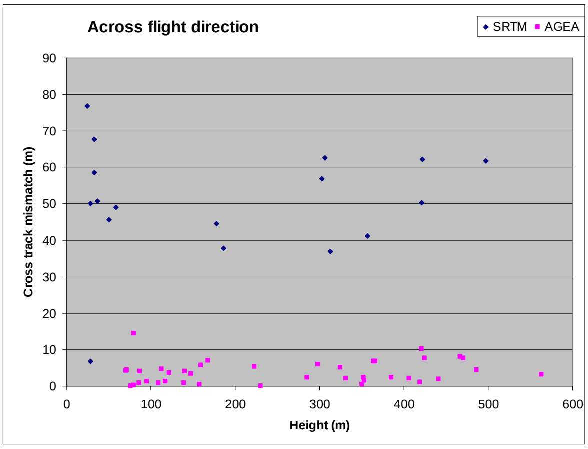

Figure 4: Across track dimension of the geometric mismatch versus the measured elevation of the GCPs used

6. INTERPRETATION CAPABILITY AND EXPECTED RESUTS

Regarding the eligibility of areas, performed tests clearly indicated the capacity of Telaer SAR to identify the territorial characteristics of the single agronomic (cadastral) parcels, even of small dimensions. In fact, buildings, roads and paths, wooded and bush-land areas, vineyards, rocky areas are clearly detectable. Concerning this activity, it must be said that woodland and single trees appear as covering wider areas than real (it is mainly due to SAR projection of the signal especially in elevated areas). This reduces in some way the “effective” and eligible surface of arable land. Another found capability during the Tests is the recognition of ploughed fields or those without vegetation during all the seasons (winter included), exploiting the SAR sensor. Some GAEC standards (pastures, set-aside) foresee the absence of mechanical working on areas declared as set-aside (certain periods) or on pastures, for protection of habitat and wild-birds life, for impeding unauthorised production or to maintain hydro-geological equilibrium. Maintenance of land under grass during the winter is often requested to avoid soil erosion due to increased water streaming and to cryo-clastism; in these cases the creation of a system of off-flow lines or naturally grassed strips, also during the vegetative phase of cultivations is requested. VHR SAR data, with Telaer tests provided a very good performance in that ambit. A possible use of this system for monitoring the grass coverage is also encouraged for several Member States that must apply “minimum soil cover” requirements.

The above mentioned countries, listed by Joint Research Centre -JRC, are the following: Flanders, Wallonia, Denmark, Germany, Greece, Spain, France, Cyprus, Lithuania, Luxembourg, Netherlands, Austria, Poland, Portugal, Finland, England, Wales, and Northern Ireland. SAR acquisition capability in all seasons can really be a solution for the expected monitoring.

Further focus on all the aforementioned possibilities, in particular in the verification of application of Cross-Compliance policies and verify their real feasibility, operation, applicability in the Italian context, was done in some of the 2007 AGEA sample areas.

More than 40 SAR flight ortho-rectified strips (average size 2 x 15-20 km) were analyzed and more than 800 declared parcels (2007 declarations) were interpreted by expert technicians in CwRS activity. The main results, divided in three targets

- Agronomic land use detection capability: crop groups definition, traditionally detected through remote sensing tools and ground survey for negative and doubt parcels;
- Eligibility updating and measuring: agronomic maximum surface delineation for eligibility to payments, to be updated regularly;
- Main GAEC infringement’s detection: agro-environmental parameters to be respected and checked, with different methods and time scheduling;

are summarized as follows:

Activity of interpretation of agronomic land use, using the same SW and the same method for CwRS classification: the main results are:

- Interpretation capacity by crop groups (arable and grasses, trees and bushes, natural vegetation, artificial surfaces) = MEDIUM
- Potential for improvement in multi-temporal analysis (e.g. with archive data) = HIGH
- Capacity as a substitute instrument of VHR optical data in case of cloud cover or dense haze = MEDIUM
- Intrinsic limits of the SAR X band data in agronomic land use activity = MEDIUM

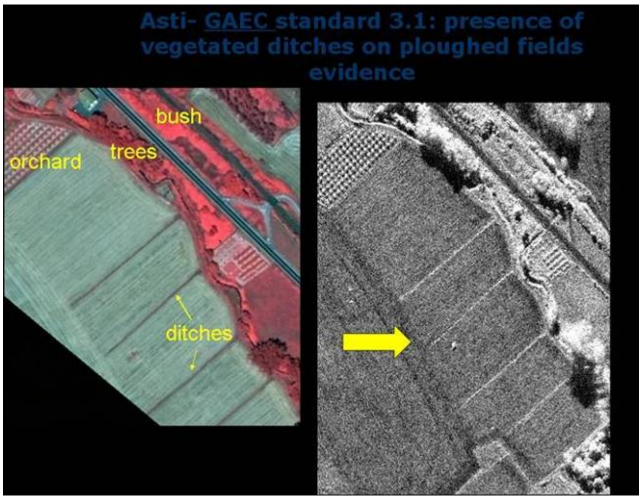

Fig.5: Comparison between optical and Telaer SAR data: GAEC analysis capability

Activity of interpretation for CAP eligibility updating: the main results are:

- Interpretative capacity for identification of specific classes of non eligibility (roads, houses and adjoining buildings, artificial areas, waters, woods, shrub areas, vineyards, etc.) = HIGH
- Capacity as a substitute instrument of VHR optical data in case of cloud cover or dense haze = HIGH
- Intrinsic limits of the X band SAR data for this activity = MEDIUM (especially due to the vegetation canopy enlargement on SAR imagery)

Activity of interpretation of erosion/land slide phenomena and the eventual presence/ absence of defence and protection measures: main results.

- Interpretative capacity to identify erosion, creeping and landslides = VERY HIGH

- Interpretative capacity to identify reflux lines, ditches, grassy areas = HIGH
- Potential for improvement in multi-temporal analysis = HIGH
- Intrinsic limits of the X band SAR data in erosion detection = (no limits appearing)

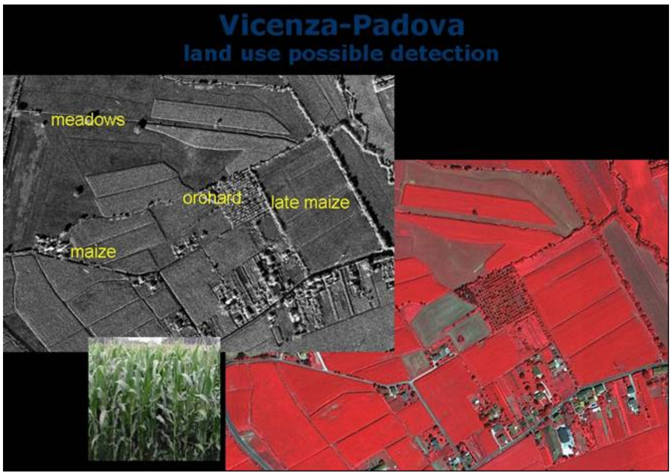

Fig. 6: Land use detection by SAR, through geometric features

Activity of interpretation of water stagnation and presence/ absence of drainage ditches, still in comparison with the traditional optical data: main results.

- Interpretative capacity to identify episodes of water stagnation = VERY HIGH
- Interpretative capacity to identify the presence and condition of ditches = HIGH
- Feasibility of analysis in temporal periods in multi-temporal mode (e.g. with archive data) =MEDIUM
- Intrinsic limits of the X band SAR data in this kind of detection =LOW

Activity of interpretation of pastures/set-aside zones and the eventual presence/absence of crop-grass mowing, again in comparison with traditional data: main results.

- Interpretative capacity to identify pastures or set-aside parcels, in their multiple appearances = MEDIUM-HIGH
- Interpretative capacity to identify grass mowing and/or agricultural workings = HIGH
- Feasibility of analysis in temporal periods in multi-temporal mode (e.g. with archive data) = HIGH
- Intrinsic limits of the X band SAR data in this kind of detection = LOW

Activity of interpretation of traditional structures of field delimitation: hedgerows, trees, dry stone walls, terracing, etc. for recording on database: main results.

- Interpretative capacity to identify traditional agronomic structures, even in their multiple manifestations = VERY HIGH
- Feasibility of analysis in temporal periods in multi-temporal mode (e.g. with archive data)= HIGH
- Intrinsic limits of the X band SAR data for agronomic structure monitoring= LOW

For the geometric assessment, considering all the expected and above listed targets, it can be said that the result can vary: RANGING FROM LOW TO VERY HIGH (always depending on morphologic complexity and ancillary data used –DEM)

Telaer SAR thematic score	Detection Problem capability	Detection of infringements (GAEC)	Multi temporal mode capability	SAR Intrinsic limits
agronomic land use	medium	NA	high	medium
CAP eligibility	high	NA	high	medium
erosion/land slip phenomena	very high	very high	high	No
water stagnation	very high	high	medium	low
pastures/set-aside	Medium-high	high	high	low
traditional structures	very high	high	high	low

Tab. 2: summary of the thematic scores obtained by the test outputs; the judgement of "intrinsic limits" is obviously inverse; NA: not available

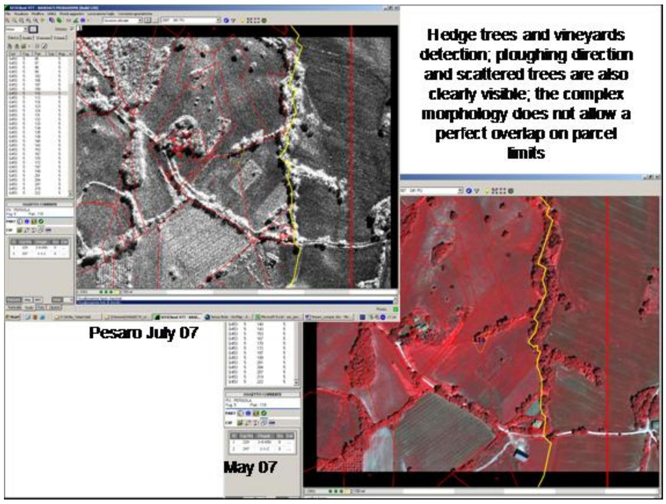

Fig. 7: SAR Telaer data ingested by AGEA SITIclient SW for CwRS activity

7. SUMMARY AND CONCLUSIONS

After the above listed thematic results, for the different targets, an additional summary, using Telaer data instead of VHR optical, and considering geometry correspondence, can be as follows:

- on flat areas, due to the geometry of fields and relief absence there is a very good compliance both in geometry and in thematic capacity, dealing up to 90% of the investigated parcels (Vicenza –Padova –Veneto region: around 200 investigated parcels)

- on flat-hilly areas some geometrical problems appear and some detection concerns are raising (e.g. the tree crowns show major volumes and therefore the orchard-olive classification presents major extension in canopy). The VHR-SAR comparison seems to show land use /eligibility capacity around 80% of the checked parcels (Asti – Piedmont region: around 200 investigated parcels)

- on <u>fully hilly areas</u> with complex morphology it is evident that, as already stated, the usual DEM, used for optical VHR data ortho-rectification appears inadequate, creating, on high gradient slopes/aspects, sometimes severe deformations on the reference parcels. Correspondence is around 65% on less steep zones up to very few workable parcels on mountain. By the way, the thematic point of view remains mostly correct. In this way, using existing multi-temporal optical data on the same area, it is possible to draw (if necessary) the geometrical lines through this layer (Pesaro –Marche region: around 400 investigated parcels).
Concerning some cadastral maps of this difficult area, the complete comparison between SAR and optical was not performed, due to evident geometrical problems.

For Cross-Compliance parcels on these extracted samples, the capacity in detection appears as good as the optical VHR multi-spectral.
For Cross Compliance analysis and monitoring, it can also be said that the capability of this system around the year/time and the all weather acquisition puts SAR in general on a very useful position.

The on going activity regards especially the geometrical improvement, using different DEMs and creating "accuracy curves", considering slopes, orientation, morphology, agronomical patterns in relationship among them.

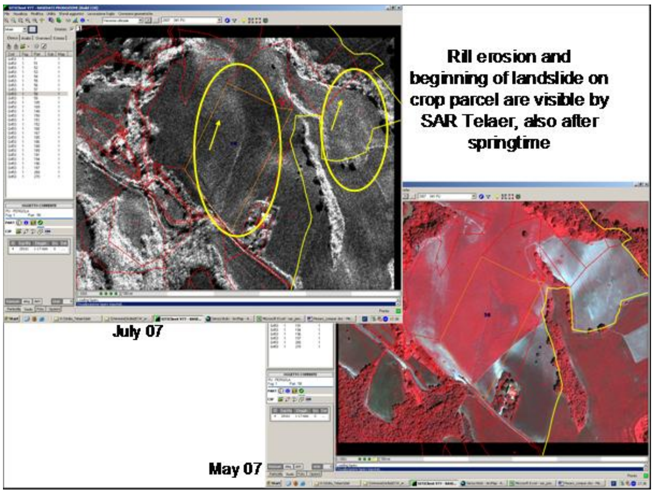

Fig. 8: Comparison optical/SAR, using SITI sw, for erosion lines detection

Taking into account the results obtained in this first part of experimentation, some further activities appear of particular interest, during the following season:

- "up-scaling" of control activities, in terms of amplitude of geographical area to be controlled, their geographic location (in particular Northern Europe, also with Cosmo Skymed), and the temporal revisit frequency.
- improvement of image geometric correction also in conditions of complex morphology, through the generation of accurate DEMs or using the interferometric mode (tandem);
- improvement of the capacity of classification and discrimination of SAR system, through the experimentation of further techniques of processing (multi-polarimetric analysis);
- possible automatic extraction of some parameters, currently identified through photointerpretation, through the development and implementation of algorithms;
- improvement of agriculture crops discrimination capacity, through the enhancement of multi-temporal acquisitions;
- GIS ingestion, including SAR, optical VHR, historical orthophotos, maps, declarations for AGEA usual management.

One of the most important achievement of these tests, as already mentioned in the introduction is the comparison and the assessment between the use of airborne and new SAR satellite systems. The next phases have been therefore including the use and the qualitative/quantitative comparison of high resolution satellite SAR data (mainly Cosmo SkyMed, but also Terrasar is foreseen) and their integration with Telaer airborne SAR and optical data into CwRS AGEA system.
All the current test areas (and for the next campaign in 2008) are planned for SAR Cosmo satellite acquisitions and successive related capability assessment, using the same above described targets.
Concerning satellite SAR data, it is important to say that the Commission has stopped to supply Member States with Radar imagery to complement or replace optical data. The main reason was because their usefulness was not proven and the Member States did not managed to use them in a proper way, mainly due to the lower resolution. The new scenario introduced by the VHR SAR sensors opens therefore a possible new request and satisfactory use of these tools, especially on countries above 50° degrees north. The combined use of Telaer with VHR SAR satellites, both as prototype and operative in AGEA systems is goes in that direction.

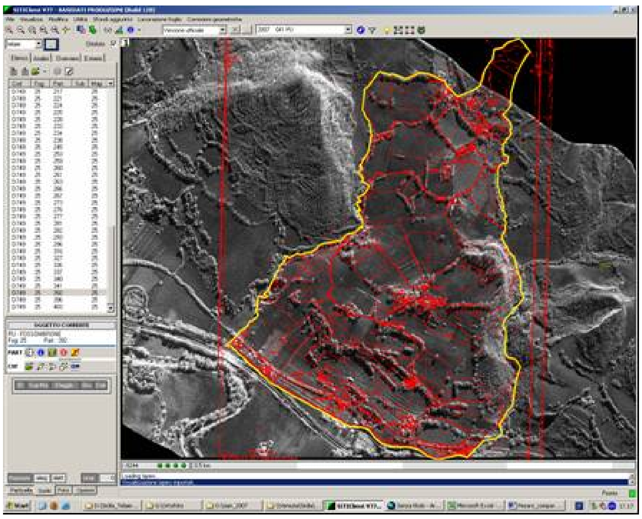

Fig. 9: Telaer, SAR airborne data on SITI client: full cadastral map overlaid

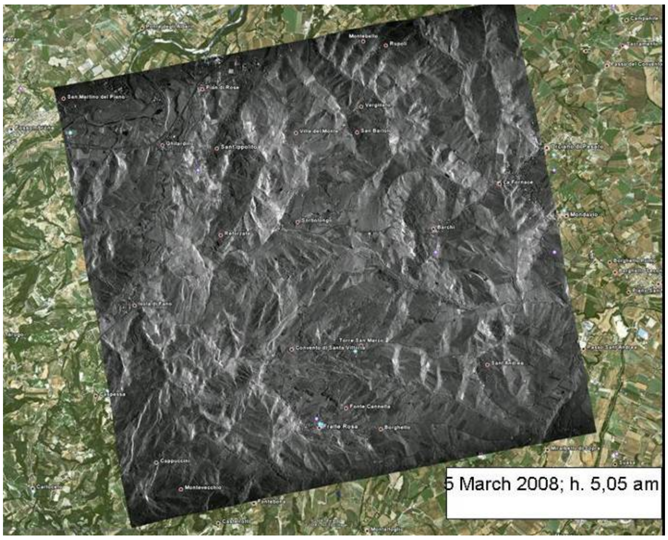

Fig. 10: Cosmo Skymed Spot light (1m) imagery already acquired on one of the test area for JRC activity

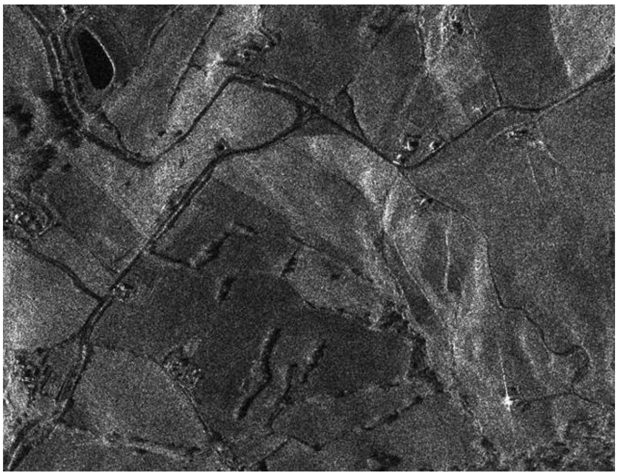

Fig. 11: Cosmo Skymed image portion acquired in March 2008 over the Pesaro test area for JRC: agronomic landscape overview

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Session T4: Cross Compliance and FAS

THE USE OF REMOTE SENSING FOR THE CONTROL OF CROSS COMPLIANCE

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KEY WORDS: GAEC, cross compliance, remote sensing, control

ABSTRACT
In cross compliance checks carried out in Spain since 2005, 22 are done at area level, 4 belong to environmental issues and 18 affect GAECs. RS may be used in 15 area checks, 1 environmental check and 14 GAECs.

Using RS to verify all the area-based elements in cross compliance needs many and varied starting data: graphical and alphanumerical information from SIGPAC (LPIS/ GIS Spanish system), different kinds of satellite imagery, high (HR) and very high (VHR) resolution, VHR panchromatic imagery filtering, summer imagery lush index (XS3) plus slopes and environmental data digital layers.

Work procedures demand an outline of the elements to be controlled at declared agricultural parcel level in the first place, to solve them via CAPI using RS. Verified elements may be accepted (end of procedures), rejected or doubtful. In this case an on the spot check will be needed.

During 2006, 16.991 reference parcels in Madrid and Castile - La Mancha had their area-based cross compliance elements checked, 49% solved using RS. Only 48% needs on the spot checking.

1. INTRODUCTION

Cross Compliance is defined as a group of statutory management requirements and good agricultural and environment conditions that farmers have to respect to receive full funding from direct payments and/or some rural development support measures from CAP (Common Agricultural Policy). Breach of any of these requirements implies a reduction in the payments that can goes up to the farmer exclusion of the aid scheme.

This requirement is collected in the article 3 of The Council Regulation (EC) No 1782/2003, of 29 September 2003 (DOUE L 270 of 21 October 2003) where common rules for direct support schemes for farmers are established under the common agricultural policy. Also, article 51 of the Council Regulation (EC) 1698/2005 of 20 September 2005 (DOUE 277 of 21 October 2005), relates to aids for rural development through the FEADER.

The minimum control rate established for the control is:

- At least 1% of all producers applying for direct aids schemes according to article 2 (d) of the Regulation (EC) Nº 1782/2003, also have to respect at least one of the requirements or measures included in cross compliance.
- At least 1% of all producers applying for aids according to article 36(a) (i, ii, iii, iv and v) and article 36(b) (i, iv and v) of Regulation (EC) No 1698/2005, also have to respect at least one of the requirements or measures included in cross compliance.

A total of 160 standards are included in the 2007 Cross Compliance Controls carried out in Spain. Between these standards, 22 are verified at area level:

- 4 belong to Environmental Field and
- 18 belong to Good Agro- Environmental Condition Field.

In 15 standards from these 22, the use of Remote Sensing (RS) is feasible:

- 1 belongs to Environmental Field and
- 14 belong to the Good Agro- Environmental Condition Field.

RS is possible in area checks related with measures managed to avoid soil erosion, maintenance of soil organic matter, minimum maintenance of retain terraces, damage of habitat and conservation of birds.

2. MATERIALS AND METHODS

USE OF RS: INITIAL DOCUMENTATION

Verifying area-based elements of cross compliance with RS is needed of many and varied starting data

- Land Parcel Identification System (LPIS) Graphics and alphanumeric data.
- Several images of high (HR) and very high (VHR) satellite imagery just like LANDSAT 5 ETM

Multispectral, IRS LISS-III Multispectral, SPOT 1/2/3/4 Multispectral, SPOT 5 Multispectral, IKONOS Multispectral, IKONOS Panchromatic, QUICKBIRD Multispectral, QUICKBIRD Panchromatic.

- MODIS Images (Moderate Resolution Imaging Spectroradiometer) to be used for detect the burning stubbles.
- Ancillary specific imagery for cross compliance: bordering filtered very high resolution (VHR) panchromatic image, slopes coating and XS3 summer image vegetation index.

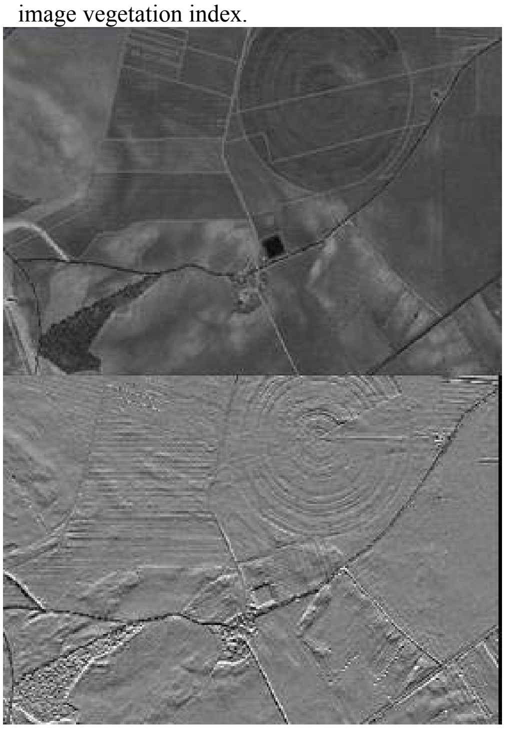

Figure 1. Bordering filtered very high resolution (VHR) panchromatic image

- Coating with assorted agro- environmental information:
    - High erosion risk areas.
    - Protected Natural Spaces
    - Natura 2000 (SAC's + SPA's)
    - Vulnerable areas in relation to agrarian nitrate contamination
    - Aquifers legal declared as over exploited

WORK METHODOLOGY

Work method demands an overview of all elements to be controlled at agricultural parcel level selected for cross compliance check in order to assess them via CAPI of imagery.

CAPI Works are developed like following; Prepare starting data (LPIS data and satellite imagery) ancillary specific imagery for cross compliance, use assignment (photointerpretation) Cross Compliance standards solution by remote sensing; prepare the lists and prints-out for the field solution of the non accepted agricultural parcels in the office and insert the results obtained during the field visit.

As result, elements that are checked may be accepted (end of procedures), rejected or doubtful. In this case an on the spot check will be needed.

FEASIBLE STANDARDS TO BE CHECKED USING REMOTE SENSING

Work methodology of the 15 feasible standards checked using Remote Sensing is:

A) STANDARD GAEC01: Check if farmers avoid ploughing in the direction of the slope, in arable crops when LPIS reference parcel average slope is greater than 10%.

Solution: Checked with processed panchromatic High Resolution image for ploughing direction with bordering filter. This processed image is use to check crop lines and that they are not in the same direction than the maximum slope. In case of being in the same direction, a field visit is performed to check the ploughing depth.

B) STANDARD GAEC02: Check if farmers to not plow or till soil in vine, olive and nuts LPIS reference parcels where average slope is greater than 15%.

Solution:
VHR image of the current year is used to check for vegetation presence between crop rows. If vegetation is not observed, a field visit is performed to check if the field has been tilled or ploughed.

C) STANDARD GAEC03: Check if farmers avoid ploughing between harvesting and pre-sowing for parcels cultivated with winter arable crops.

Solution:
Summer image XS3 is used to check the existence of shaded areas that could indicate stubble presence. Using vegetation index deived from the XS3 summer image, a heterogeneous texture, indicating the presence of stubbles, is search on image (homogeneous texture is expected for bare soils). If the parcel is considered as covered by a bare soil, a field visit is performed.

D) STANDARD GAEC04: In olive groves, when maintenance of olive trees edges is made using weed-killers, the soil cover should be cropped following contour lines.

Solution:
VHR image of the current year is used to check the existence vegetation between olive lines, otherwise, a field visit is performed to check that olive trees stems are cleaned either by means of weed- killers or mechanically and, if necessary, that the vegetation in the rows is maintained.

E) STANDARD GAEC05: Avoid tree uprooting in non-irrigated LPIS reference parcels where the average slope is equal or greater than 15%, in the areas established by the Autonomous Communities.

Solution:
Comparison between the LPIS ortophoto and a VHR image to checked that no uprooting has taken place in non-irrigated permanent crops, with the exception of olive groves.

F) STANDARD GAEC06: Fallow, set-aside and non-cultivated LPIS reference parcels shall be properly maintained with the maintenance of a proper vegetation cover.

Solution:
In fallow, set- aside and other declared uses LPIS reference parcels with a LPIS use assigned as "arable land", "green-house or crop under plastic", or "kitchen garden", a check of bushy invasion will take place by comparison between an ortophoto and a VHR image of the current year.

G) STANDARD GAEC07: Respect the minimum soil cover, crop rotations and minimum land management, reflecting Autonomous Communities conditions in those areas with a high erosion risk.

Solution:
It is checked, by means of satellite imagery, that there is no bare soil in LPIS reference parcels placed in high erosion risk areas, otherwise, respect f crop rotation will be checked.

H) STANDARD GAEC08: Maintenance of terraces, keeping their drainage capacity and avoiding the risk of silting up and gully formation.

Solution:
Non elimination of terraces, boundaries, etc. is checked by comparison between an archive ortophoto and a VHR image of the current year.

Figure 2. STANDAR GAEC08.Difference between ortophoto and current year VHR image.

I) STANDARD GAEC09: Ban of burning stubbles.

Solution:
Hotspots are derived from the thermal infra red band of MODIS images. When a hotspot is observed, technicians are sent on the field using coordinates of the MODIS image, to check if stubbles have been burnt in that area.

J) STANDARD GAEC012: Avoid burning or ploughing land classified as permanent pasture except for vegetation regeneration (in such case, it is necessary to request a permission of the competent authority).

Solution:
For LPIS reference parcels labelled as "Woody pasture", "bushy pasture" and "pasture" it will be checked that they have not been ploughed or burnt by comparison between the archive ortophoto and the current year VHR image.

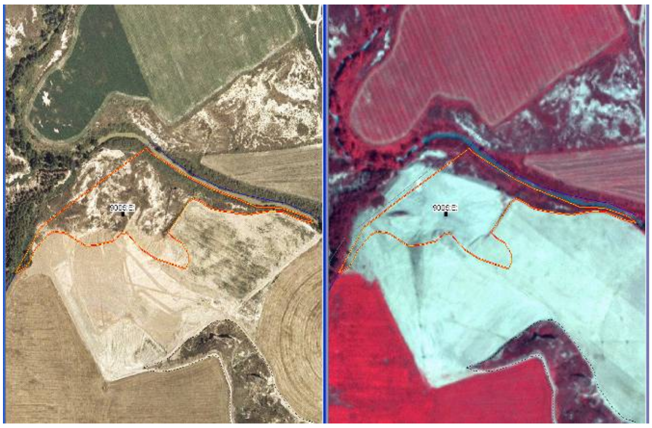

Figure 3. STANDARD GAEC12. Difference between ortophoto and current year VHR image

K) STANDARD GAEC13: Maintenance of an appropriate stocking density of livestock or appropriate management of permanent pastures avoiding the appearance of unwanted vegetation and pasture degradation.

Solution:
For LPIS reference parcels sorted as "pasture" and with at least one declared line of permanent pasture, it will be checked that livestock density is greater than 0.1 LU/ha cross checking information with animal database. If livestock density is lower than 0.1 LU/ha, evidence of bush invasion will be searched on images by comparison of ortophoto and VHR image of the current year.

L) STANDARD GAEC14: Avoid the invasion of unwanted vegetation (according to the list supplied by Autonomous Communities) on arable lands.

Solution:
For LPIS reference parcels declared as arable and permanent crops (except fallow and set-aside) sorted in LPIS as "arable land", "green house or crops under plastic" or "kitchen garden" or the corresponding wooded uses, it will be checked that there is no bush invasion by means of comparison between ortophoto and the VHR image of the current year.

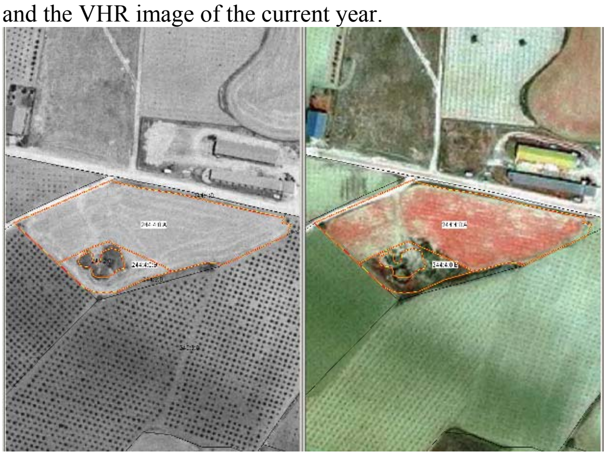

Figure 4. STANDARD GAEC14. Difference between ortophoto and current year VHR image

M) STANDARD GAEC15: Avoid uprooting of olive trees except in the areas established by the Autonomous Communities for restructuring.

Solution:
The presence of Olive trees identified in the LPIS is checked on a current year very high resolution image. Identified missing trees are checked with a rapid filed visit.

N) STANDARD GAEC17: Maintenance of topographic characteristics and land structural elements (except if permission has been required).

Solution:
It is checked by comparison between archive ortophoto and current year VHR image that no terrace, isolated trees, islands and natural vegetation enclaves or rock and natural ponds and other structural elements or traditional agricultural landscape features have been removed without permission.

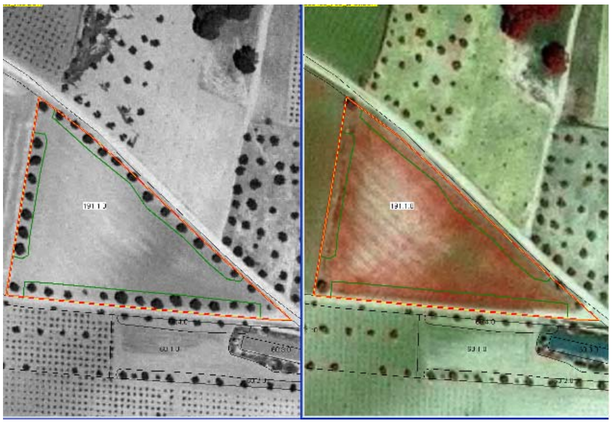

Figure 5. STANDARD GAEC17: Difference between ortophoto and current year VHR image.

O) STANDARD EN01: Maintain environmental structural terrain elements, particularly, in riversides and glens.

Solution:
For LPIS reference parcels flagged as special protection area for birds (SPA), it is checked, by comparison between currant year VHR image and archive ortophoto, that terrain natural structural elements have not been damaged.

3. RESULTS AND DISCUSSIONS

Results obtained during the cross compliance controls in the two Spanish regions in which this work methodology has been developed (Madrid and Castile- La Mancha) are:

YEAR	SAMPLE AGRICULTURAL PARCELS				TOTAL (A)
	INSIDE OF THE RS SITE		OUTSIDE OF THE RS SITE		
	(nº)	(% s/A)	(nº)	(% s/A)	
2005	5.099	48%	5.476	52%	10.575
2006	8.393	49%	8.598	51%	16.991

Table 1: Sample agricultural parcels.

YEAR	RESULTS OF AGRICULTURAL PARCELS INSIDE OF THE RS SITE				TOTAL (A)
	COMPLETELY ACCEPTED IN THE OFFICE		WITH ANY STANDARD VERIFYED IN FIELD		
	(nº)	(% s/A)	(nº)	(% s/A)	
2005	4.061	80%	1.037	20%	5.098
2006	4.338	52%	4.055	48%	8.393

Table 2: Results of agricultural parcels inside of the site.

In both years, half of the area-based elements were checked by Remote Sensing. From these parcels, only 20% to 48% had needed a follow up on the field.

YEAR	SAMPLE STANDARDS				TOTAL (B)
	INSIDE OF THE RS SITE		OUTSIDE OF THE RS SITE		
	(nº)	(% s/B)	(nº)	(% s/B)	
2005	24.184	49%	25.633	51%	49.817
2006	36.080	50%	36.259	50%	72.339

Table 3: Sample standards.

YEAR	RESULTS OF AGRICULTURAL STANDARDS INSIDE OF THE RS SITE				TOTAL (B)
	COMPLETELY ACCEPTED IN THE OFFICE		WITH ANY STANDARD VERIFYED IN FIELD		
	(nº)	(% s/B)	(nº)	(% s/B)	
2005	22.584	93%	1.600	7%	24.184
2006	30.894	86%	5.096	14%	35.990

Table 4: Results of agricultural standards outside of the RS.

For both years over 49-50% of the standards elements where checked by Remote Sensing. In the worst case, only 14% of these checks had to be completed with a field visit.

When comparing work sequences with or without the use of remote sensing imagery, differences between both methodologies are obvious.

	TASK TO CARRY OUT	
	WITH REMOTE SENSING	**WITHOUT REMOTE SENSING**
OFFICE	Prepare LPIS data and satellite imagery	Prepare LPIS data
	Create the Cross Compliance specific imagery	-
	Use assignment (CAPI)	-
	Cross Compliance standards solution by remote sensing	-
	Prepare the lists and prints-out for the field solution of the non completely accepted agricultural parcels in the office **(48% over the total of the agricultural parcels to be checked)**	Prepare the field documentation (lists, prints-out) for the **100% of the agricultural parcels**
FIELD	Cross Compliance verification of the non accepted standards in the office **(14% of the total standards to be checked)**	Use assignment and Cross Compliance solution **(100% of the standards to be checked)**
OFFICE	Insert the results obtained during the field visit **(14% of the standards in the 48% of the total agricultural parcels)**	Insert the results obtained during the field visit **(100% of the agricultural parcels and 100% of the standards)**

Figure 6: Work schedule with and without RS.

From this experiment, one can conclude that the use of remote sensing imagery can save 20-40% of workload compared to a complete check of cross compliance on the field.

Different factors are involved in the saving, for example:

- Geographical distribution of the parcels: bigger spread out of the parcels, greater savings with the use of remote sensing
- Terrain topography: savings will be greater if there are more parcels placed in lands with a complicated topography
- Land uses (arable crops, woody crops, pastures), average slope and location of the parcels to be controlled in specific sites (high erosion areas, special protection areas): The bigger is the number of standards to be controlled, the higher is time saved using remote sensing support.

This technique has some constraints and advantages compare to traditional field controls. They are listed hereafter.

A) <u>Constraints</u>:

- Remote Sensing can be sued only for parcels bigger than 0.1 hectare.
- The image request shall be placed before December of the previous year.
- Remote sensing can not be used for all standards to be checked (for example, is not useful to verify the vegetative status of olive trees).
- Most of breaches identified on images must be confirmed by a field visit.

B) <u>Advantages</u>:

- Possibility to carry out a high number of controls in a short term.
- Check on images in the office avoids field visit constraints like steep slope, lack of parcel access paths, fenced farms, etc.
- More exhaustive view of all parcels of the holding.
- Once the technician is in the field, he has more complete information for a quicker check, due to all the data collected in the office.
- All documentation used during the cross compliance checks (satellite imagery, ortophoto, etc.) can be used as evidence of a considered breach if farmers complain.
- Cost and time saving using remote sensing with regard to field visits: the area checked per technician and day is definitely higher with remote sensing.

3. CONCLUSIONS

- The use of remote sensing reduces almost half (48%) of the number of parcels to check in the field after the work carried out in the office.
- Using remote sensing can be used to check 85% of the total requirements related to the surface. If remote sensing is not be used it is necessary to control in the field the 100% of the parcels and the 100% of the elements.
- Use of remote sensing allows reducing time and volume of work in the field.

4. REFERENCE DOCUMENTS

Methodology and work procedures developed to carry out compliance controls in the Castile-La Mancha and Madrid Autonomous Communities.

Session T5a: New sensors

RAPID MULTI-SENSOR SYSTEM FOR EFFECTIVE RISK ANALYSES

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KEY WORDS: CAP, GAEC, LPIS, Risk Analysis, Multi-Sensor, Lidar, Orthophoto, Soil Moisture, Thermography

ABSTRACT
An international consortium of specialists from the Netherlands, Russia, Bulgaria, United States and Australia has developed and demonstrated a new airborne multi-sensor system that is ready for implementation in two major areas of application, related to the Common Agriculture Policy (CAP): control of the Good Agricultural and Environmental Conditions (GAEC) and the update of the Land Parcel Identification System (LPIS). The airborne multi-sensor system consists of several cameras and produces (underground) soil moisture data, ground temperature data, digital elevation models, and high resolution orthophotos. All sensors are mounted on board one single light aircraft and are operated simultaneously to produce a wide range of critical information at a time that is then processed into an Information Monitoring System (IMS). The international team has demonstrated the benefits of the system in a show case project in Bulgaria in the summer of 2007. The results are presented in this paper.

1. INTRODUCTION

An international consortium of specialists from the Netherlands, Russia, Bulgaria, United States and Australia has developed and demonstrated a new airborne multi-sensor system that is ready for implementation in two major areas of application, related to the Common Agriculture Policy (CAP): control of the Good Agricultural and Environmental Conditions (GAEC) and the update of the Land Parcel Identification System (LPIS). As for the GAEC, the system has especially proven successful for standards – after Monaldi G. *et. al.* – 1.1 Temporary channeling of surface water on sloping terrain, and 3.1 Defense of ground structure through maintenance of surface water drainage.

The airborne multi-sensor system consists of several cameras including a soil moisture scanner for (underground) water and drought mapping, a thermal infrared camera for ground temperature data, a lidar scanner for elevation models, vegetation mapping, and deformation detection, and a digital photo camera for visual and near infrared imagery of the project area. All sensors are mounted on board one single light aircraft and are operated simultaneously to produce a wide range of critical information that is then processed into an Information Monitoring System (IMS). The international team has demonstrated the benefits of the system in a show case project in Bulgaria in the summer of 2007.

The beneficiaries of this project are the State Agency for Information Technologies and Communications (SAITC) and the Agency for Sustainable Development and Euro integration (ASDE). These two organizations have a frame agreement for risk assessment in implementation of governmental policies and EU Directives (Directive 207/02 INSPIRE and Directive 207/60 Floods).

The project was successfully performed by MIRAMAP, a private company from the Netherlands that was founded at the European Space Incubator (ESI) initiative of the ESA Technology Transfer & Promotion (TTP) office. The TTP office is contributing to the capitalization of space-based technology and know-how for the benefit of Europe economy and science.

2. MULTI-SENSOR SYSTEM

The MIRAMAP sensor suite simultaneously collects high accuracy soil moisture data, ground temperature data, digital elevation data, and ortho photos. It consists of three microwave sensors in X-band, C-band and L-band that are all GNSS integrated, a thermal infrared camera, a lidar scanner, and a digital photo camera. Table 1 lists the specifications of each different sensor and specific use.

The platform on which these instruments are flown is a reliable and safe twin Aero Commander (Figure 1). The aircraft is specially modified to simultaneously carry this range of instruments. The capability to measure such a comprehensive range of remotely sensed parameters from a single low-cost airborne platform is unique worldwide.

Sensor	Wavelength	Specs	Use
Passive Microwave Scanner	Microwave 2, 5, 21 cm	5-m GSD, 0.15 K precision	(Sub)surface detection of wet and dry areas
Thermal Camera	LW Infrared 7.5-13 micron	3-m GSD, 0.1° C precision	Surface Temperature
Lidar Scanner (Laser scanner)	SW Infrared 1064 nm	2-m GSD, 0.10 m precision	Elevation Model, Hydrological Model, Deformations
Digital Photo Camera	Visible 0.4-0.7 micron	10-cm GSD, subpixel precision	Detailed Visible Interpretation, Cartography

Table 1. MIRAMAP Multi-Sensor Specifications

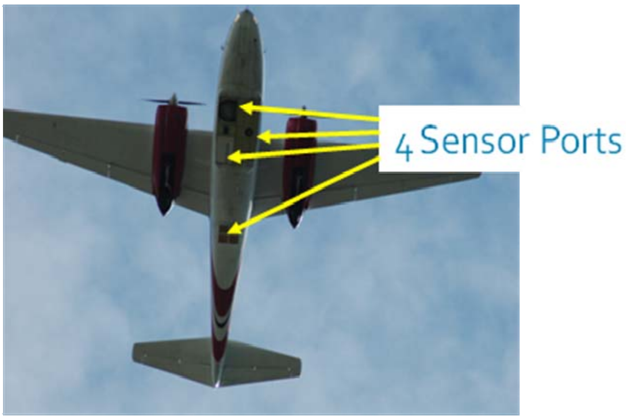

Figure 1. MIRAMAP Multi-Sensor Aircraft

As for the soil moisture products, the X-band and C-band sensor makes a conical scan at constant incidence angle over a wide swath, while the L-band sensor for underground soil moisture mapping makes a twin-beam oscillating scan (Figure 2). The small instrument sizes and weights enable use of a low-cost light aircraft as the observing platform, providing decision makers with a new affordable tool.

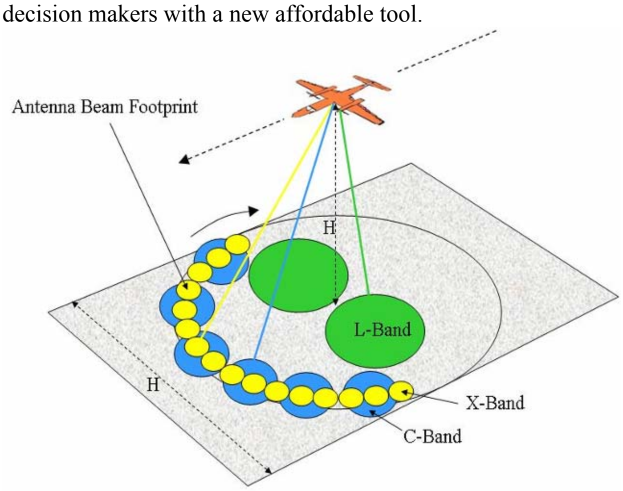

Figure 2. MIRAMAP Soil Moisture Scanner

Through both laboratory and field experiments it has been documented that the passive microwave radiometers with internal calibration, and the processing/retrieval algorithms from the Institute of Radio-engineering and Electronics (IRE) of the Russian Academy of Sciences (RAS) and Radio Corporation VEGA, are feasible to determine several soil, water and vegetation related environmental parameters and conditions. These are soil moisture content, depth to shallow water table, buried metal objects under shallow dry ground, contours of water seepage through hydro technical constructions (levees and dams), sliding zones, plant biomass above wet soil or water surfaces, temperature changes, oil slicks, salt and pollutant concentration in water areas, on-ground snow melting and ice on roads and runways.

Simultaneously collected multi-sensor data from the air offer a high social-economic relevance. The approach brings government managers and decision makers the following benefits:

- Rapid: Large areas can be monitored in a short time frame. The quick availability of information can also be of advantage to minimize the impact of disasters, or to prevent disasters. Adequate and rapid response in the first hours of an (pending) emergency situation is of great importance. Many data can also be collected at night.
- Effective: Simultaneous acquisition of remote sensing data is a very effective tool to monitor water barriers and coastal zones. Detailed data and flexible deployment on a single platform enables water managers and decision makers to take adequate action, and therefore spend their financial resources effectively.
- Accurate: A complete and detailed view of possible failure locations is given. The main failure indicators of water barriers and coastal zones are water seepage, dry areas, deformations, and vegetation quality. The results can be easily imported and combined with existing geo-information.
- Safe: The measurements are collected from the air, so field inspection specialists are not faced with potentially dangerous situations, such as rising water.

3. DATA COLLECTION

The State Agency for Information Technologies and Communications (SAITC) of Bulgaria, the Agency for Sustainable Development and Euro integration (ASDE) of Bulgaria and MIRAMAP agreed to collaborate and perform a multi-sensor project for preventive risk management of natural hazards, part of which is flood preventive measures and preventive control of flood protection facilities.

Airborne multi-sensor data was collected over two selected areas – River Rusenski Lom and Dams at Nikolovo – near Rousse, and additional areas over River Danube, River Yantra, and a forest fire between July 30 and August 2, 2007. The project locations are shown in Figure 3. Unique information was received related to:

- Land surface cover, including true orthophoto at 10-cm ground sample distance, ground temperature data at 0.1 degrees precision, and relief features at 2-m grid and 15-

cm vertical precision of terrain impacting moisture parameters

- Surface soil moisture, dry conditions 0.05 to 0.10 m^3/m^3 and saturation up to 0.35 m^3/m^3
- Underground soil moisture reached 0.35 m^3/m^3 in the condition of saturation
- Revealing over-moistened zones near water barriers

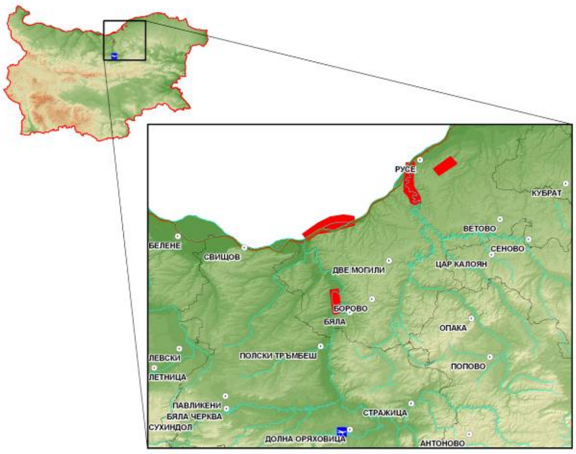

Figure 3. Project Locations in Bulgaria

All different datasets – soil moisture maps, ground temperature data, digital elevation data, and ortho photos – were processed and delivered to the product specs listed in Table 1 in UTM35 coordinates, so that all data can be quickly combined with existing datasets such as digital topographic maps and satellite imagery.

4. PROJECT RESULTS

During the project weather changed rapidly from dry to very wet conditions, so that unique information was received related to soil moisture changes. Figure 4 illustrates surface moisture related data of July 31 under dry condition, and Figure 5 illustrates surface moisture related data of August 2 under wet condition of the same area.

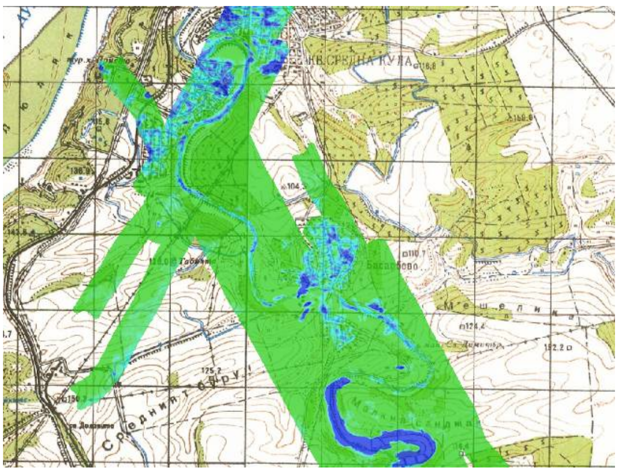

Figure 4. Soil Moisture under Dry Condition

The colors in Figures 4 and 5 correspond to the soil moisture gradations in the upper 0-5 cm thick layer. Dark green ranges between 0 and 0.05 m^3/m^3, light green ranges between 0.05 and 0.10 m^3/m^3, light blue ranges between 0.10 and 0.20 m^3/m^3, and dark blue ranges between 0.20 and 0.35 m^3/m^3, and represents open water.

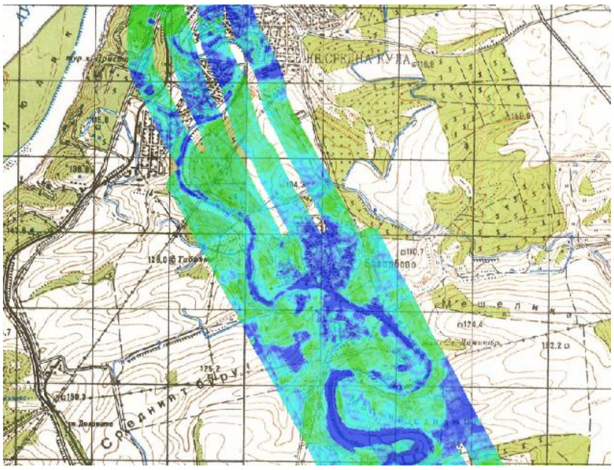

Figure 5. Soil Moisture under Wet Condition

Microwave surface moisture related data revealed over moistening in the areas near the Yantra River outflow zone, which is indicated with red arrows in Figure 6. Water seepage of Danube River through the dike or in land surface depression located in these spots could be reason of this phenomenon.

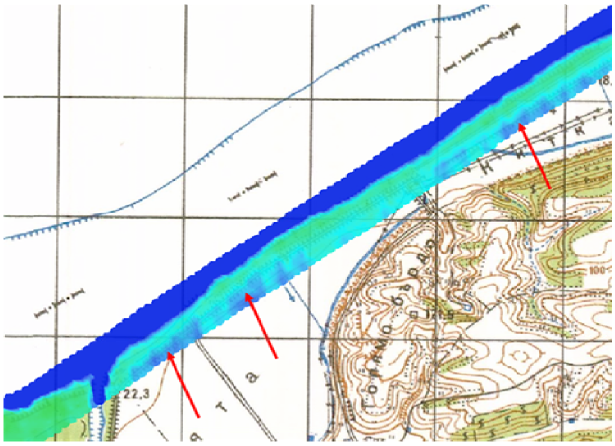

Figure 6. Water Seepage at Danube River

The land surface cover from 10-cm true orthophoto (Figure 7) was combined with the lidar relief features (Figure 8) in a three-dimensional (3-D) fly-through by ReSAC. A snapshot of this product is shown in Figure 9.

Figure 7. 10-cm Orthophoto for LPIS

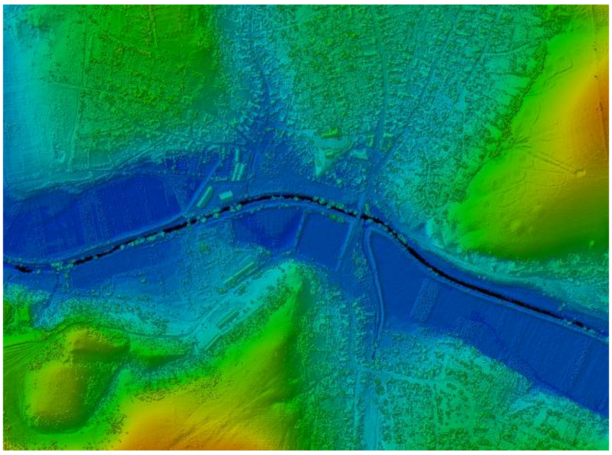

Figure 8. Lidar Elevation Model for GAEC

Figure 9. 3-D Fly-through of Orthophoto and Lidar Elevation

Figure 10 illustrates a composite of all datasets at Dams at Nikolovo. The surface temperatures (top left) range between 25°C (dark blue, open water) and 50°C (white, dry and open fields), and correlate with the soil moisture data (bottom left) and lidar elevation data (bottom right).

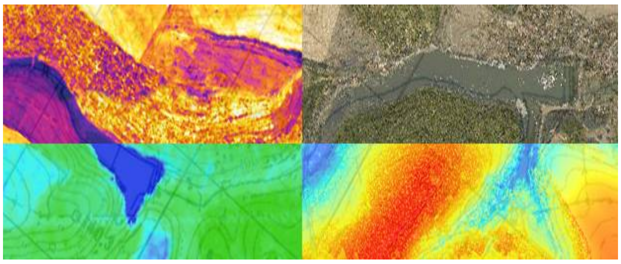

Figure 10. Multi-Sensor Composite

The simultaneously collected multi-sensor data was finally combined in a Information Management System (IMS) for effective risk analyses. The block diagram of Figure 11 illustrates the various elements of the IMS: the airborne data that is geo-referenced using positioning and inertial data, a backup and retrieval database system that includes existing a-priori geodata, and an integral processing part using various mathematical procedures, such as normalization, weighting, and distribution.

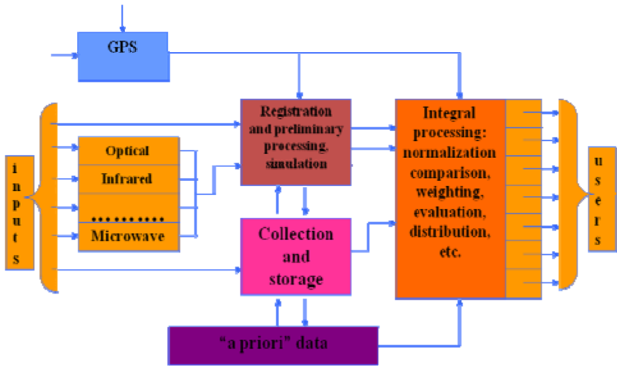

Figure 11. Block Diagram of IMS for CAP

5. CONCLUSIONS

The main conclusions and recommendations of the show case project in Bulgaria are:

- The project has successfully proven the effectiveness of the used MIRAMAP multi-sensor technology and approach for preventive risk management of natural hazards, part of which is flood preventive measures and preventive control of flood protection facilities.
- The MIRAMAP system is ready for implementation in two major areas of application, related to the Common Agriculture Policy (CAP): control of the Good Agricultural and Environmental Conditions (GAEC) and the update of the Land Parcel Identification System (LPIS). As for the GAEC, the system has especially proven successful for standards – after L. Rossi and P. Tosi – 1.1 Temporary channeling of surface water on sloping terrain, and 3.1 Defense of ground structure through maintenance of surface water drainage.
- The conditions of over-moistening revealed on the August 2nd data were the important indicator of expected flooding.
- The authors recommend organizing a Risk Assessment Unit to periodically monitor the current hydrological conditions and variations around the water reservoirs, water barriers, and coastal zones (erosion and sliding).

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Session T5b: New sensors and image processing

ORTHORECTIFICATION TESTS OF FORMOSAT-2

ORTHORECTIFICATION OF FORMOSAT-2 DATA FOR USE IN THE COMMON AGRICULTURAL POLICY CONTROL WITH REMOTE SENSING PROGRAMME]

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KEY WORDS: Common Agricultural Policy (CAP), Control with Remote Sensing (CwRS), FORMOSAT-2 (F2), Very High Resolution (VHR), revisit capacity, off-nadir angle, orthorectification, location accuracy, rigorous modelling, accuracy, Ground Control Point (GCP), Independent Check Points (ICP), Quality Control (QC).

ABSTRACT
FORMOSAT-2 (NSPO, Taiwan) was launched on 21st of May, 2004. FORMOSAT-2 was programmed as Very High Resolution backup sensor in the CwRS campaign for the first time in 2006 [Ref 1]. Acquisition success rate has been high since it was introduced due to its high (daily) revisit capacity, but difficulties were initially encountered to reach the required location accuracy in production of orthorectified imagery. This resulted in a 1st study (2006) where FORMOSAT-2 imagery over Sofia (BG) was assessed; 4 software suites were tested on this image with low off-nadir viewing angle [Ref 2]. Results were promising, demonstrating that it is possible to perform good orthorectification using standard software packages reaching results inside the CwRS requirements for such imagery (location accuracy preliminary set to 3.5m $RMSE_{1D}$). In this 2nd study (2007) the aim has been to assess the effect of large off-nadir angles on the accuracy of the orthorectification, and to define the optimal number of GCPs to be used when orthorectifying FORMOSAT-2 images on a routine basis. Results of orthocorrection of 4 images of different off-nadir angles (along/across angles), over 2 sites in France and Bulgaria, using 4 different sw suites (PCI, ERDAS Imagine, PRODIGEO, and Keystone SIPOrtho,) and with varying number of GCPs are discussed. The results are consistent with theoretical expectations; x error increases when across angle (roll) increases, the y error increases when along angle (pitch) increases. Basically the accuracy of 5m $RMSE_{1D}$ is reached with all tested software, the 3.5m $RMSE_{1D}$ accuracy may be reached if limits are placed on the acquisition angles. Concerning the GCP requirement a total of minimum 10 GCPs should be used: four GCPs spread in the corners of the scenes, the others evenly distributed, and clearly visible.

1. INTRODUCTION

1.1. STUDY AIM

The European Commission Services use remotely sensed data in a series of programmes; one of the largest being within the CAP is the Control with Remote Sensing programme where the aim is to identify irregularities in subsidy claims. Taking into account the enlargement of EU to 27 Member States and subsequent increased number of sites to be controlled with use of satellite imagery, the possibility to include new sensors like FORMOSAT-2 has to be explored. This will increase total acquisition capacity and will ensure timely delivery of the necessary imagery to the MS administrations and their contractors. Due to its fixed orbit FORMOSAT-2 is particularly interesting for the areas covered by its swath because of the daily revisit capacity. In this respect, the satellite is suitable to be used as backup to the “prime” dedicated VHR sensors Ikonos and Quickbird. In 2006 7.500 km^2 at 88% success rate was acquired by FORMOSAT-2, and in 2007 13.000 km^2 at 97% success rate.
The study objectives were:

- To assess the effect of large off-nadir angles on the accuracy of the orthorectification;
- To define the optimal number of GCPs (Ground Control Point) to be used when orthorectifying FORMOSAT-2 images on a routine basis;
- To test different software (sw) suites

This study was performed in collaboration between ReSAC, SPOTImage, Spacemetric, and the EC Services at JRC.

1.2. STUDY SITES

The two sites selected for the study were Sozopol (BG), site “C” (Fig. 1) and Mausanne (FR) (Fig. 2). The choice was based on the geographic location, giving the technical acquisition possibility to test different view angles (across-track), and on the available reference data of a quality enough to provide reliable results.
The Sozopol site is located in South-Eastern Bulgaria at the Black Sea coast. The landscape is hilly with some footsteps of the Strandja Mountain in the southern part of the area (elevation up to 375 meters above sea level). The land cover is equally represented by agriculture area, around the scattered settlements and forest massifs on the hills. There are very few inland water bodies. Up to 10% of the area of interest is covered by the sea.

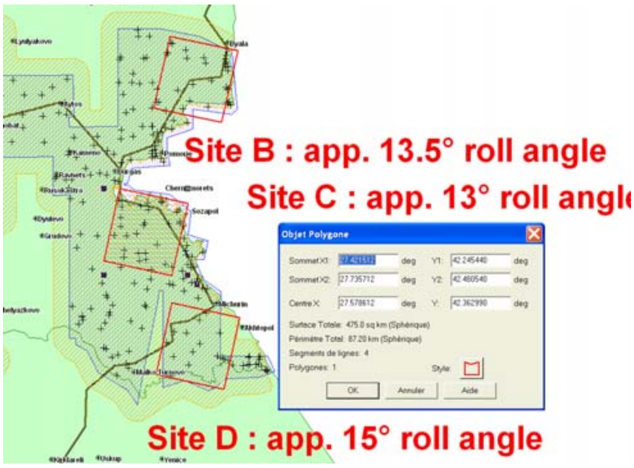


Fig. 1 - Location of Sozopol site. The available DGPS points are shown with crosses. Site "C" chosen for the study

The Mausanne site is located near to Mausanne-les-Alpilles in France. It has been used as test site by the European Commission Joint Research Centre since 1997 (Spruyt and Kay, 2004, Ref. 10). It therefore comprises a time series of reference data (DEMs, imagery, ground control) and presents a variety of agricultural conditions typical for the EU. The study site contains a low mountain massif (elevation up to around 650m above sea level), mostly covered by forest, surrounded by low lying agricultural plains. A number of small urban settlements of low density and a few limited water bodies are present in the image.

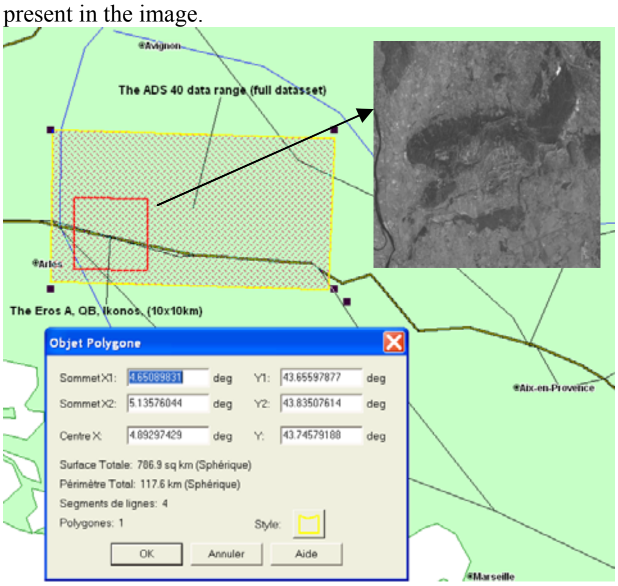


Fig. 2 - Location of the Mausanne site (FR) showing source image

1.3. STUDY INSTRUMENT

FORMOSAT-2 (NSPO, Taiwan) was launched on 21st of May, 2004. It carries two cameras that deliver imagery of the Earth in the visible (panchromatic (PAN), 0.45 – 0.9µm) and near infrared (multispectral (MSP), 4 bands) electromagnetic spectrum. The swath covered by these high resolution cameras is 24 km at Nadir and their nominal instantaneous geometric field of view, at Nadir, is 2 metres for the PAN sensor and 8 metres for the MSP sensor (Fig. 3). FORMOSAT-2 has a sun and geosynchronous orbit of 14 fixed orbits/day and the sensor can be tilted ± 45º along and across track which results in a daily revisit time within the corridor covered (Fig. 4).

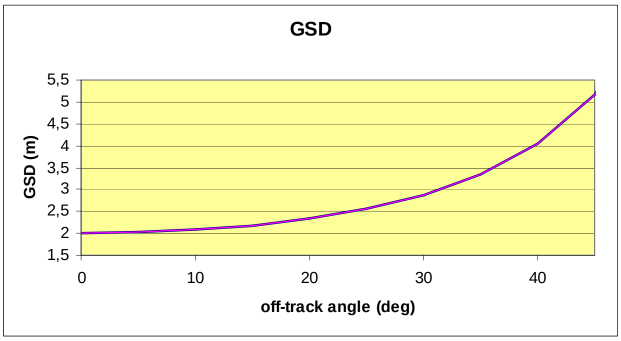


Fig. 3 - GSD at Nadir, is 2m PAN, and 8m MSP. Off-nadir angles in all JRC studies performed cause cross track GSD(X) resolution to vary between 2.025 - 3.104m

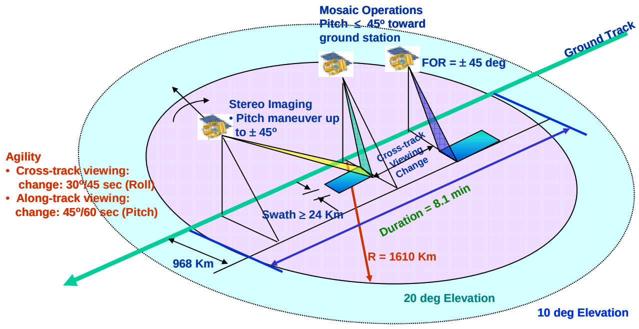


Fig. 4 - FORMOSAT-2 NSPO Taiwan; agility

1.4. ACQUIRED IMAGERY

For the present study the FORMOSAT-2 imagery with the highest spatial resolution was considered, i.e. the panchromatic one, as it requires greater accuracy for the orthorectification. The radiometric resolution of this band is 8-bit.
The imagery was delivered as raw imagery, Level 1A, with basic radiometric normalisation for detector's calibration, but with no geometric correction. The product was in DIMAP format and as such comprises a GeoTIFF file for storing the imagery and an XML file – METADATA.DIM ancillary data (filtered ephemeris and attitude data, refined focal plane calibration). Further details on the 4 images acquired are given in Table 1 below.

Site - date	Along track angle	Across track angle	GSD (X)
SOZ 1 - 04/04/07	-0.692732°	17.687877°	2.680
SOZ 2 26/04/07	-29.878595°	17.762129°	3.104

Site	Along track angle	Across track angle	GSD (X)
MAUS 1 21/03/07	-15.9666662°	+26,822819°	2.340
MAUS 2 25/03/07	-30.893181°	+26,246151°	2.803

Table 1 - Characteristics of the four FORMOSAT-2 images used in the study

2. METHODS

2.1. SOFTWARE

Given that the objective of the study was to determine whether FORMOSAT-2 imagery could be used by contractors orthocorrecting imagery on a routine basis for farmers' subsidies monitoring the main internationally recognised software platforms were firstly considered. Specifically, for this study, PCI Geomatica 10 and ERDAS Imagine 9.1 were tested for orthorectification performance. In addition, the orthorectification was performed with some image provider/vendor specific software suites: PRODIGEO of EADS SPOTImage and Keystone SIPOrtho of Spacemetric.

2.2. REFERENCE DATA

Ground reference data for the Sozopol site included:

- 29 GCPs/CPs from previous very accurate DGPS measurements ($RSME_{2D}$ and RMSEz of < 0.05 m)
- DEM from SPOT Reference3D with RMSEz of < 3.5 m [Ref. 2, 8].
- IK orthoimages, produced with the above mentioned DEM and GCPs with $RMSE_{2D}$ of the different tiles (based on independent CPs) from 0.7m to 1.82 m.

Ground reference data for the Mausanne site included:

- 53 GCP/CP from DGPS measurements with accuracy of (x, y) < 0.05m and (z) < 0.1 m
- Orthophotos from aerial flight using ADS40 (RMSEx = 0.88 m and RMSEy = 0.72 m)
- DEM from SPOT Reference3D
- DEM generated from ADS40 (GSD=2.0 m), with RMSEz of 0.6 m (compared to the Z-value of the independent well-defined points)

According to the JRC guidelines [Ref 3], the RMSE of the GCPs used in orthorectification should be 3 times better than the tolerable RMSE. This was set preliminary to 3.5m for FORMOSAT-2 at low/moderate off-nadir viewing [Ref 2]. For the purpose of this Study the use of well distributed GCPs from the reference orthophotos (Ikonos orthoimages for Sozopol, and the orthophotos from the aerial flight using ADS40 for Mausanne) were judged adequate for the orthorectification. This also fits with the most commonly used, and afforded, reference data by the contractors during the CwRS campaign. The CwRS contractors in fact most often use the national orthophoto coverage (with accuracy of 0.5 m to 1.5 m) to collect GCPs for the orthorectification of VHR data. Another reason to use GCPs from the orthophoto is that this allowed more flexibility in the selection of the control points, than to rely on limited set of DGPS point, which might not be well visible and/or properly distributed.

The DGPS points mentioned above were solely used as ICPs for the external QC.

The DEM used in this study was the first layer of the product of SPOT Image – Reference3D – produced from SPOT-5's HRS stereo pairs. The absolute elevation accuracy of the Reference3D product is 10 metres with @ confidence of 90% for a slope less then 20 degrees, while the planimetric accuracy is as good as 15 metres. Testing the Ref3D accuracy over Sozopol cf. DGPS points gave an accuracy of 3.440m RMSEz. Earlier tests over Sofia, BG [Ref 2] gave accuracy values of down to 2.968m RMSEz. It was concluded that the Ref3D is suitable for orthorectification of the FORMOSAT-2 satellite imagery.

2.3. ORTHORECTIFICATION AND QUALITY CONTROL

The four FORMOSAT-2 images were orthorectified with PCI Geomatica, ERDAS Imagine, PRODIGEO and Keystone SIPOrtho.
In order to ensure the consistency of the software performance test, all GCPs and ICPs were identically chosen for each software-respective test, and their image and ground coordinates were transferred via import, to avoid errors during the tests. The number and location of the ground control points were in accordance with the "Guidelines for Best Practice and Quality Checking of Ortho Imagery" [Ref 3]. For the purpose of the GCPs, 15 well identified points were selected from the reference orthophotos. Imagettes with the position of the point on the raw data was also extracted.
In order to have comparable results the DEM used for the test was the Reference3D product by Spot Image.
It is clear that having a strict control on the reference data and a sufficient proven quality, the results of the orthorectification will be mainly influenced by the accuracy of the geometrical model and not by external factors.
Orthorectification was performed in stepwise series using 6-15 GCPs (PCI 32 orthorectifications, ERDAS Imagine 40, PRODIGEO 20, and Keystone SIPOrtho 40; ∑ 132 orthorectifications)
The geometric assessment that was undertaken afterwards was systematic and conforms to the standard method developed by the JRC in the "Guidelines for Best Practice and Quality Checking of Ortho Imagery" [Ref 3]. This method applies strict use of points other, and more accurate, than the ones used in the orthorectification, i.e. ICPs, for the evaluation of image correction performance, which allows the comparative robustness between different processing methods. DGPS points (see Section 2.2 Reference Data) of cm accuracy were used for this purpose: 15 over Sozopol and 20 over Mausanne. Geometric assessment was performed by viewing imagettes, thereafter placement, and measurement of the DGPS points on the orthophoto to be checked. Orthophotography corrected with 8, 10, 12, 15 GCPs were checked: residuals and RMSE calculated on a total of 64 images.

Fig 5 - Imagette and photo used in geometric assessment

3. ORTHORECTIFICATION PROCESS

3.1. ORTHORECTIFICATION WITH PCI

The PCI sw suite has a dedicated FORMOSAT-2 rigorous physical model (Toutin, 2004 [Ref 6]) available upon loading the original GeoTIFF image file (patch 10031 was used which includes critical enhancements made for the F2 modelling). The application reads image metadata supplied in the DIMAP format. PCI requires an extra step prior to the input of GCPs for refinement of the exterior orientation, which involves reading the raw satellite data and its transformation into a file with the PIX wildcard – the software's internal file format. A minimum of 8 points are necessary to solve the model why only 32 orthocorrections could be performed making use of 8, 9, 10, 11, 12, 13, 14, 15 GCPs on each of the 4 images on hand (∑32 orthocorrections). The model adjustment residuals and RMSE were calculated.

The quality of the PCI modelling appears primarily dictated by the quality and the good distribution of the GCPs. The convergence of the model is more sensitive to no. of GCPs cf. to PRODIGEO and Keystone SIPOrtho. The model performs well independent of off-nadir viewing angles, when GCPs are sufficient [Table 2-5, Fig 5-8]

3.2. ORTHORECTIFICATION WITH ERDAS IMAGINE

The ERDAS Imagine sw suite applies the orbital pushbroom model (patch 32472 was used that adds a geometric modelling for FORMOSAT-2). Also ERDAS Imagine reads ephemeris data directly from the DIMAP format. Orthocorrections were performed using 6, 7, 8, 9, 10, 11, 12, 13, 14, 15 GCPs on each of the 4 images on hand (∑40 orthocorrections). The model adjustment residuals and RMSE were calculated. Also for ERDAS, the quality of the modelling appears primarily dictated by the quality and the good distribution of the GCPs. The convergence of the model is more sensitive to no. of GCPs cf. to PRODIGEO and Keystone SIPOrtho. The model result is strongly influenced by large along track angle (pitch) and there is a need to model the along angle (y component) properly[10]. The model is less sensitive to large across track angle (roll) [Table 2-5, Fig 5-8]

3.3. ORTHORECTIFICATION WITH PRODIGEO, AND KEYSTONE SIPORTHO

Both sw suites use a rigorous physical model based on orbit and attitude parameters (independent of the ground). The quality of the modeling is primarily dictated by the rigorous restitution of the position/orientation of the satellite via the auxiliary data. The number of parameters to be adjusted can be varied. The default Formosat adjustment uses 6 parameters. There is always a trade-off between model accuracy and stability; using few parameters in the model will give stable results with few GCPs, using larger numbers of parameters will give possibility for a more accurate model but will then require larger numbers of GCPs to give reliable results.

As for PCI, and ERDAS Imagine these applications both read image metadata supplied in the DIMAP format. Orthocorrections were performed using 6, 8, 10, 12, 15 GCPs on each of the 4 images on hand for PRODIGEO (∑20 orthocorrections). Orthocorrections were performed using 6, 7, 8, 9, 10, 11, 12, 13, 14, 15 GCPs on each of the 4 images on hand for Keystone SIPOrtho (∑40 orthocorrections). The model adjustment residuals and RMSE were calculated.

Both perform well at high off-nadir viewing angles (especially for high along track angle (pitch)). In Keystone SIPOrtho the along track component is modeled by a 3rd degree variation in along track angle (pitch) by addition of 3 additional parameters. In both the convergence of the model is less sensitive to no. of GCP cf. with PCI and ERDAS Imagine [Table 2-5, Fig 5-8]

Site	GCPs used	SW suite used	external QC JRC (on ICPs)		
	GCPs used		rmseX	rmseY	2D meters
MAUS 1	8	PCI	6,6665	15,6898	17,0474
MAUS 1	8	ERDAS	4,2869	4,6683	6,3380
MAUS 1	8	SipOrtho/Keystone	3,5560	2,4164	4,2993
MAUS 1	8	PRODIGEO	4,5296	2,7541	5,3012
MAUS 1	10	PCI	4,6603	3,3992	5,7682
MAUS 1	10	ERDAS	3,8546	2,6672	4,6874
MAUS 1	10	SipOrtho/Keystone	3,5669	2,2494	4,2169
MAUS 1	10	PRODIGEO	5,1090	2,7452	5,7998
MAUS 1	12	PCI	4,3317	3,2294	5,4030
MAUS 1	12	ERDAS	4,0359	2,8509	4,9413
MAUS 1	12	SipOrtho/Keystone	3,7948	2,2086	4,3907
MAUS 1	12	PRODIGEO	5,0127	3,3237	6,0145
MAUS 1	15	PCI	4,1804	3,0358	5,1664
MAUS 1	15	ERDAS	3,5340	2,6837	4,4375
MAUS 1	15	SipOrtho/Keystone	3,7508	2,2727	4,3857
MAUS 1	15	PRODIGEO	4,7812	2,9986	5,6437

Table 2 - External QC of the MAUS 1 image

Site	GCPs used	SW suite used	external QC JRC (on ICPs)		
	GCPs used		rmseX	rmseY	2D meters
MAUS 2	8	PCI	6,6771	16,1125	17,4412
MAUS 2	8	ERDAS	11,2026	31,2716	33,2177
MAUS 2	8	SipOrtho/Keystone	3,8260	2,8573	4,7752
MAUS 2	8	PRODIGEO	4,6204	4,0881	6,1694
MAUS 2	10	PCI	3,7505	4,1394	5,5858
MAUS 2	10	ERDAS	23,3090	53,5554	58,4079
MAUS 2	10	SipOrtho/Keystone	3,2621	2,9424	4,3931
MAUS 2	10	PRODIGEO	4,9578	3,9254	6,3237
MAUS 2	12	PCI	3,8237	4,0931	5,6013
MAUS 2	12	ERDAS	14,5497	21,8033	26,2121
MAUS 2	12	SipOrtho/Keystone	3,5006	3,1597	4,7157
MAUS 2	12	PRODIGEO	5,0793	3,8041	6,3459
MAUS 2	15	PCI	4,1210	3,9058	5,6778
MAUS 2	15	ERDAS	13,3278	18,9219	23,1445
MAUS 2	15	SipOrtho/Keystone	4,0194	3,1278	5,0930
MAUS 2	15	PRODIGEO	5,4263	4,2312	6,8810

Table 3 - External QC of the MAUS 2 image

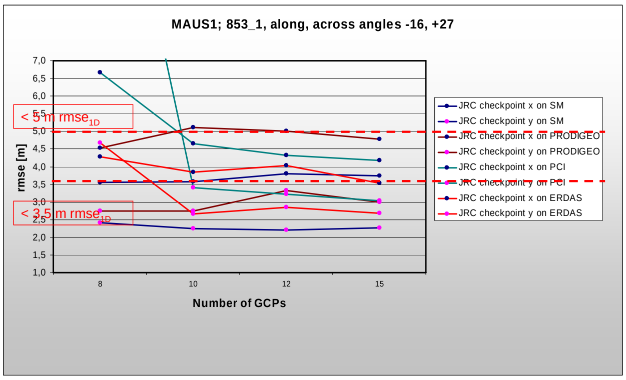
Site	GCPs used	SW suite used	external QC JRC (on ICPs)		
	GCPs used		rmseX	rmseY	2D meters
SOZ 1	8	PCI	3,7400	1,9567	4,2209
SOZ 1	8	ERDAS	2,8176	5,2089	5,9221
SOZ 1	8	SipOrtho/Keystone	2,1074	2,4070	3,1992
SOZ 1	8	PRODIGEO	2,2370	2,3349	3,2335
SOZ 1	10	PCI	2,5613	2,1698	3,3568
SOZ 1	10	ERDAS	2,3602	2,5288	3,4591
SOZ 1	10	SipOrtho/Keystone	1,7344	2,3523	2,9226
SOZ 1	10	PRODIGEO	2,1605	2,4018	3,2305
SOZ 1	12	PCI	2,4532	2,3156	3,3735
SOZ 1	12	ERDAS	2,1800	2,7610	3,5179
SOZ 1	12	SipOrtho/Keystone	1,4449	2,3279	2,7398
SOZ 1	12	PRODIGEO	2,2992	2,1342	3,1371
SOZ 1	15	PCI	2,3385	2,1400	3,1699
SOZ 1	15	ERDAS	1,9383	2,7186	3,3388
SOZ 1	15	SipOrtho/Keystone	1,7637	2,3198	2,9142
SOZ 1	15	PRODIGEO	2,5687	1,8646	3,1741

Table 4 - External QC of the SOZ 1 image

Site	GCPs used	SW suite used	external QC JRC (on ICPs)		
	GCPs used		rmseX	rmseY	2D meters
SOZ 2	8	PCI	4,6010	10,2214	11,2092
SOZ 2	8	ERDAS	12,2700	20,0675	23,5214
SOZ 2	8	SipOrtho/Keystone	1,6368	3,6863	4,0333
SOZ 2	8	PRODIGEO	2,5687	1,8646	3,1741
SOZ 2	10	PCI	2,1183	2,4402	3,2314
SOZ 2	10	ERDAS	16,1960	37,5661	40,9087
SOZ 2	10	SipOrtho/Keystone	0,9473	4,0950	4,2031
SOZ 2	10	PRODIGEO	2,4954	4,9806	5,5708
SOZ 2	12	PCI	1,6633	2,8751	3,3216
SOZ 2	12	ERDAS	11,1688	36,0725	37,7620
SOZ 2	12	SipOrtho/Keystone	1,3564	4,1841	4,3985
SOZ 2	12	PRODIGEO	2,7062	5,2619	5,9170
SOZ 2	15	PCI	1,8450	2,7970	3,3507
SOZ 2	15	ERDAS	3,7976	28,3522	28,6054
SOZ 2	15	SipOrtho/Keystone	1,3793	4,0946	4,3206
SOZ 2	15	PRODIGEO	2,7228	5,9535	6,5466

Table 5 - External QC of the SOZ 2 image

[10] New fix 33599 for ERDAS Imagine 9.1 including improved F2 support appears to solve the along angle modelling problem [Ref 9].



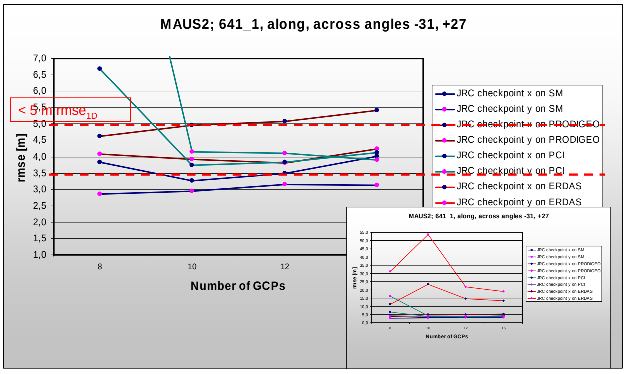
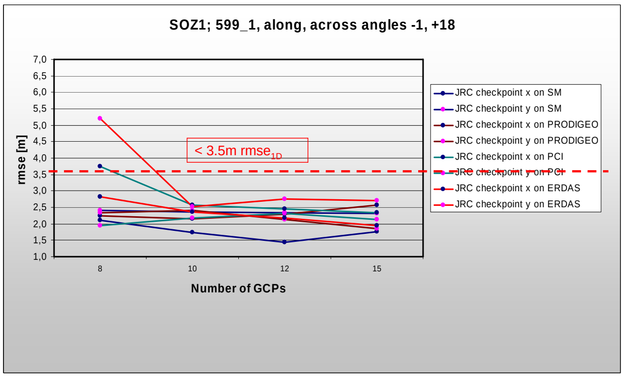


Fig 5, 6 - cf. MAUS1 – MAUS2, increase in along angle; y component error increase; large error in the ERDAS Imagine model.



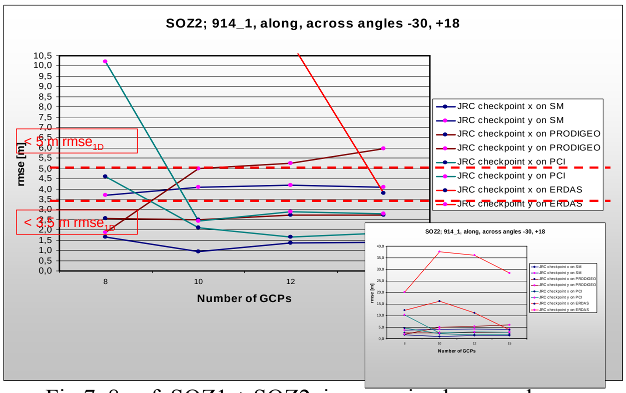


Fig 7, 8 - cf. SOZ1–>SOZ2, increase in along angle; y component error increase; large error in the ERDAS Imagine model cf. SOZ ->MAUS x-component error increase (across track)

3.4. ORTHORECTIFICATION SUMMARY

It was demonstrated that it was possible to perform good orthorectification using the software packages tested. The accuracy of 5m $RMSE_{1D}$ is reached with all tested softwares, at all off-nadir view angles, except ERDAS that should be corrected to model the along angle properly[1][Ref 9] 3.5m $RMSE_{1D}$ accuracy may be reached if limits are placed on the acquisition angles. Extrapolating the results of these tests, it is suggested that these limits are placed at a maximum of 20 deg for across track angle, and at a maximum of 25 deg for along track angle.

4. CONCLUSIONS

Following the 1st study (2006, Ref 2) where FORMOSAT-2 imagery of low/moderate off-nadir viewing was assessed giving orthorectification results within the CAP CwRS accuracy threshold (preliminary set to 3.5 $RMSE_{1D}$), this 2nd study (2007) further assesses the effect of large view angles on orthorectification accuracy, and defines the optimal number of GCPs to be used when orthorectifying FORMOSAT-2 images on a routine basis for the purpose of the CAP Control with Remote Sensing programme. Four FORMOSAT-2 images over two sites (France and Bulgaria) were used in the study. Four different sw suites (PCI Geomatica, ERDAS Imagine, PRODIGEO and Keystone SIPOrtho) were used in the orthorectification tests which were performed systematically and under strict control with varying no. of GCPs. Results were quality assessed in line with the JRC "Guidelines for Best Practice and Quality Checking of Ortho Imagery" [Ref 3]. In total 132 orthorectifications were performed using 6-15 GCPs and thereafter geometric assessment was made on 64 of these orthophotos.

The following important overall conclusions may be drawn after the study:

The effect of the acquisition angles on one dimensional errors is consistent with theoretical expectations; x error increases when across angle (roll) increases, i.e. from image SOZ to MAUS, while the y error increases when along angle (pitch) increases (satellite viewing direction) i.e. from image SOZ1 to SOZ2, and MAUS1 to MAUS2.

Basically the accuracy of 5m $RMSE_{1D}$ is reached with all tested softwares, except ERDAS that should be corrected to model the along angle properly. Vassilev [Ref 9] reported that with the new fix of ERDAS (fix 33599), issued by Leica Geosystems in June 2007, the FORMOSAT model was significantly improved[1]. 3.5m $RMSE_{1D}$ accuracy may be reached if limits are placed on the acquisition angles. Extrapolating the results of the tests performed, it is suggested using maximum 20 deg for across track angle, and 25 deg for along track angle. This is consistent with GSD as a function of satellite viewing angles. GSD remains below 2.5m if above angles are maintained, and F2 may therefore be used for a similar purpose as SPOT supermode as far as the PAN image content concerns.

Concerning the GCP requirement a total of minimum 10 GCPs should be used: four GCPs spread in the corners of the scenes, the others evenly distributed, and clearly visible. Moreover the use of GCPs from a reference dataset (e.g. aerial orthophoto or satellite orthoimage) already available in the EU Member States and broadly used for the LPIS is possible.

Concerning DEM the Ref3D (grid size 25m, RMSEz < 3.5m) appears appropriate.

At last, since the PAN and the MSP bands of the FORMOSAT-2 sensor are not registered simultaneously further tests should be made on orthorectification of the MSP bands, and on the result of pansharpening, for the use of these multispectral bands within computer aided photointerpretation and crop identification relevant for CAP CwRS.

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Session T6: LPIS updating

WORKSHOP ON DATABASE QUALITY ASSESMENT AND UPDATE

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KEY WORDS: LPIS, INSPIRE, UML modelling, Core Conceptual Model, Update, Quality assessment

ABSTRACT
Member States have implemented the LPIS-GIS as part of the IACS; the EU 15 had to implement the 2005 reform and the New Member States had to create their systems under the Acquis requirements. All these LPIS systems are in operation for several years and now is a good time to look into the functioning and maintenance issues.
We had the entry into force on May 15th of the INSPIRE Directive that focuses on environmental data, but also lays down a more general framework for interoperability of all geospatial data in Europe.
These combined issues were addressed during the annual LPIS workshop held in October 2007 at Ispra, where several cases of advanced LPIS applications and operational maintenance procedures were presented. The workshop demonstrated that many LPIS administrators are well prepared for the ongoing mainstream geo-information developments and participants feel there is potential for a standardized methodology to define and document the LPIS components, procedures and quality assessment.

1. INTRODUCTION

The Council Regulation (EC) 1782/2003 called for EU Member States to establish an Integrated Administration and Control System (IACS) by January 1st, 2005. An essential element of this IACS is the identification of land (commonly called the land parcel identification system LPIS) to enable precise localisation of agricultural parcels as well as to quantify the area of land that is eligible for aid. The LPIS system also serves as an instrument for the compulsory control by national administrations of farmers' aid applications.

As the LPIS systems have been in operation for a number of years, Member States have been confronted with the maintenance or upkeep processes of their systems; not only in support of the annual aid application and control operations but also to address quality issues that have been identified during the audits performed by DG Agriculture of the European Commission.

The 2007 LPIS workshop was organised around the assumption that the LPIS maintenance practices are driven by the occurrence of quality issues that appear in any operational database system. In this particular instance, LPIS quality requirements are to a large extent, implicitly or explicitly specified in the EU Regulations and therefore common to all LPIS systems. The workshop organisers introduced geospatial modelling, as promoted by the INSPIRE Directive, as a potentially suitable methodological framework to deal with all these issues in a consistent manner and to take full advantage of the common features. The presentations sessions were organised along the above lines to offer the presenters a clear focal point for addressing each issue with more detail.

1. CORE MODELS

A core model is a definable inner model of a universe of all sets. Core models act as a reference or standard and several have already been developed in specific application domains such as cadastral, agriculture, geosciences and business models (ESRI, 2003; Lake, 2005; Steudler, 2006; van Oosterom et al. 2006; Babaie and Babaei, 2005).. The purpose of a core model is not to provide a standard to which everybody is forced to adhere or transform, but rather to represent common modelling components and practices that can be reused within the domain and facilitate the translation from one conceptual realm into another.

Since LPIS originates from a common policy, all implementations can be considered as having the core model as a basis, whilst being extended according to their own national requirements. The resulting set of LPIS is still interoperable but each LPIS still reflects the particular demands of the different countries. To test conformity of any national system with the core model, individual mapping between the national and the core model will be needed.

The Core Cadastral Domain Model (CCDM) (Van Oosterom et al. 2006) is an excellent example of a core model, developed in the cadastre or land registry domain. The CCDM show components and patterns that are very familiar to features in the LPIS environments. The CCDM core is the relationship between object, right and subject. The object part or land (called *RegisterObject*) is fully developed as a spatial part with geometry attributes and topological constraints. Survey data are indeed quite similar over the various cadastres. The CCDM offers an extensible frame for the legal and administrative part to accommodate for national extensions.

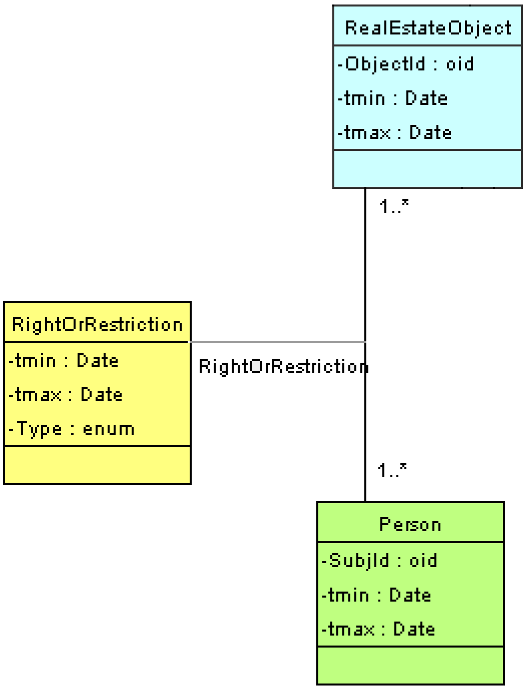

Figure. 1 Core of the CCDM: Person, RightOrRestriction and RealEstateObject[11]

Since the CCDM is an object-orientated model, the authors chose to express it in Universal Modelling Language (UML). The CCDM is designed to fit a model driven architecture system development and so is readily accepted by a large community of domain stakeholders (such as FIG, OGC, ISO) and this greatly facilitates user's support, which is favourable for the commercial actors in the domain. Please note that the apparent simplicity of the CCDM core above contrasts with the complexity of the detailed elaboration of each of these three key components.

The CCDM choices maximize co-operation and minimize the chances of double effort. Under the name Land Administration Domain Model, an updated version of this model has been proposed for ISO standardisation under TC211 in February 2008 (ISO/TC 211 N 2385).

The three CCDM core components are very recognisable in any LPIS system, The Subject (Person) corresponds to the farmer as defined in the farmers register, the right (RightorOrRestriction) matches the eligible activation of aid entitlements and Object (RealEstateObject) relates to the land parcel. In the LPIS realm, this latter means reference parcel.

However, to assess the extent to which the CCDM can act as a LPIS core model depends on how far its elaborations corresponds with the LPIS core model that lies hidden in the Regulations and national LPIS implementations.

2. TOWARDS THE LPIS CORE MODEL

The development or re-engineering of the LPIS core model involves a well structured process that makes optimal use of the functionalities and advantages of a dedicated modelling language. Blueprints of this development process can be borrowed from the Standardisation and harmonisation methodologies.

A standardisation process can be subdivided into well identified components or steps. The modelling language, in this case the UML provides appropriate structures and diagrams for a suitable representation within each modelling step. These are the steps:

1. A Universe of Discourse (UoD) for the LPIS application domain is outlined and documented on the basis of the EU Regulations that define the key concepts, basic (spatial) objects and functions of the system
2. The Regulations also lay down strict use cases (procedures) and specifies their requirements in detail. The most quintessential application of any LPIS is obviously the annual farmer's aid application. This inventory of EU-originating requirements needs to be supplemented by use cases and common practices observed within operational LPIS systems in the Member States.
3. The Model of Feature types provides the formal representation of the conceptual model outlined in the UoD.
4. An essential component of the above model of feature types is the Data Feature Catalogue that holds descriptions of the feature type definitions and their properties for our domain. The description of the reference parcel is at the hearth of the LPIS Feature Catalogue.
5. The application scheme accommodates for the unambiguous description of internal structures of the model and of the interaction between the feature types. At this application schema level, the data component of the model is represented by the commonly known "class diagram".
6. Finally, the modelling activity serves data storage or information exchange purposes that require some further standardisation, in particular regarding choices of physical implementation, formats, media, protocols etc.

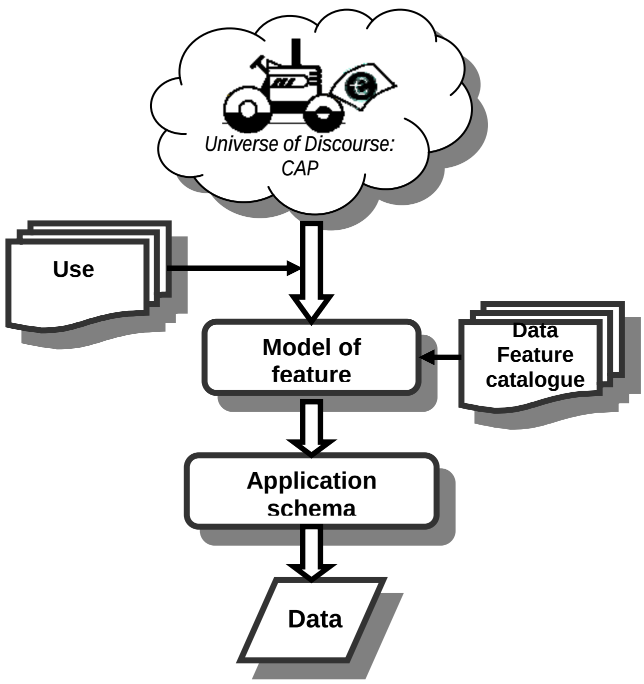

Figure 2: The data modelling process of the LPIS core model (adapted from ISO 19109)

The revised version of the CCDM as proposed for standardization (ISO/TC 211 N 2385) is named Land Administration Domain Model (LADM) and its core consists of Person, RRR (right/restriction/responsibility) and RegisterObject

The development process of the LPIS core model should identify what LPIS components are common, what these components mean and what quality they should meet. The resulting better and more universal understanding will directly benefit all traditional actors in this CAP domain. But this development would not pass in isolation; Directive 2007/2/EC, adopted in April 2007, calls for Member States to establish an Infrastructure for Spatial Information in the European Community (INSPIRE), for the purposes of Community environmental policies and policies or activities which may have an impact on the environment. This should be done by building upon infrastructures for spatial information established and operated by the member states. This Directive puts in place a legal and methodological frame that triggered a surge of harmonisation initiatives of geospatial data within and between the Member States.

Although LPIS is not explicitly mentioned as a theme in the Annexes of the Directive, the CAP requirements for compliance with Statutory Mandatory Requirements (SMR) and keeping land in Good Agricultural and Environmental Condition, (GAEC) suggest that LPIS is not too far outside of the INSPIRE scope. In practice, the implementation of cross-compliance measures has already driven many Member States to integrate within the national Spatial Data Infrastructure when it was available. The LPIS core model should further facilitate LPIS systems to participate to the various spatial data infrastructure developments and provide the opportunity for a better and bidirectional exchange of data beyond the traditional LPIS actors.

INSPIRE will achieve interoperability by establishing a services architecture supported by a relatively reduced harmonised EU data specification. This specification produces an online EU standard extract of the objects within an Annexe theme. By contrast, the model oriented approach of the LPIS core model enables a much closer harmonisation within the domain and harmonisation is supported by three starting conditions that are unavailable for many environmental data sets:

1. the presence of common concepts derived from a common agricultural policy
2. the common use cases and requirements laid down in the Regulations
3. the presence of an audit mechanism at EU level

The central concept connecting all stockholders in the CAP domain is the farmer's Single Application. A farmer lodges his application for aid to the Paying Agency, established or nominated by the Member State administration. Among other farmer's data, an application shall contain ((EC) No 796/2004): (a) the identity of the farmer; (b) the aid scheme(s) concerned; (c) the identification of payment entitlements; (d) particulars permitting identification of agricultural parcels in holding and their area. So the central part of the LCM consists of five main spatial and non-spatial objects classes of IACS: 'AidApplication', 'FarmingLimitation', 'ReferenceParcel' 'AgriculturalParcel', and 'Farmer' (Figure 4). The LCM distinguishes between the non-spatial object class AgriculturalParcel which is part of an aid application and its referencing spatial object class in LPIS – ReferenceParcel. Generic class ReferenceParcel has sub-types according to the type of reference system applied by the member state in question. The FarmingLimitation class has two additional abstract specializations: one for SMR and one for GAECs and both these specialisations are further differentiated by type of Directive or by national GAEC measure. Two Abstract classes, ReferenceParcel and FarmingLimitation, are spatial features and therefore specialisations (sub-types) of coordinate geometry type POLYGON as defined in ISO 19107 standard.

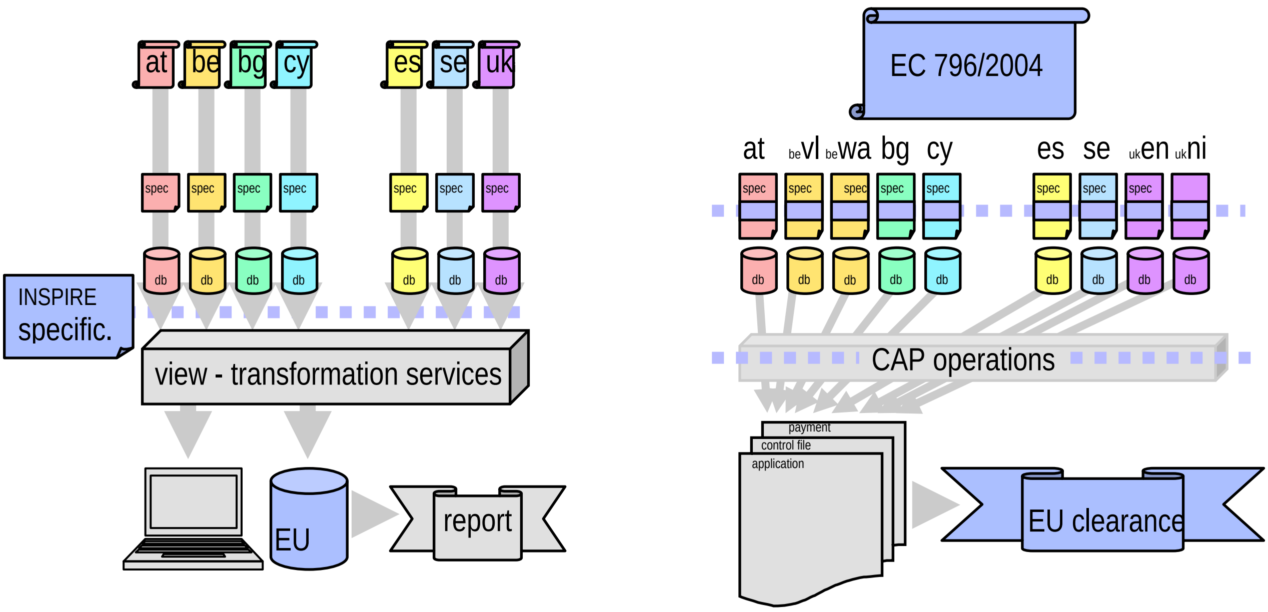

Figure 3: Difference in harmonisation approach between INSPIRE - service oriented and LPIS core model -model oriented (blue elements relate to common components)

'Spatial Schema'. The feature class CartographicReference is explicitly required by the CAP regulations: to serve the aid farmer's application with a map document and to ensure that the layer of reference parcels corresponds to the true ground situation. It can be represented by digital orthophoto imagery or cartographic map products at scale 1:10000 or more detailed. Since a majority of the Member States chose for orthophoto imagery, the class DigitalOrthoPhoto is included as a sub-type of the CartographicReference class and it is an implementation of the ISO standard 19123 Coverages. In the case of a topographic map, the original application schema of that cartographic product should be aggregated with the LPIS application schema. The Feature Catalogue is designed to further detail LPIS database objects with attributes which are necessary to accomplish needs of declaration and administrative check of aid applications.

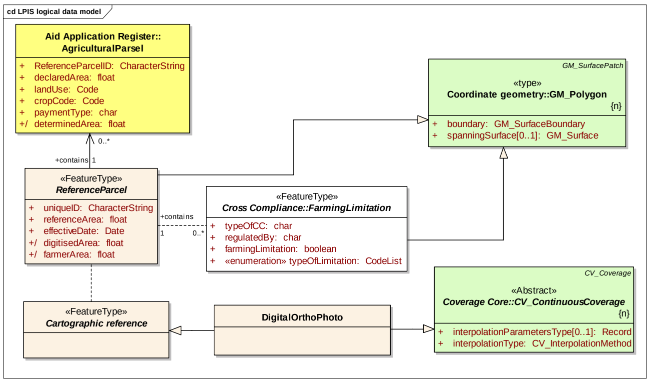

Figure 4: overview of the first cut LPIS core model.

It is safe to say there is a strong case to be made for the development of a LPIS core model: the benefits are numerous and clear, the general and specific conditions are right. But for the modelling process to be relevant and complete, a better understanding of the current LPIS systems is essential.

2. APPLICATIONS UPON EXISTING LPIS

The annual aid application of the farmer involves declaring position and cultivated area of his agricultural parcels. The LPIS is designed to offer a stable framework of reference parcels to facilitate and streamline this declaration process and the possible controls. Consequently, these two types of parcels each operate in a specific cycle: an annual cycle of the agricultural parcel driven by the choices of land use by the farmer and the generally longer cycle of the reference parcel, driven by the change of eligible land cover of the field.

In the centre of figure 5 is the concept of anomaly, which is essential for studying and controlling the data maintenance processes in a model oriented environment. An anomaly is an observed non-conformity between the real world and its model representation. Anomalies can be caused by processing errors, omissions, commissions, terrain change and model upgrades. In its strict sense, the update process deals only with observed terrain changes.

The challenges for the various actors can be easily identified from figure 5; farmers, inspectors and administrative processes should all help identify anomalies and, where possible, offer the candidate update information. Regulation changes, as a consequence of the CAP reform, affect the core LPIS model and can possibly start dedicated reference parcel upgrade activities. Systematic external quality reports, appearing ever more frequently with the growing integration of LPIS within spatial data infrastructures, help identify and address errors, commission and omissions.

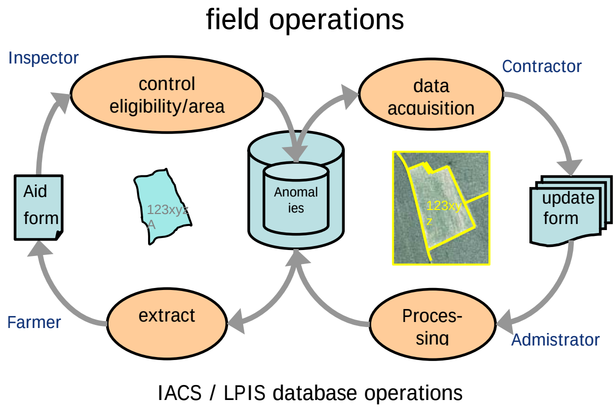

Figure 5: Operations during the annual agricultural parcel cycle (left) and the quasi-continuous reference parcel cycle (right)

The strategy chosen to implement this LPIS maintenance varies over the Member States. The workshop offered examples where the above cycle was clearly identifiable and update information was collected trough e-service applications that allowed for either an online update or the generation of an authenticated documented to be submitted separately. Some Member States had organised large administrative centres to process the workload and still other had rather ignored the cycle and are faced with a systematic overhaul of the system. Many Member States combine their update activities with specific actions targeting quality enhancements.

The complexity and cost of the LPIS maintenance cycle as well as its dependency on the aid application cycle and on many ancillary data sets, require that any LPIS design needs to accommodate for the role of the reference parcel as "common reference" for all stakeholders in the rural domain and for easy development of tailored applications to support this role. This enables cost-sharing benefits to become in reach.

To date, most LPIS applications, in the sense of IT applications, relate to the automation of the annual aid application use case, as laid down in the Regulations. The control process is often run in a closed environment, but many Member States have developed web-based applications for the declaration process. The decision to implement such e-services by the payment agency is often facilitated as an implementation of a wider national e-government policy.

The primary use cases are common and mandatory for all systems so the comparison between them addresses mainly the implementation and development choices. Member States have already implemented solutions that cover a wide range of architectures (client-server solutions, various plug-ins, and open source online editors). From the presented automation experiences, it seems that most developments had to negotiate a trade-off between

- customised (in-house or outsourced) development versus commercial solutions,
- portability of the application versus extensive development environment
- large user communities versus complex functionality
- wide access versus strict security

In general, the customised, standalone, development seems to raise issues on long term sustainability, financial scalability and interoperability.

As far as the integration of the LPIS with other (geospatial) data sets is concerned, not surprisingly many member state presentations reveal a tendency for centrally available, authenticated and interoperable databases that are expected to offer more ease of use and higher LPIS database consistency.

LPIS systems interoperate mainly with three application domains:
1. with IACS registers and ancillary data: examples are animal disease control, eligibility zoning and boundary layers
2. with several of the INSPIRE annexes: although the cartographic scale for LPIS is larger than that of EU environmental policies, land use and orthoimagery are the obvious themes; cadastral and topographic data are often supportive of LPIS maintenance. SMR and GAEC measures require access to data as the Nature2000 or Water Directive zone, Digital Elevation Models and soil maps
3. with the rural domain information; these thematic layers define e.g. the Less Favoured Areas and biologic value of land

3. THE SELF-PERCEPTION OF THE LPIS ADMINISTRATORS

The image of a common LPIS model background, with common use cases and quality requirements and with a high level of similarity between the various national implementations and application developments is a general picture that emerged from the fourteen workshop presentations from various Member States. The presentations represent half of the twenty seven EU Member States and all were deliberately focussed on the specific topic of their respective session. To test this picture, a short inquiry was launched by the workshop organisers, assessing the views of the larger LPIS community represented in the workshop. This inquiry consisted of ten questions that also served as a trigger for further discussion.

From the 74 registered participants, an “electorate” of 54 persons was asked to agree or disagree on 10 statements regarding the topics that were addressed during the workshop. It is clear that the outcome represents the view of these individuals, not of MS and one must also note that not all MS were represented by an equal number. The raw results from the counting of cast votes are presented in table 1 below.

Statement	Y	N	?
I think LPIS is within the current INSPIRE scope	16	13	25
Our LPIS is part of our national SDI	18	20	16
We have (digital) metadata	6	26	22
We use UML/XML/ISO191XX	18	20	16
I think a core LPIS model would be useful	43	1	10
We have a documented inventory of user requirements	15	25	14
We have publicly available update procedures	14	8	32
Our farmers contribute to update measurements (digital boundaries)	18	5	31
Our LPIS interacts with veterinary registers with IACS	20	18	16
Our LPIS includes a formal quality monitoring system	23	10	21

Table 1: The participants' view on the applicability of the various workshop issues on their LPIS implementation:
Y: agreement, N: disagreement, ?: no reply

The responses of table 1, imperfect as they are, still allow identifying some general tendencies:
1. The participation of LPIS in the national or regional spatial data infrastructure (questions 1-4) the situation is roughly divided. Half of the participants that expressed an opinion seem to have their LPIS system integrated; the other half operates the LPIS in a standalone manner.
2. The methodological approach of modelling LPIS (questions 5 -7) is perceived by the community in pretty much the same way, However, a majority participants considers that such exercise would be advantageous.
3. Questions 8-10, dealing with generic system components like automated applications, interoperability with databases and the presence of a quality system indicate that these components are available to the larger part of the participants.

4. CONCLUSIONS

The workshop focussed at update needs and underlying quality issues.
It introduced and investigated the geomatics modelling approach, as promoted by the INSPIRE directive, in the domain of the agricultural subsidies and more particular in its LPIS component. Its theoretical framework and opportunities were demonstrated by an example from a similar domain and by “first cut illustrations” from the very LPIS domain

More importantly, the presentations from the various Member States show that many have aligned themselves with that mainstream GI technology. Advantages from the use of standards and application with proven methodologies and architectures are generally recognised.

By contrast, a significant number of LPIS still runs in a standalone configuration, with little or no connection to their national or regional spatial data infrastructure. Not all Member States have a fully operational spatial data infrastructure available.

The Member States face similar issues and quality requirements, not surprisingly as they have to comply to common Regulations and are implementing very similar operations. They have adopted different strategies to cope with these issues.

Still, exchange of information between those Member States is very limited, especially regarding documentation on quality elements, parameters, test procedures, acceptance values and performance. A similar lack can be identified for the description of the upkeep process, with clear roles of the various stakeholders and the business rules for the data processing. All this lack of sharing documentation results in a nearly complete absence of any internationally re-usable component from the many software applications and interfaces that were designed to meet the common use case.

Documenting a voluntary LPIS core model, in alignment with the methodological and regulatory developments of the INSPIRE Directive, should address this lack of exchange of information. Compared to most environmental data sets for which harmonisation will be mandatory, LPIS harmonisation may even have a head start.

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Session T6: LPIS updating

EXTENDING THE USE OF LPIS INFRASTRUCTURE

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KEY WORDS: LPIS, Extendibility, SDI, giselle, cross-usage

ABSTRACT

The LPIS requires a highly efficient infrastructure, as it has to support hundreds of concurrent editors and thousands of viewers to meet demands in peak seasons. In Slovenia and in some other countries the LPIS system is the largest GI system in place. Having such a system the government can use it also for other purposes - if set-up correctly, it can support a large number of different applications in agri-environmental field and elsewhere, lowering the total costs and even improving the core LPIS data.

LPIS holds different sets of information – aerial photos, maps, elevation model, basic farm-holding data, land-use and other graphical and attribute data. These are usually the basis of every GIS application upon which some specific data are presented. A Giselle-based system in MAFF, Slovenia, has been implemented around this idea, so there are several usages possible:

- GIS viewing – system administrators can set-up a new application in a matter of minutes – they have to select which data layers are used, which will be searched-upon, etc. and they can do it while the system is running.
- Editing – browser-based or desktop application can be implemented much quicker as the development can build on top of underlying infrastructure (image distribution, access control, LPIS control procedures) and focus only on problem-specific functionality.
- Custom-made applications can also benefit from LPIS infrastructure as they can get all the information needed via web services (WMS and similar).

Since most of organizations demand to store their data in-house, the system cannot be completely centralized and has to follow some basic needs:

- Different access points (public web, secured connection, internal systems, etc.);
- Use of different data sources – Oracle, ESRI SDE and others in multiple instances;
- Local caching of raster layers to minimize the data transfer and speed-up the process but still making sure that the most recent data are used.

We will demonstrate different applications in the Ministry (LPIS, drainage and irrigation inventory, land consolidations) and in related organizations – Veterinary Administration, Phytosanitary Administration and Forest Service – which are all using the same infrastructure. This brings many advantages – re-using the data (instead of duplicating them), linking different sets of data (and enabling additional analyses) and cross-checking between data which all contributes to the quality of the system.

1. INTRODUCTION

In mid 2004, the Ministry of Agriculture, Forestry and Food, responsible for the LPIS registry in Slovenia, and Cosylab started a development of web-based LPIS system. Their deadlines were short – LPIS data was to be captured and finalized before the end of 2005. They started with spatial land use layer and an application for managing these data, well-tested by about 15 employees who spent a year interpreting the aerial photography. When the Ministry discovered that they will not be able to use the digital land cadastre data (because of insufficient positional accuracy), the team realized they have a lot of work to do in a short time frame. The plan was to interview more than 70.000 farmers about their fields in 6 months. The calculation was simple – there had to be almost 1000 people involved (not all full-time). As the Ministry did not have enough of its own staff, they had to include temporary people from other organizations. All this influenced the design of the LPIS infrastructure in a several ways – it had to be big and resistant to constant changes. Year 2005 was tough, but the results were great – the LPIS data were on-time and the system was open enough for new uses.

2. IMPORTANCE OF EXTENSIBILITY

When organizations start building a system, the next phase, extensibility, is usually not of the highest importance. But it is important to think about it and to plan it. Not only for achieving buzzwords such as SDI (spatial data infrastructure) but for more real-life reasons. The costs of setting up an LPIS are humongous - hardware itself costs at least a couple of 10 thousand EUR, usually even ten times more, the software is also in 100 thousand EUR. The most expensive are the data. Just the aerial photography, which is a basis of such system ranges from one to several million EUR (depending on the country size). But when you calculate the costs of work to set-up the data, all before mentioned figures are exceeded. In 6 months, the people at the Slovenia's LPIS project spent more than 120.000 man-hours just using the application (this was what we measured). The government should not afford to pay such expenses many times. As the legislation is changing quickly, there has to be a possibility to introduce new registers, procedures and processes in the system. It should be that easy that the question about the budget should not come in the way of implementing it. Extensibility is also important for the ease of use - the end-users are not fond of learning new systems, so adding new features to an existing system is much better.

3. BUILDING BLOCKS OF AN EXTENSIBLE SYSTEM

a) Inside expert for the data and information systems

The importance of the data expert inside the organization is greatly undervalued. The government usually depends too much on external consultants, IT companies or experts. There is no need for exaggeration such as the Ministry having a total control over the system. The thing that is important is that someone in the administration really understands the data, the relations between different data sets and procedures and that he/she has a general knowledge about how software development is going on. This is not useful just in case of changing the supplier but also during the development. This person is also the most suitable for evangelizing the data and infrastructure inside the organizations, pushing other departments to make use out of it (by using the infrastructure, not by e-mailing Excel files) and to improve it. Quite some effort will be needed to persuade all the people involved to set up procedures so that they will be as inter-operable as possible. Sometimes it is even important to have an IT system in mind when writing the legislation.

b) One database

The data will be used all the time so it is important that they are stored in a way everyone can access them, everyone with the right privileges. Services for managed access are useful but since it is impossible to predict all the possibilities there has to be a way to connect directly to the source – without obstacles such as non-optimized APIs, etc. That is why there is a need for standard, open and clearly structured database (in the Ministry, they use Oracle).
As alpha-numerical data are the knowledge behind graphical data, we have to keep them together.
If it is possible to persuade all departments of using the same database, that is the easiest way of taking care for the consistency. If this cannot be achieved, either because of legacy, security or some other reason, the infrastructure has to support connection of several databases at the same time.

c) Alpha-numerical data

The LPIS does not consist solely of spatial data – there are number of other registers that are included – starting from farm registry, vineyard cadastre, olive trees, animal stock register, etc. In case some of these registers already exist, the data links should be made, connecting data sets as much as possible.
Once the relations are in place, it is easy to use the data inside different applications. In the Ministry, they built a simple report generation tool, based on the Oracle stored query functionality. The tool makes it possible for somebody who knows SQL, but does not have to be a programmer, to quickly make views of the data and store it in a way that other end-users can view it too. These reports can be easily included in the applications (by simply calling a specific URL) and therefore became the integral part of the system.
Once generic search was implemented, these views became a large registry, presenting all the data that are in any way related to the LPIS. And the registry is in total control of the Ministry – no outsourcing is required.

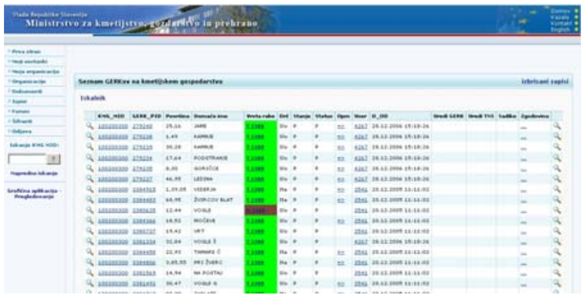


Figure 1 An application for displaying stored views of different data sets with defined styles and references to other views

d) Image server and GIS server

LPIS is usually based on detailed aerial photography and/or satellite images. They are both large datasets, usually measured in terra-bytes. Image server has to support several hundred concurrent users. Once such a powerful infrastructure is in place (note that image processing is the most CPU consuming task) it would be a shame not to use it for other applications. For that, some criteria have to be met:

- The system has to be scalable – adding new users to the system should not interrupt the core LPIS process; note that scaling up a (properly designed) system is much more cost effective than building a new one;
- The infrastructure has to support adding new spatial layers – both raster (topographic maps, digital elevation model, etc) and vector (forest line, drought area, etc.);
- The system must be configurable so that it is possible to visualize the same data differently for different users - in such way, one can set-up his application regardless of the other ones in the system.

Figure 2 Easy and powerful configuration is one of the most important factors for extensibility of the service

Having a centralized image server allows monitoring of all graphical applications from one point. Support centre can use this for providing effective help to non-educated users.

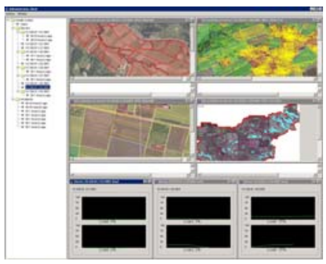


Figure 3 Administrator's application for monitoring the GIS activity in real-time

e) Thick clients

For core spatial activities (LPIS and similar) there have to be specialized applications, which are designed to mimic the process. As they are used by a large number of users, which are usually not GIS experts, they should not be too generic – they have to be simple for use and have just the right functions. Too much functionality would only confuse users.
Several observations should be taken into account:

- Speed is of great importance – reducing the time of specific process by 5% means a lot when this process is repeated 10.000 times;
- The application should implement as many controls as possible in order to improve the data quality;
- If it is possible to re-use the infrastructure, it should be done – this way the costs will be reduced and the end-user will get an application with a similar user interface so he/she will be more comfortable using it.

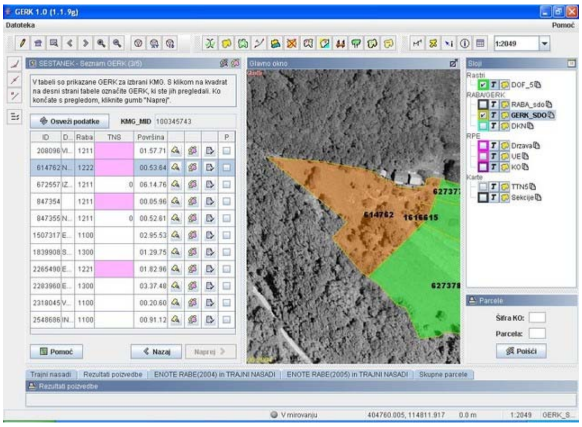
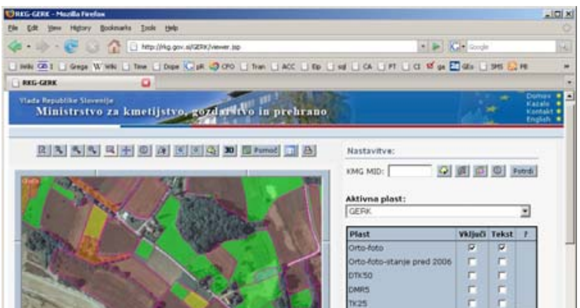


Figure. 4 A customized application for editing of LPIS data

f) GIS viewers

More than 80% of the GIS usage is viewing the data. If LPIS infrastructure is set up properly, a large number of applications can be built on top of it. If making a new viewer application is simple, we can make one for each purpose. We should try to avoid one generic, all-purpose application with lots of use-cases. This will only distract the end-users (officials and/or farmers). Rather, think of exactly which data are needed and



put links to other applications.

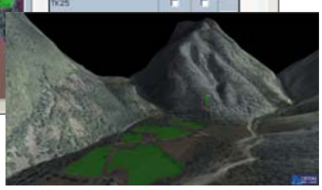


Figure 5 A generic viewer application with a possibility to show 3D visualization of the data

The viewer should therefore be as configurable as possible and because of a large number of non-educated users, it has to be using plain HTML interface without unnecessary installations.
Building a viewer, if GIS servers have all needed functionalities, should be as simple as configuring which layers are displayed and how are they visualized, which are searchable and which not.

g) WMS and other services

Once the spatial and alpha-numerical data are in the database, one can easily set up a WMS (web mapping service) and WFS (web feature service). The first one is most useful as one can include the geo-referenced image in other, external applications, without having to hassle with the complex infrastructure – with a simple HTML link.
This is how the LPIS infrastructure first pushed over the border of the Ministry, answering the most common answers by other departments, such as “Show location of this farm”.

h) Data catalogue

Once you arranged all the layers of data (spatial, alpha-numerical and the mixtures of these two) in the database, there is not much to do. One simply selects which data sets are important and inserts them in the application.
It is useful to have some sort of data catalogue so that all relevant people know what they can get out of the system. Its form is not so important – it can either be a database table, a document or something similar.
We should note here that the data sometimes come with a restricted license so one should get information about whether he/she can use the data for some specific purpose or not. Since government usually owns its data, the further use for other departments should not be obstructed.

4. AN EXAMPLE – NON-LPIS USES OF THE INFRASTRUCTURE

How does all this work in the real-life? The Veterinary service in Slovenia needed an application for logging of disease outbreaks. Actually, they already had the application; they just needed the GIS part. The Veterinary information system uses its own Oracle database, which is connected to the Ministry’s database because of information about farms (Farm registry) and GERKs (graphical unit of farm land-use). Their existing spatial data is in ESRI SDE. They wanted to host the GIS application on their server but they did not have aerial photography. So we connected the Ministry’s GIS and image server, Veterinary’s SDE and their Oracle database and created a rich GIS web application. The work was accomplished in less than three months. If everything is in place, it is easy to connect the parts.

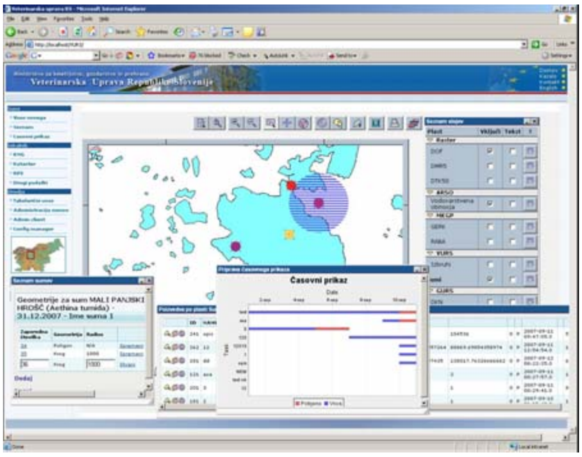


Figure 6 An example – an application for Veterinary unit, using LPIS data within Oracle and veterinary's data through ESRI SDE. Note that aerial photography from Ministry's Image server is not turned on for demonstration purposes.

5. TASKS FOR THE FUTURE

The work is not yet finished. The infrastructure in the Ministry is not nearly as optimized, as it should be. First of all, the relation to the Mapping Authority's data should be more direct. Currently, the vector data (cadastre, registry of spatial units, etc.) is replicated weekly (full copies are made) and the raster data were brought to the Ministry on external hard disks. First task would therefore be to download only the changes of vector data on daily basis. The final step would be to connect to State Mapping Authority's GIS infrastructure and use their data on-demand.

One "skeleton in the closet" is even closer. The Paying Agency, which is under Ministry's administration, has an almost completely unrelated system. They have their own database, image and GIS server, they duplicate the raster data. Luckily, the core data (GERKs) are replicated from the Ministry on daily basis. With some easy steps, the infrastructures could work together and improve the general experience.

Quite a big step is a more direct integration with the public. Currently, the farmers can check the public data about the farms on browser based GIS viewer and, if they have a digital certificate, they can check a complete set of the farm's data via browser. Ministry should now make it possible to update at least some parts of the data. Or allow some third parties, such as farmer's consultancy service, to connect directly to their infrastructure (again, using some rights of access regulations) and to build applications around it. This would improve the efficiency of the consultancy services and reduce the amount of work for the Ministry.

An interesting initiative that is starting in Slovenia is a Web 2.0 GIS portal in which public users can browse all sorts of data (including Ministry's land use and State Mapping Authority's cadastre and other spatial data) and even make some new layers similar to Wikipedia, but focused on GIS data.

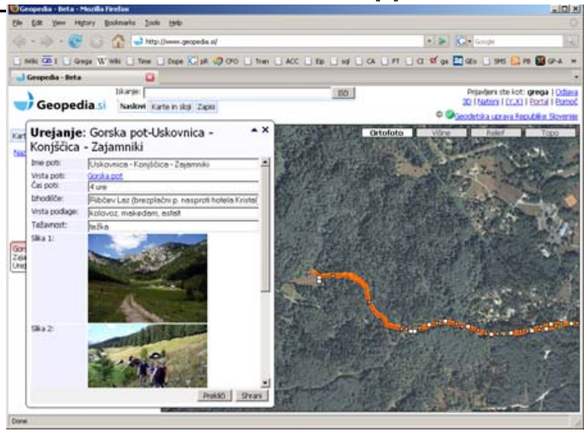


Figure. 7 Geopedia – a Web 2.0 way of using the data and infrastructure

6. CONCLUSIONS

Building an extensible infrastructure brings all sorts of positive effects. As one is not limited with one set of applications, all of them can be accessible at the same place. The user (farm-holder) can therefore get all the data at once. And as there is a possibility to show more data to him, he can give better feedback.

Second effect is possibly the most important for the government. Cross-checking of the data is much easier as the data are at one place, as one is able to visualize different sets of data at the same time and as there is a way of introducing additional administrative controls, which cover more data sets. All of the mentioned greatly improves the data quality.

The maintenance is also easier if the total number of systems is smaller. There is less hardware infrastructure that is breaking, there are less inter-organization network connections to manage and the backup is much easier.

Last but not least – if one is using the infrastructure for other purposes, he/she can get more feedback for its own data (in our case LPIS data). This, again, enlarges the value of the total system and the data themselves.

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Session T6: LPIS updating

TECHNICAL ASSISTANCE FOR THE MINISTRY OF AGRICULTURE AND RURAL AFFAIRS FOR THE DESIGN OF A FUNCTIONING IACS AND LPIS IN TURKEY

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KEY WORDS: IACS, LPIS, on the spot checks, control with remote sensing, photo-interpretation

ABSTRACT
"The Project on Technical Assistance for the Ministry of Agriculture and Rural Affairs for the design of a functioning Integrated Administration and Control System (IACS) and a Land Parcel Identification System (LPIS) in Turkey" (contract number TR 0402.08/002) started at 29th of January 2007 and finished at 21st of September 2007. Beneficiary institution is Ministry of Agriculture and Rural Affairs (MARA), General Directorate of Agricultural Production and Development (GDAPD), explicitly Agricultural Land Evaluation Department (ALED). Consortium consists of the Companies; INTA-SPACETURK (TR) (Consortium Leader) Ankara, EKOTOXA s.r.o.(CZ) and CS Systèmes d'Information S.A.(FR). Aims of IACS/LPIS Project are to provide support for MARA in establishing the main elements of IACS according to EU standards, to increase the capacity of MARA about legal and institutional issues related to IACS and LPIS in accordance with the EU legislation and applications and to establish the elements of a system, which operate in harmony with the EU. This project was implemented to prepare Turkey for nationwide implementation of IACS/LPIS. In this study, comprehensive explanations will be given regarding IACS/LPIS Project. "Final Report of IACS/LPIS Project" has been utilized during the preparation of this study.

1. INTRODUCTION

Turkey has launched the establishment of IACS with all its components. In Agriculture two main priorities are defined;

- Adopt the necessary legislative measures and set up suitable administrative structures to operate EU instruments related to rural development. (Short-term priority)
- Continue to work on the setting up of the Integrated Administration and Control System (IACS), in particular with regard to Land Parcel Identification System (LPIS). (Medium-term priority)

The project mainly deals with the second topic. It aims to provide support to the Ministry of Agriculture and Rural Affairs for the establishment of the components of the IACS.

The overall objective of the IACS/LPIS project in Turkey was to support the Turkish administration in setting up a functional IACS in line with the EU acquis and practices. The project represents a first step towards the nationwide IACS and LPIS implementation in Turkey. It consists of two main phases. The implementation phase was focused on implementation of the project in two pilot areas, whereas the thematic phase aimed at identification of institutional structures, investment, technical assistance and training requirements, and assistance to MARA in the preparation of project fiches and drafting the legislative framework.

2. PROJECT ACTIVITIES

The project consists of 2 phases for nationwide implementation of IACS;
Implementation Phase and Thematic Phase

2.1. IMPLEMENTATION PHASE:

- Creation of the ortho-imagery
- Digitisation of blocks & creation of LPIS database
- Establishment of the link with selected farmers
- Update of LPIS database
- Testing and demonstration of selected IACS procedures
- Training and dissemination of results

2.2. THEMATIC PHASE:

- Identification of the institutional structures
- Identification of the investment and technical assistance requirements
- Identification of the staff and training requirements
- Assistance to the MARA for the preparation of project fiches
- Assistance to the MARA in drafting the legislative framework

Outputs of Thematic Phase

Legislative Framework

3 DRAFT LAWS;

1. Bye-law on IACS implementation
2. Law on Implementation of a decoupled and simplified agricultural support system
3. Law amending the law on Agriculture and Rural Development Support Institution (ARDSI) were elaborated and submitted to establish IACS implementation

Project Fiches

1. Project fiche on digitisation of LPIS in Turkey
2. Project fiche for Paying Agency part for single payment scheme (SPS) using IACS

3. Project fiche on permanent crops
4. Project fiche for MARA staff training
5. Project fiche for cross compliance
6. Project fiche for on-the-spot control
7. Project fiche for maintaining and accelerating SW

Project fiche on digitisation of LPIS in Turkey
It aims to implement the most important cornerstone of the system, which is currently lacking.
The project consists of the following parts:

- Acquisition and creation of orthophotos for the whole country, with the special case of permanent crops where the resolution is required to be less than 0,5m.
- Digitisation on the basis of physical blocks of the whole area (agricultural land, forest land and other kind of land)
- External quality control of the digitisation process

Project fiche for Paying Agency part for single payment scheme (SPS) using IACS
The project shall elaborate the organizational chart of the expanded paying agency (ARDSI) with description of units, positions and functions to be delegated to related institutions (Inter & Intra Relation Determination) and manuals and guidebooks for the IACS procedures. It will also ensure ARDSI accreditation by fulfilling all the necessary conditions.
This project implies investment in IACS software and hardware, office equipment and field measurement equipment**.**

Project fiche on permanent crops
This project is aimed at setting up a special register for permanent crops, to establish a management system to rationalize the support schemes for permanent crops, to implement tools to avoid market and competition distortions, to suggest rules compliant with EU regulations.

Project fiche for MARA staff training
This project aim is to train and educate MARA staff in IACS / LPIS procedures as a management tool.

Project fiche for cross compliance
This project reviews all Turkish laws establishing a basis for cross compliance, to determine if these laws are compatible with EU acquis, to propose legislative amendments and information sheets to make farmers aware of their obligations.

Project fiche for on-the-spot control
This project aim is to elaborate the methodology for on-the-spot-controls and risk evaluation, guidebooks for on-the-spot-controls customized for Turkish situation

Project fiche for maintaining and accelerating SW
This project aim is to develop criteria and tender dossiers for tendering a multi-annual service contract for maintenance, implementation of innovations and enhancement of the IACS - IT system.

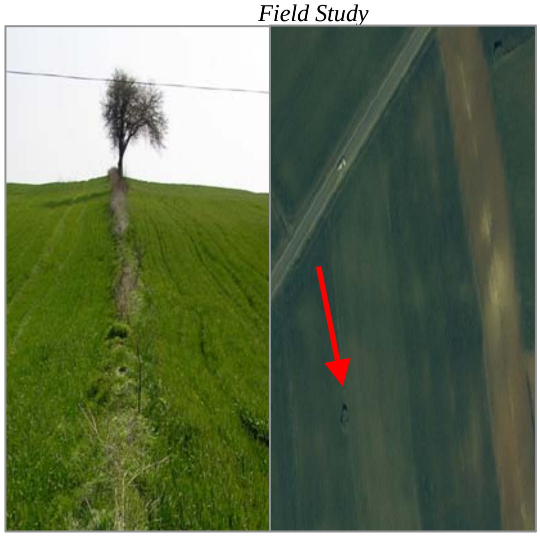
Selection of Pilot Zones
MARA provided local support for the field survey and establishment of the link with farmers. In this scope MARA collected data for 500 sample farmers and 100 additional alternate farmers per pilot province.

MARA also provided geographic co-ordinates of selected areas which characterise Ağrı and Tekirdağ provinces.

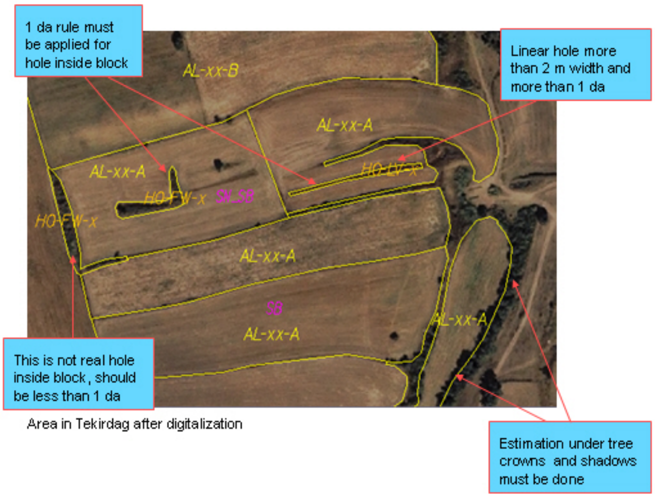
3. DESIGN AND CREATION OF LPIS IN PILOT PROVINCES

1. Evaluation of available orthoimages
   - IKONOS orthoimages from pilot provinces
2. Field study
   - GPS + camera
   - Comparison with orthoimages
3. LPIS design and photo-interpretation guideline
   - Basic unit – physical block
   - Seamless geodatabase
   - Agricultural land, Settled areas
   - Selected landscape features outside/inside physical blocks (aerial/line/point vegetation)
   - Remaining “gaps” (Natural graze land, Woods, Water bodies...)
4. Training of staff
   - MARA staff and operators, digitisation lasted for 29 working days
5. Creation of LPIS database
   - Ikonos 1m, Auxiliary data, Database design, Unique code
6. Result supervising (EQC)

Field Study



Photointerpretation guideline – example of photointerpretation



4. CONSULTATIONS WITH FARMERS

Selection of farmers

The purpose of the consultations with farmers was to gather information related to their agricultural parcels, such as their spatial position, declared area, crop type, and some other general information (age, education level). In each province a sample of 600 (500+100) farmers per zone was selected by the MARA using the National Farmer Registration System (NFRS) data of the previous year

Manual for consultations

Manual that explains how to realise the consultation procedure.

Training of the consultants

8 consultants have been trained for 3 days in Tekirdağ and 6 consultants in Ağrı for 2 days. These consultants from MARA have been trained about SW and filling the consultation forms

Consultations with farmers

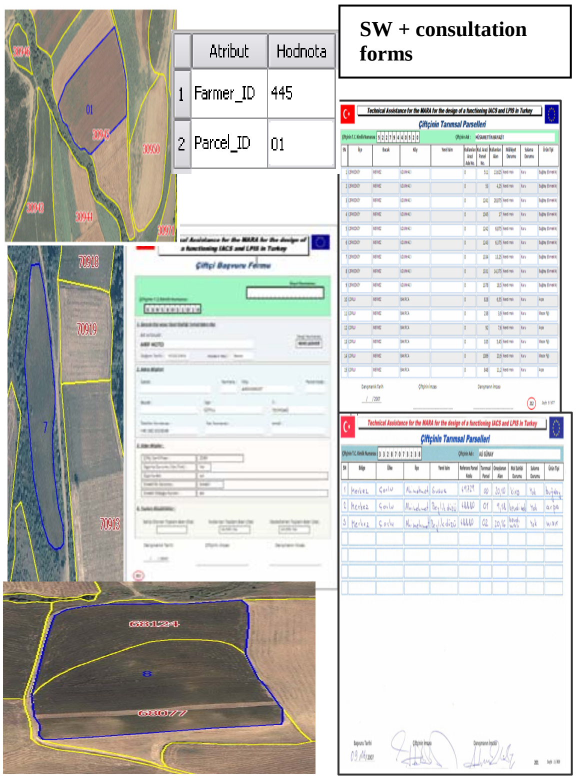
Free Quantum GIS software has been used during the consultation with farmers at the time of rough digitization of agricultural parcels according to instructions in the Photointerpretation Guideline.

Pre-printed forms have been generated separately for each selected farmer in the pilot provinces, based on NFRS previous year declarations.

The main objective of the consultation phase was to contact the selected farmers and more specifically to facilitate the location of their claimed parcels on the orthoimages, register them in the LPIS database and to ask farmers to answer to a submitted questionnaire.

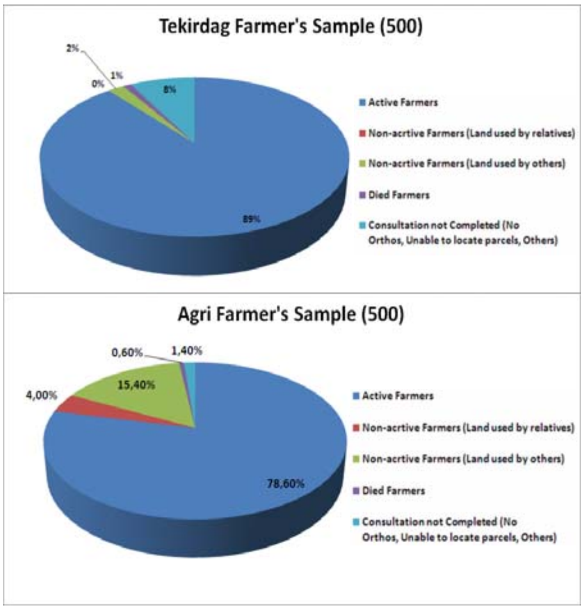
During the meetings with both provincial authorities it was decided that the training / information to the farmers should be incorporated with the consultation in one step during the first visit to each district centre.

The relevant statistical figures concerning the number of parcels and the declared areas, using both the data from NFRS database and the data collected from the consultation with farmers, have been presented in the form of charts.



Achieved results regarding consultation

In the following charts the status of the farmers is presented. It is remarkable that the percentage of non active farmers in Ağrı is considerably higher than in Tekirdağ.

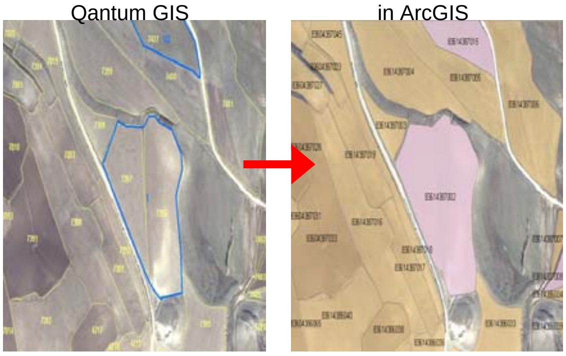


Update of LPIS database

The final step of the database update was to modify the LPIS data according to the new agricultural parcels, where the operator had made mistakes during creation of the LPIS. The "topology" tool was often used in this process to modify the LPIS blocks to match the boundary on orthoimage and agricultural parcels properly.

Rough digitisation of agricultural parcels in Qantum GIS

Update of LPIS - creation of agricultural parcel layer in ArcGIS



The final database included the new agricultural parcel layer containing the farmer and parcel information. Being fully consistent with the consultation data and the final version of the LPIS data; it was also fully consistent with the agricultural parcel layer.

5. DEMONSTRATION OF IACS PROCEDURES

Selected IACS procedures were demonstrated on a representative sample of farmers using the TIDS web-based software application. The demonstration covered preparation and submission of aid-applications, administrative control and on the spot checks including the control with remote sensing.

Development of TIDS SW

During this project, web-based software application "**Turkish IACS Demo Software** (**TIDS)"** was developed to demonstrate IACS procedures in a graphical way.

Selection of farmer sample

Parcels with valid graphic (not null, linked to a valid LPIS block) and farmers with a small number of parcels and with a large number of parcels were also included to have a representative set. Representative geographic localization of parcels was randomly distributed among Tekirdağ province. Representative list also includes crop types / Land use. Membership in advisory associations and without such membership is another criterion. Some parcels of neighbouring farmers and some farmers with the same surname were also taken into consideration. The criteria list included enough farmers to allow INTA/MARA to choose eligible farmers from the list.

Training of consultants

A variety of documents were prepared, such as presentations, manuals and sample background data to be used for simulation of the consultation procedures during the training session.

Consultations

During consultations pre-printed forms were used and on-line updates using the TIDS were realised.

Turkey IACS SW and Procedures Demonstration

Çiftçi Başvuru Formu

Kayıt Numarası:

Çiftçinin T.C Kimlik Numarası: 32216108980

1. Gerçek Kişi veya Tüzel Kişiliği Temsil Eden Kişi

Adı ve Soyadı: METİN TEZCAN

Vergi Numarası: 8410109063

Doğum Tarihi: 3/9/1959 Medeni Hali: Evli

2. Adres Bilgileri

Sokak: Numara: Köy: AHIMEHMET Posta Kodu:

Bucak: İlçe: ÇORLU İl: TEKIRDAĞ

Telefon Numarası: +90 282 6786016 Fax Numarası: email:

3. Diğer Bilgiler

Çiftçi Sertifikası: 3928

Sigorta Durumu (Var/Yok): Var

Sigorta Adı: ssk

Emeklilik Durumu: Emekli

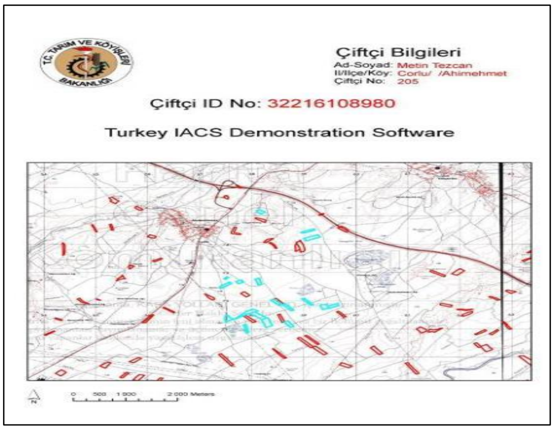
Emekli Olduğu Kurum: ssk

Notlar:

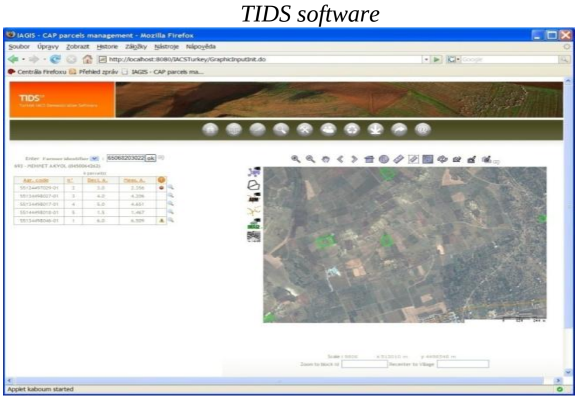
Sunuş Tarihi / / 2007 Çiftçinin İmzası İşlemi yapanın Adı ve İmzası

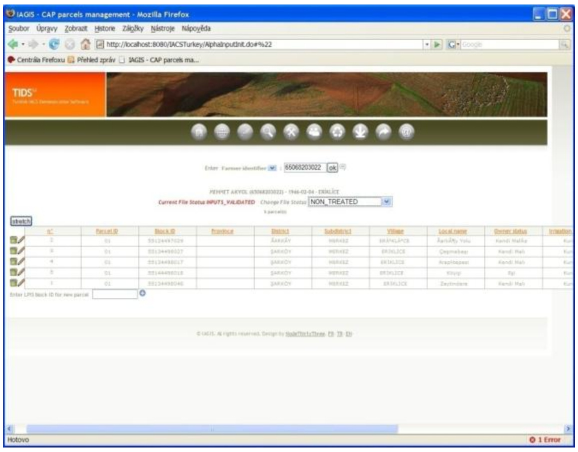
205

Pre-printed forms



TIDS software



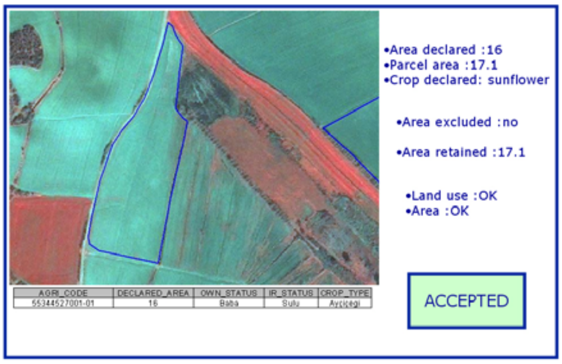


Enter Farmer identifier : 65068203022 ok

693 - MEHMET AKYOL (0450064262)

5 parcel(s)

Agr. code	n°	Decl. A.	Meas. A.	!
55124497029-01	2	3.0	2.356	
55134498027-01	3	4.0	4.206	
55134498017-01	4	5.0	4.651	
55144498018-01	5	1.5	1.467	
55134498046-01	1	6.0	6.509	



Control with Remote Sensing

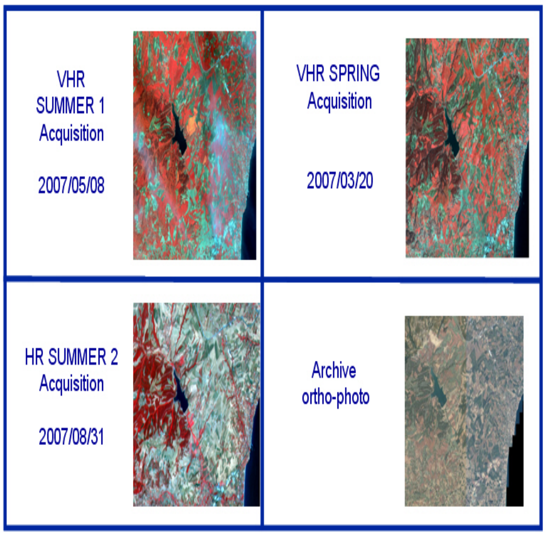
Administrative controls
Performing administrative controls and tracking possible anomalies.

On The Spot Checks – OTS

- Field visit
- Control with Remote Sensing – CwRS

On-the-spot Checks

Control with Remote Sensing



6. MAIN FINDINGS FROM PILOT PROJECTS

During the localisation of agricultural parcels farmers provided valuable inputs and were co-operative.
Instead of printed maps, more sophisticated tools for registration of farmers' parcels should be used during consultations (preferably web-based application).

The physical block appears to be the most suitable concept for Turkey.

During the implementation of pilot projects MARA staff gained unique practical experience with LPIS and IACS implementation which can be used during the planned nationwide IACS/LPIS implementation in Turkey.

7. CONCLUSION

Support to MARA for the establishment of the main elements of IACS according to EU standards has been provided .Capacity of MARA concerning legal and institutional issues related to IACS and LPIS in accordance with EU legislation and applications has been increased. In this line, 3 draft laws and 7 follow-up project fiches have been produced in preparation for of nationwide implementation after the project.

Elements of IACS system, which operate in harmony with EU have been tested and established. The physical block appears to be the most suitable concept for Turkey. The main finding in the pilot areas of Tekirdağ and Ağrı was that it is possible to implement IACS/LPIS as management tools in the pilot areas which are extremely different. If it is possible to use these tools in such different areas, then it is certainly also possible to implement the systems throughout Turkey.

The Turkish Government is aware of the time constraints in order to get IACS / LPIS installed by 2010, SPS implemented by 2011 and tested before 2013.
The paying agency for SPS as part of ARDSI has to be accredited by 2011

Decisions upon legislation and projects should be implemented as soon as possible.

The Project Team has installed a website: www.iacstr.com which informs about the objectives, the chosen approach and the main results.

Session T7: Use of LPIS and IACS data outside the CAP

USE OF SIGPAC FOR FIRE CONTROL

R. Fernandez[1]

[1] Tragsatec, Spain

KEY WORDS: Fire, control, LPIS, Web tool, real time positioning

ABSTRACT

SIGPAC Database in Spain has been successfully used to build a location and management Web tool for the control of forest fires.
The technology developed for the SIGPAC cartography and data viewfinder has been combined with mobile wireless positioning and management features that permits the system visualise in real time the position of resources deployed in the field, record tracks, locate individual resources, associate events information, manage alarm situations and maintain fleets composed of heterogeneous media.

1. INTRODUCTION

Tragsa Group, which owns Tragsatec, is a public capital holding that operates as an independent body of the Spanish Administration. It has developed SIGPAC IT system (Spanish LPIS) in consultation with the Spanish Agricultural Guarantee Fund (FEGA).

Due to its scope, wildfire management is one of the most significant services offered. It includes prevention, extinguishing fires and environmental recovery of affected areas.

Every year, Grupo Tragsa provides human resources (about 5000 technicians specialised in fire extinction), machinery and aviation resources to the different Autonomous Administrations during the campaign period that extends from May to October, depending on the regions.

In 2006, as part of a pilot exercise, an emergency display was developed based on SIGPAC BD to be used by the Autonomous Communities as a support tool to define the characteristics of the environment where fires take place and control the resources allocated to extinguishing fires.

In its first campaign, the display offered the possibility of displaying information on fuel combustion models according to vegetation, environmentally-protected areas and positioning of mobile units (roadblocks and heavy machinery) through localisers (GPS + GPRS modem) over SIGPAC graphic layers (orthophoto and topographic maps).
In the 2007 campaign, we added another feature to facilitate the management of fire-fighting resources.

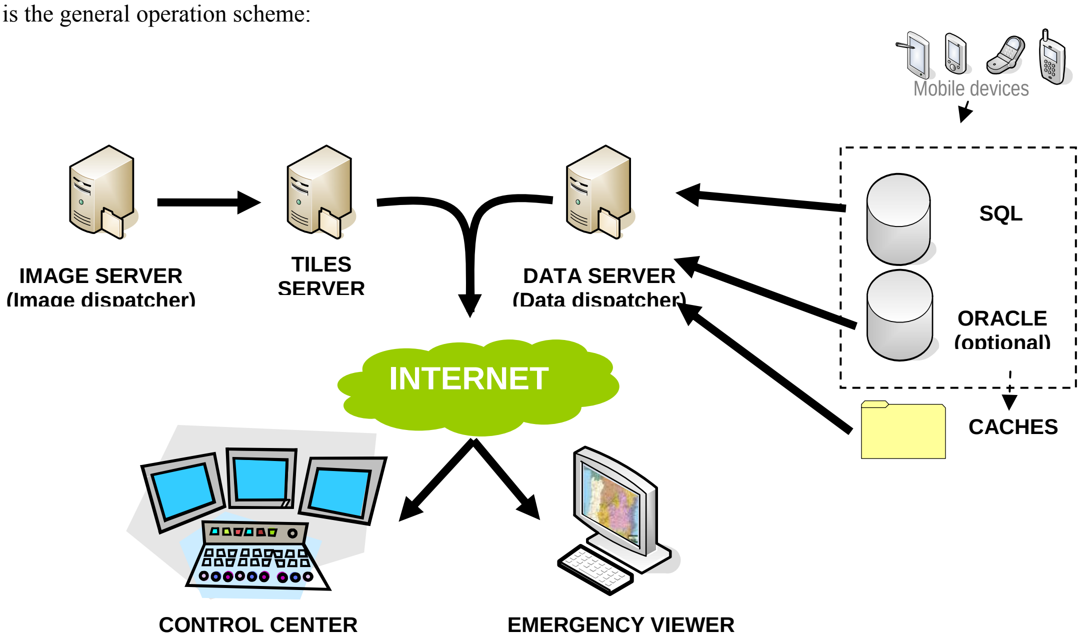
This tool has been implemented in several Autonomous Communities, making it easier to manage all the information relative to each region:

- Addition of resources.
- Addition of users.
- Incidence management (fires).
- Allocation of resources to incidences.
- System inquiries.

2. TECHNOLOGY

The development was carried out using Adobe Flash technology. Database systems were Oracle and SQL-Server, and the program runs on Internet Explorer, Netscape, Opera and Firefox.
It uses SIGPAC images, compressed to ECW format. During its development, priority was given to keeping a simple interface for non-specialised users who already had a SIGPAC display.

This is the general operation scheme:



- Real-time reception and storage of mobile units positioning information.
- Availability of cache files with static information in vector format (fuel models, protected areas and layers to be added).
- Image server for the orthophoto and topographic maps layers.
- The information altogether is published on the Internet. It can be accessed through the display from any terminal connected to the Net through a browser.

3. DATA ACCESS

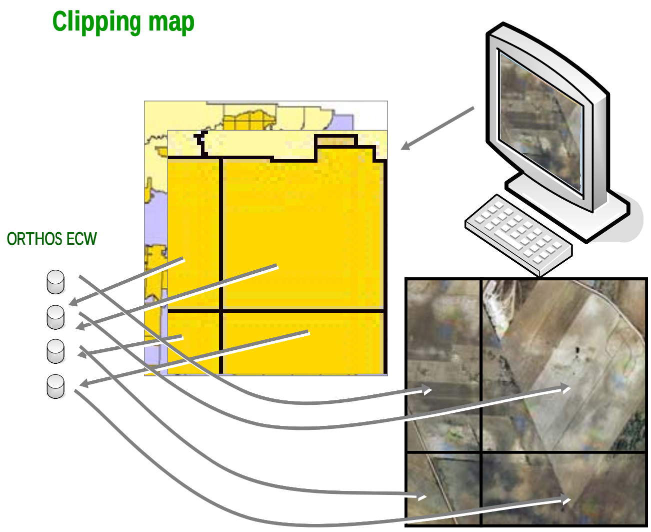
System configuration options are the same as for SIGPAC display. Data from different computers can be combined (one can provide vector information, another alphanumeric information on fire-fighting resources, another image service, etc.).

Another feature inherited from SIGPAC display is the possibility of setting up cache files in local and network disks, which speeds up information access, avoiding queries to remote servers.

Finally, tile image storage technology is used. Thus, if a tile has already been requested by a system user, there is no need to retrieve it from the image database in ECW format, then sample it and convert it to JPEG format. Rather, it is already available to be sent to the client.
The mobile resources management module can be accessed from the display or from an independent Web application, with no need to go through the graphic window.

4. IMAGE COMPOSITION OF THE TERRITORY

The composition of continuous image coverage or its update is performed from manifold irregular-shaped parts obtained from various photogrammetric flights on different dates.



In order to present the image as a continuous and homogeneous layer, the CUTTING MAP is used. To view a certain image window, the CUTTING MAP allows the definition of which image files should be accessed to extract the part to be composed.
The system extracts the requested image blocks and once the image server arranges the pieces that will be shown on the browser graphical window, a single JPEG file is created and delivered over the network.

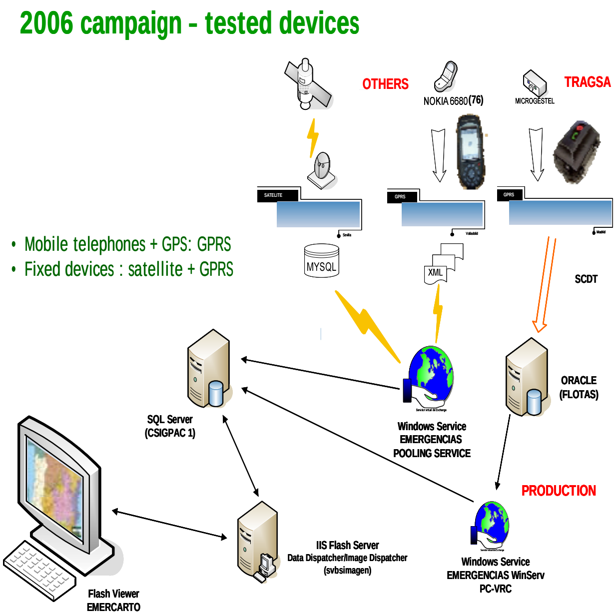
5. 2006 CAMPAIGN - TESTED LOCALISERS

During last campaign, which served as a pilot exercise, two types of localisers were integrated.

Bulldozers were fitted with fixed localisation and communication devices capable of reporting data through GPRS or via satellite when there is no GPRS coverage available.

Fire-fighting technicians used handheld devices: a mobile phone tied to an independent Bluetooth GPS device for data communication purposes.

Positioning data were integrated in the display based on services provided by other companies in different formats (XML, BD MYSQL, ORACLE). Data were then homogenised into a single database on SQL-Server, which displayed them in a single format.



6. CAMPAIGN 2006 - RESULTS AND PROBLEMS

Based on the experience from last year, these are the conclusions for improvement implementation:

- Bluetooth communication between the mobile phone and the GPS was sometimes interrupted without the operator noticing. Coordinates could not be sent as a result. The use of an integrated GPRS and GPS device was recommended.

- The data transfer service delivered by external suppliers was sometimes interrupted too, and data were occasionally lost. To avoid these problems, it was recommended that communication software be developed to provide a direct link between localisers and the display, reducing the number of subsystems involved and incidence of failure accordingly.
- Some improvements for the design of the communication vehicle were also identified. In 2006, Tragsa developed the first prototype of an all-terrain vehicle, engineered to support the advanced control centre. It comprises a radio transmitter, data communication by satellite, portable equipment with access to the emergency display and a DIN A3 printer to get printouts at the foot of the fire.
- Improvements were also deemed necessary to depict the travel paths of mobile units, in order to set timeslots to be viewed more accurately.
- Finally, the need to avoid logistical problems when changing SIM cards among mobile phones due to breakdowns was highlighted as well. Such problems caused confusion in their identification.

7. CAMPAIGN 2007 - IMPROVEMENTS

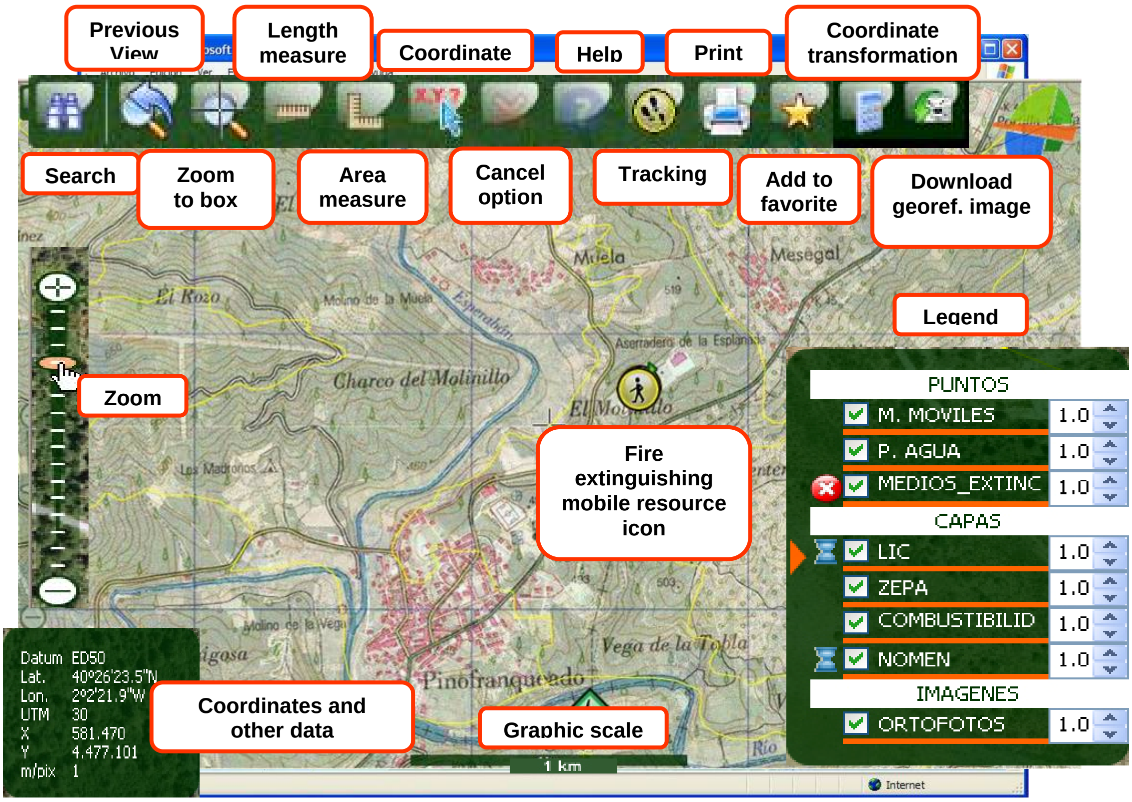
Major upgrades to the display version for the 2007 campaign included the new image service using AJAX technology, with tile buffering, the use of integrated location equipment (MODEM and GPS in the same device) and the development of the communication software, which sends locations to the system directly without the need for external services.

In this campaign we also extended the functionality available in the system, adding an application for managing resources and incidences (fires).

Lastly, location equipment configuration modules were developed. This makes it possible to handle the process remotely with no need to collect the modules for their reconfiguration at the office, thereby avoiding any downtime. A clear example of remote configuration is the modification of the coordinate sending interval (30 to 20 seconds), as well as the shutting-off of an activated alarm signal, once the danger situation is solved.

8. FUNCTIONALITY

This is the home view of the emergency display with overlapping comments on the feature embedded in its components:



The upper section contains a command bar that enables the search of mobile units, approaching or leaving the land fixing boxes, measuring distances or surface areas, capturing the coordinates for a position, requesting the representation of the path of a mobile unit, obtaining printouts, adding the view to favourites, carrying out transformation of coordinates across projection systems and downloading images to the local disk of the equipment where the program is being run.

A continuous zoom bar is displayed as well as a small graphical bar scale to estimate distances.

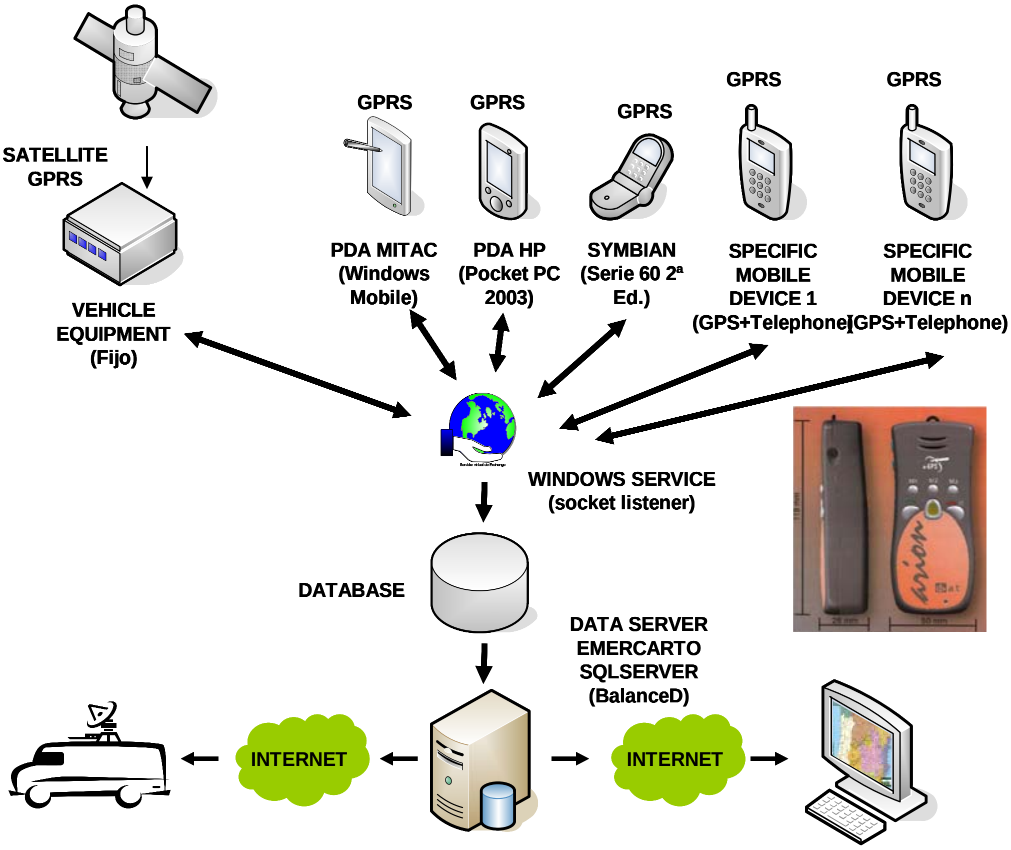
The legend box shows the visible layers at the current scale. Layers can be viewed or hidden through the switch on the left, and represented with a degree of accuracy set between 0 and 1 with one-tenth gaps.

Finally, the information box at the bottom-left corner at all time shows the cursor coordinates in latitude and longitude and in UTM with the corresponding X and Y according to the time zone where we are located.

The icon in the centre of the figure represents the last position reported by one of the fire-fighting mobile units.

9. LOCATION DEVICES AND COMMUNICATION SCHEME

The following figure shows the communication scheme used in 2007 campaign:

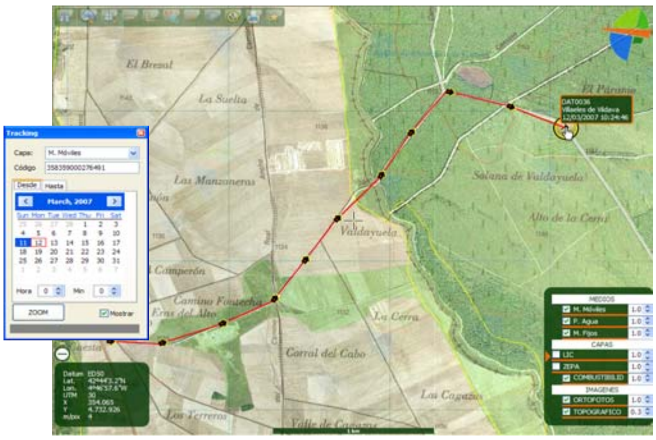


A direct link between the localiser and the system was set up through a unique Windows listening service which identifies the type of device reporting the data and the protocol used.
Storage was reduced to a single database implemented in SQL-Server, which serves the display and advanced command vehicles.

The picture with orange background on the right shows the handheld location device used by fire-fighting technicians in this campaign. It has the size approximately of a mobile phone with a user-friendly design. As soon as it is switched on, it starts reporting the GPS coordinates to the preset GPRS service. The keypad only allows starting and ending a call to any of the three preset numbers.

10. MOBILE UNIT TRACING

To request the representation of a localiser-fitted mobile unit tracing, the user's identification code must be entered, as well as the starting and ending point where their positions will be displayed. This information is input with the tool shown on the screen, setting date and time and starting and ending point of the path.
The system draws the path for the period set, showing a representation of the intermediate points, which varies depending on the scale. The small arrows that represent the crossing points are cursor-sensitive, so when the cursor is placed on them, a small window opens and shows the mobile unit identity and the date and time when it passed that location.



11. RESOURCE MANAGEMENT MODULE

The following figure shows the system administration application. It is an alphanumeric application that can be activated independently or from the graphical display.

Specifically, we see the form to assign the fields that define an operator roadblock as well as the operator's identification code, the base assigned to them, the crew they belong to, the number of operators involved, the base coordinates, etc.

12. INCIDENCE MANAGEMENT MODULE

The following figure shows the resource management mode when a fire is activated. The upper section shows information on the fire epicentre reported to the system and the lower section shows a list of the resources that the manager can assign to the fire-fighting procedure by clicking on the central arrow.

When a resource is allocated, it is no longer shown as an available resource in the left column. Then the system allows inquiries on which resources are assigned to a mission at each given time and which are still available.

One can request different listings of the resources recorded in the system: their status, incidences where they have been involved, hours in active service, etc.

This article is intended to show a running adaptation of the information and technology developed by the Ministry of Agriculture within the scope of the SIGPAC project. Other adaptations could be mentioned as well such as those conducted for the Directorate General of Civil Protection and crisis follow-up centres, in addition to other applications that prove the significant usefulness of the information contained in SIGPAC, and the value that the various administrations are adding to this major Database.

2nd Plenary session:

SYNERGIES BETWEEN GMES AND COMMON AGRICULTURAL POLICY

J. Masson

European Commission, DG Enterprise, GMES Bureau – Brussels, Belgium

KEY WORDS: GMES, GMES Land Monitoring Service, CAP, Earth Observation, Space Infrastructure, Environment information, EO data access

ABSTRACT

GMES (Global Monitoring for Environment and Security) is a European initiative implementing services that produce information on environment and security, based on Earth Observation satellite and other sources of observation. The GMES services will deliver information in the field of Land, Marine, Atmosphere, Emergency Response and Security, to support European policies (CAP being one of them) and user requirements at European, national or local level. There are potential synergies between GMES and MARS PAC activities:

- PAC activities could benefit from the reinforced European Earth Observation satellites infrastructure
- IACS information could be shared with other communities though the GMES in-situ infrastructure and CAP activities could benefit from other in-situ data
- It is planned to develop an agriculture component in the Land service of GMES which could be linked to MARS PAC activities.

1. SCOPE OF GMES

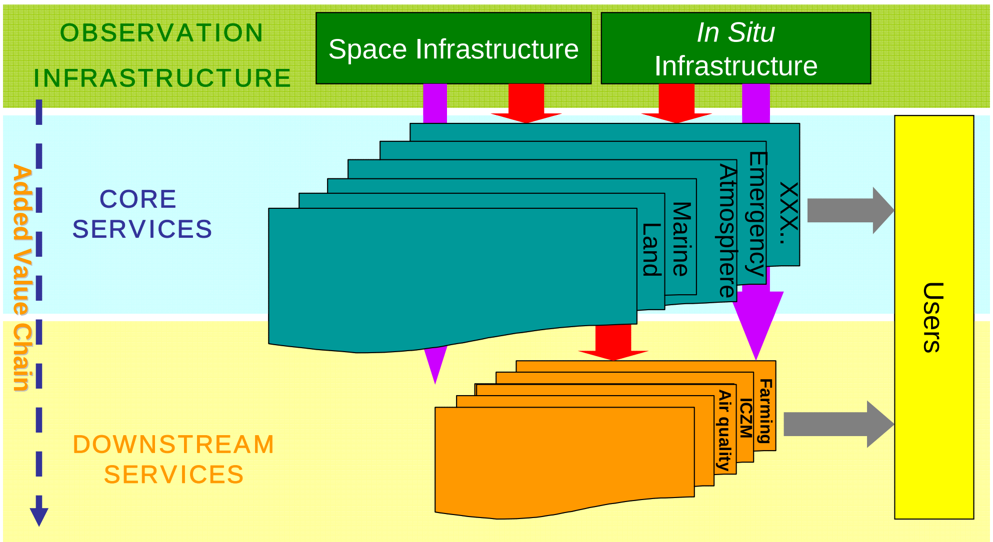
GMES (Global Monitoring for Environment and Security) is a European initiative for the implementation of information services dealing with environment and security, based on Earth Observation satellites and other observation sources. As stated in COM(2005)565 final, the objective of GMES is to contribute to the sustainability of European spatial information capacities to support a variety of European policies, in particular:

- Europe's environmental commitments, within EU territory and globally, by contributing to the definition, implementation and monitoring of the Community environmental policies, national regulations and international conventions
- Other policy areas such as **agriculture**, regional development, fisheries, transport, external relations, development aid and humanitarian assistance,
- Common Foreign and Security Policy, and other policies relevant to European citizens' security at Community and national levels.

GMES is based on an integrated system approach (System of System), building on existing capacities and filling the gaps, producing services of guaranteed validity and quality, and moreover, ensuring their sustainability.
The overall architecture of GMES encompasses an observation infrastructure (Space and In situ infrastructures) and services aiming at delivering information which can be either generic and shared among a large community of users (the so-called 'Core services') or dedicated to specific requirements at local, regional levels (the Downstream services). One of the purposes of GMES is also to reinforce the European Space infrastructure based on both dedicated Satellite missions developed by ESA (the 'Sentinel' suite) and contributing mission.

Five GMES Core Services (CS) have been defined: **Land** (which is of interest for the Common Agricultural Policy), Emergency Response, Marine, Security and Atmosphere. It was decided to develop the GMES services in steps, starting with **3 Fast Track Services (FTS) on Land, Marine and Emergency response** in 2008. The choice of the three Fast Track services was based on their maturity, their user uptake and the long-term sustainability on supply-demand.

The development of the GMES infrastructure and services is based on the combination of existing operational capacities and additional components which are funded through EC Research projects and ESA projects (called GSE, i.e. GMES Service Elements). A large part of the Space theme (85% of 1.4 Billion Euros, i.e. 1.2 Billion €) of the EC 7th Framework Project (2007-2013) is dedicated to the pre-operational phase of GMES (2007-2013), which will become operational in 2014. Of these 1.2 Billion €, 650 M€ should be dedicated to space infrastructure and 400 M€ to the development and validation of the services.



2. CONTRIBUTION OF GMES TO THE CAP BY A REINFORCED SPACE INFRASTRUCTURE AND A COORDINATED DATA ACCESS

2.1. REINFORCED SPACE INFRASTRUCTURE

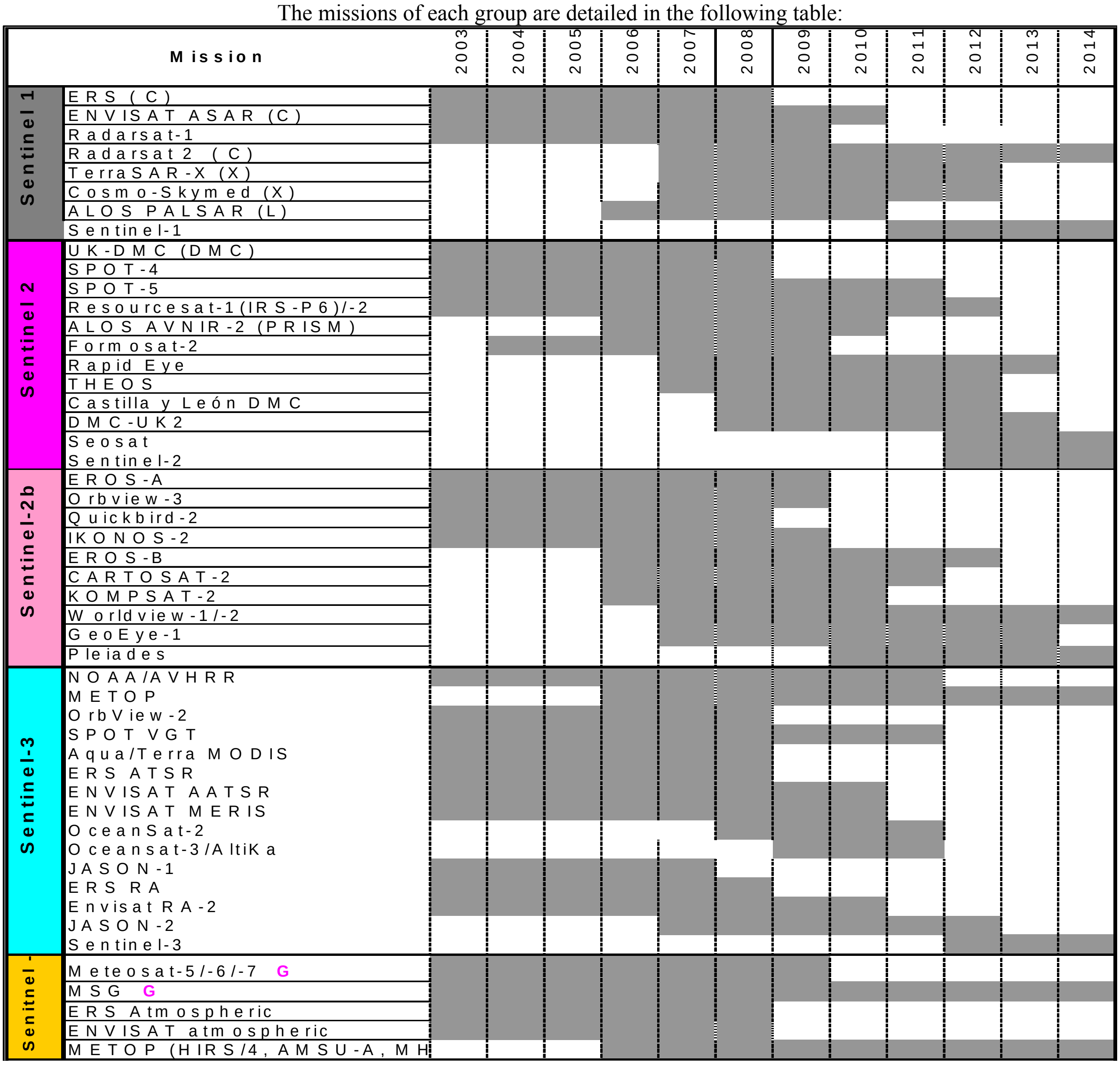
One of the objectives of GMES is to reinforce the European autonomy in Earth Observation infrastructure. The GMES Space Component (GSC) relies on:

- The development of the 'Sentinels', which are a series of dedicated missions for the requirements of the GMES service, in order to fill the gaps of the existing European Earth Observation missions. This development is coordinated by ESA and co-funded by the European Commission. Five Sentinels are planned and will be launched between 2011 and 2014.
- The EO infrastructure belonging to the Member States, to private or semi-private entities, to Eumetsat missions, and other ESA missions.

Those missions have been categorised into groups:

Mission group type Sentinel 1	High-resolution SAR imaging (different Radar bands)
Mission group type Sentinel 2	High-resolution multi-spectral imaging.
Mission group type Sentinel 2b	Very High-resolution multi-spectral imaging.
Mission group type Sentinel 3a	Medium-resolution Ocean and Land monitoring.
Mission group type Sentinel 3b	Altimetry
Mission group type Sentinel 4	Geostationary atmospheric.
Mission group type Sentinel 5	Low Earth Orbit atmospheric.

The missions of each group are detailed in the following table:



Source: ESA

2.2. COORDINATED SPACE DATA ACCESS

The rationalisation of the access to input data is crucial for running operational services. A coordinated data access mechanism for all services could benefit the services. ESA has already acquired similar experience from Corine, which is the precursor of the Land FTS, with the acquisition of the Pan-EU coverage Image 2006. In order to test the concept of coordinated data access for all GMES services, ESA has recently signed a GSC Data Access grant with the EC to deliver space data to the FP7 GMES projects (2008-2010). This encompasses the collection of service requirements and the definition of priorities of satellite tasking on the basis of contributing mission capabilities, as well as the acquisition of licenses, and the monitoring of data supply. If this Data Access grant is successful, it might be extended to the GMES operational phase.

The expected advantages of the GSC-DA are:

- for the GMES Service providers:
  - a consolidated portfolio of data to avoid redundancy and maximise the synergies
  - an interoperability approach through the concept of mission groups
  - to get better conditions with common bulk agreements
- for GMES data providers and operators of contributing missions:
  - a framework agreement leading to a better long-term vision of the market.
  - a sustainable basis for planning their operations and the development of future missions

In the future several options are possible, depending on the future Governance and funding of GMES: to stay with licensing, bulk agreements with data providers, or to move to data buy or data resource approach.

3. ADDRESSING AGRICULTURE IN THE LAND MONITORING CORE SERVICE

- ***Current situation***

So far the EO activities related to land applications have been sector-based, thematic-oriented and project-oriented, even on a multi-annual basis (Corine, MARS activities).

On the other hand data, sharing is at the heart of several initiatives at European level (INSPIRE Directive, the new Shared Environmental Information System initiative and GMES) and at Member States level. More and more countries are moving towards multi-purpose Land Information Systems (e.g. Spain with SIOSE, Germany with Decover, UK, NL...) in which IACS is or can be a component. But the situation varies a lot from one country to another.

- ***GMES approach***

The GMES approach is service-oriented rather than project-oriented, multi-purpose oriented rather than sector-oriented. The purpose is to build or to reinforce sustainable capacities, based on a long-term strategy at European level, maximising the use of existing activities and avoiding duplication. The Agriculture community has a long history of EO based applications, in particular in the field of controls of agricultural subsidies (MARS PAC) and is now well organised at MS and EU level, under the coordination of the JRC. The objective of GMES is not to duplicate what is already in place but to build upon the basis of existing capacities and to identify possible contribution from GMES.

The contents of the Land FTS have been defined following a workshop with Land user community in October 2005: it was decided to focus first on Land use and Land Cover mapping, which is a common need for all land-user communities. The Land FTS has a Land Cover component at continental Pan-EU level, based on the extension and improvement of Corine Land Cover, driven by the EEA (European Environmental Agency).: better resolution (from 25 ha to 5h and 1ha for some classes) and a better update frequency (from 10 to 3-5 years). The Land FTS has also a local component with the Urban Atlas (part of the Urban Audit of DG REGIO), mapping the main EU urban areas (around 500 cities) using Very High Resolution data.

However the Land FTS is far from covering all the requirements of the Land communities; and this should be addressed by the Land CS Evolution beyond 2008, which will cover:

- A **European Land Thematic component** addressing environmental European policies and other Land-related policies**, including the CAP**.
- A **Global Land component** to support EU international development and cooperation policies and the implementation and monitoring of international conventions.

Agriculture has been identified as one of the priorities for the Land CS evolution. The identification of this service element is in progress, the GMES Bureau of DG ENTR is in charge of collecting the user requirements, assisted by a Land Implementation Group whose members are representatives of user communities.

The implementation of the Land FTS is based on the consolidation and integration of various elements: R&D activities (FP6 GEOLAND project and the upcoming FP7 project GEOLAND2), ESA pre-operational projects (GSE Land, Forest and Food Security) and existing operational activities such as Corine. The link with other existing operational activities such as MARS should be addressed.

4. IN-SITU COMPONENT: SHARING DATA (IACS AND OTHER DATA)

The in-situ component of GMES covers by default all 'non-EO' satellite data, which are very diverse: (i) measurements from observation infrastructure, (ii) surveys, including on the ground and airborne surveys, and (iii) collection of already elaborated products. Another important aspect is that a lot of data already exists at national, regional or local level. This is why the MS have a key role to play in the in-situ Infrastructure. An in-situ Working Group with the MS and major actors has been created recently, under the coordination of the EEA. There is a strong need for coordination and harmonisation at European level (for example for reporting on European policies), which is addressed in Inspire and SEIS.

In-situ data requirements have already been identified by the Land Monitoring Implementation Group for the Land FTS:

- Ground Control Points for geo-referencing, ortho-rectification
- Field Survey data for calibration, interpretation and validation: LUCAS has been identified as main source for the Pan-EU level
- DEM
  - existing Level 1 SRTM data (90m) freely accessible
  - Level 2 product (30m): EURODEM product under discussion
  - Level 3 product for local component, covering Urban areas
- Topographic maps and data
- Aerial photos: the possibility to reuse the LPIS orthophotos should be discussed with the MS
- Other data
  - Thematic maps, including LPIS land parcel data
  - Statistical data

IACS Land Parcel Identification System contains reference data (orthophotos, parcels, some information on land cover and land use) which are very useful for many other user communities. On the other hand, the IACS community might be interested in sharing other reference data accessed by the Land service (e.g. EURODEM, topographic maps, thematic data, cross-border data) or on Land service products (in particular land cover/land use products). There is a need to start a dialogue between GMES and the IACS community to discuss a possible strategy, in particular regarding:

- access conditions and data policy
- technical options
- harmonisation, aggregation required at EU level

A specific workshop on this issue could be organised, with the support from the JRC.

5. CONCLUSIONS

The added-value of GMES for the CAP controls could be:

- a reinforced and more sustainable European space capacity
- a coordinated access to Space observation data
- possible 'mutualisation' of capacities, for example for ortho-rectification,
- to share data with other user communities, for example through the acquisition of a EURODEM (Digital European Model at European level).

On the other hand, MARS PAC could have a role of model for the other components of GMES. We would like to propose a framework for collaboration between GMES and the MARS

PAC activities, which could be coordinated by the JRC through the existing discussion forum with the MS.
It is important to hear the voice of the IACS community in the definition of the GMES Land service. The Agriculture component is not yet addressed in the Land CS and the requirements of agriculture community need to be defined.
The IACS community should be also present in the on-going discussion on multi-purpose Land Information Systems, as it is the case in some Member States and at EU level. For this a better coordination of land user communities is required as well. A very good example is given by Spain.

Final Conference Programme

Auditorio B: sessions with interpretation **Sala Amsterdam**	
Monday 12/11	**Spanish showcase day** **Auditorio B**
8:30 – 10:00	**Registration / Installation of posters and stands (hall B)**
10:00 - 10:30	**Coffee service**
10:30 - 11:15	Welcome addresses (Spanish Authorities and EU Commission)
11:30 - 12:15	• Policy distribution of geographic and agronomic data in the EU (J. Delincé, JRC) • GMES activities (M. Facchini, DG Enterprise, GMES bureau, EC)
12:15 - 13:15	• Presentation of the Spanish GIS LPIS and of its applications (F. Miranda Sottillos, FEGA) • The SIGMAPA application (Mrs Gomez Andres, MAFF)
13:15-14:15	**Lunch break**
14:15 - 15:15	• The national plan of aerial orthophotgraphy (PNOA) (Mr Garcia Asensio, IGN) • The spatial data infrastructure of Spain (IDEE) (Mr Mas Mayoral, IGN)
15:15 - 16:00	• Convergence between the Cadastre and SIGPAC: improving the information on land use and property (Mr Miranda Hita, Mr Serrano Martinez, Dirección General de Catastro de España)
20.00 - 24.00	**Gala dinner**
Tuesday 13/11	
	Plenary session **Auditorio B**
9:00 - 10:30	• SIGPAC tools in support of the farmer's application and of the LPIS updating (Francisco Montero, FEGA) • Integration of the SIGPAC maintenance in the management and control of area based subsidies in Cataluña (Valenti Marco and Albert Domingo, autonomous community of Cataluña) • Assessment of the use of the optical pen for updating SIGPAC (Fernando Ruiz, Tragsatec) • Exploitation of RS data for the control of CAP subsidies using EDACON, (Fernando Gragera, Tragsatec)

<table>
<tr><td>10:30 - 11:00</td><td colspan="2">Coffee break
Poster / demos Hall Auditorio B</td></tr>
<tr><td></td><td>Session T1: CwRS Review of 2007 / preparation 2008
<u>Restricted to National/Regional Administrations</u>
Auditorio B</td><td>Session T5a: new sensors
Sala Amsterdam</td></tr>
<tr><td>11:00 - 13:00</td><td>• Summary statistics 2007 (Andrew Rowlands, JRC)
• Image acquisition 2007 (Maria Erlandsson, JRC)
• Selection of control zones (Hervé Kerdiles, JRC)
• Changes to CwRS Common Technical Specifications and Image allocation for the 2008 campaign (Hervé Kerdiles, JRC)
• Image acquisition campaign 2008 (Pär Åstrand, JRC)
• Consequence of the 2006 agricultural parcel definition (Andrew Rowlands, JRC)</td><td>• Introducing WorldView: DigitalGlobe’s Next Generation System (Bruno Biagini, Eurimage IT)
• TerrasarX in support of crop monitoring (Simon Ashby, Infoterra Group UK)
• The Cosmo SkyMed Satellite Constellation for Earth Observation and applications (Giorgio Apponi, e-geos IT)
• Use of Intergraph's DMC digital frame camera for classification (Klaus Neumann, Intergraph DE)
• Rapid Multi-Sensor System for Effective Risk Analyses (R. Haarbrink, Miramap NL)</td></tr>
<tr><td>13:00-14:30</td><td colspan="2">Lunch break</td></tr>
<tr><td></td><td>Session T2: New guidance on checks of areas for 2008
Auditorio B</td><td>Session T3: GAECs control with Remote Sensing
Sala Amsterdam</td></tr>
<tr><td>14:30 - 16:00</td><td>• Assessment of risk factors: example based on 2005 data from Italy (Hervé Kerdiles, JRC)
• Selection of control zones in IT (Maurizio Piomponi, AGEA IT)
• Validation of area measurement: JRC plan (Simon Kay, JRC)
• WikiCap: sharing regulatory reference documentation on the control of CAP subsidies (Pavel Milenov, JRC)</td><td>• Telaer AGEA VHR SAR system. A Remote Sensing solution for Cross-Compliance controls and data integration (Livio Rossi, Agrisian IT)
• Semi-automated extraction of Landscape Features from VHR satellite data (Lucas Brodsky, GISAT, CZ)
• Our view on the use of remote sensed data for cross compliance (Philippe Loudjani, JRC)
• Combining orthophotography with Wireless Sensor Networks to improve agriculture quality (Javier Longarez, Edosoft Factory, ES)</td></tr>
</table>

16:00 - 16:30	**Coffee break**	
	Session T4: Control of cross compliance and FAS **Auditorio B**	**Session T5b: new sensors and image processing** **Sala Amsterdam**
16:30 - 18:15	• Ongoing discussion of the CC legislation (Ansa Norman-Palmer, DG AGRI D1) • Outcomes of CC workshop (Philippe Loudjani, JRC) • Use of RS for the control of cross compliance (Marisol Sardon, autonomous community of Castilla La Mancha, ES) • Overview of FAS implementation (Vincenzo Angileri, JRC) • Implementation of FAS in Spain (María Pajarón, MAFF ES) • ICT-platform for FAS: a new dimension for CAP (Walter Mayer, Progis AT)	• Orthorectification tests of Formosat 2 (Pär Åstrand, JRC) • ImageSat - capabilities and services EROS B satellite (Rani Hellerman, ImageSat, Israel) • Orthorectification tests of Eros B (Gabi Lubovski, IIT IL) • Orthorectification of VHR data (Pedro Miguelsanz, Tragsatec, ES) • Comparison between Vexcel 50 cm digital ortho and QBird images for the control of areas, GAEC (Csaba Wirnhardt, FOMI, HU) • Image server in 2008 (Paul Hasenohr, JRC)
19:00-20:30	**Tour of Madrid**	
Wednesday 14/11		
	Session T6: LPIS updating **Auditorio B**	**Poster / demos** **Hall Auditorio B**
9:00 - 11:00	• Overview of 2007 LPIS geodatabase updating workshop (Wim Devos, JRC) • Extending the use of LPIS infrastructure (Grega Milcinski, Cosylab, SI) • LPIS update in FR (Emmanuel de Laroche, AUP FR) • Methods of upgrading the LPIS/GIS in Poland and the role of LPIS /GIS in the implementation of the INSPIRE directive (Jolanta Orlinska, Jacek Jarząbek, ARMA PL) • Turkey: IACS/LPIS project in Turkey and achieved results (I. Hakan Erden, Hasan Dursun, MARA TR)	

11:00 - 11:30	**Coffee break**
	Plenary session: Inspire / use of LPIS and IACS data outside the CAP **Auditorio B**
11:30 - 13:00	• Use of SIGPAC for the control of fires (Jesus Fernandez, Tragsatec, ES) • Agricultural statistics in the USA (Roberta Pense, USDA NASS, USA) • Use of SIGPAC as a tool for optimizing the Crop Area and Yield Survey (ESPYRE) of the Spanish Ministry of Agriculture, Fisheries and Food (Antonio Fuertes, MAPA ES)
13:00 - 14:30	**Lunch break**
	Plenary session: Round table: interest of CAP geomatics data for other policy areas **Auditorio B**
14:30 - 15:45	Introduction to round-table: A Commission perspective of CAP geomatics data interest for other policy areas. • Synergy between GMES and CAP (Josiane Masson, DG Enterprise, GMES bureau) • Using IACS data for fostering environmental objectives (Hugo de Groof, EC, DG Environment) Round table: includes Speakers from Session T7
15:45 - 16:15	**Coffee break**
	Plenary session: Summary and conclusions **Auditorio B**
16:15 - 17:30	• Scientific conclusions (Peer review panel) • Industry findings and observations (Tragsatec) • Administrations' findings and observations (FEGA) • Closing remarks (J Delincé)

All abstracts and presentations may be found on-line at:

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European Commission

EUR 23378 EN **– Joint Research Centre – Institute for the Protection and Security of the Citizen**
Title: Geomatics in support of the Common Agricultural Policy - Proceedings of the 13th MARS PAC Annual Conference, 2007 - Palacio de Congresos, Madrid 12th-14th November 2007
Editor(s): **Philippe Loudjani, Simon Kay, Paolo Pizziol, and Andrew Rowlands**

Luxembourg: Office for Official Publications of the European Communities
2008 – 90 pp. – 21x 29.7 cm
EUR – Scientific and Technical Research series – ISSN 1018-5593

EUR 23378 EN - 2008

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