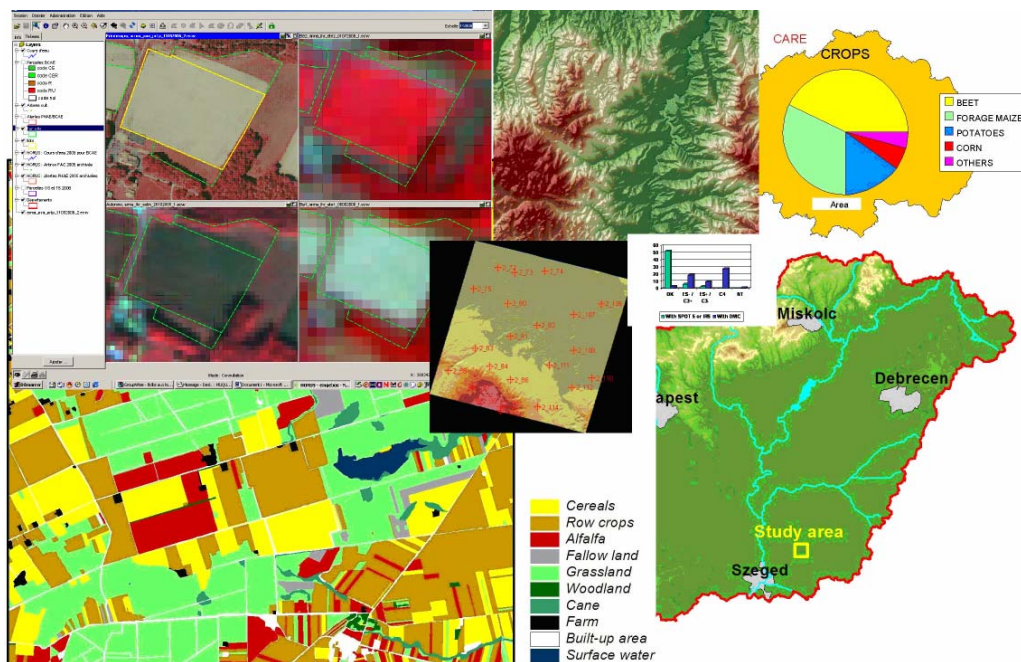




Geographical Information in support of the Common Agricultural Policy

Proceedings of the 12th MARS PAC Annual Conference, 2006

Edited by: Simon Kay, Aleksandra Sima, Philippe Loudjani



EUR 22160 EN - 2007

The Institute for the Protection and Security of the Citizen provides researchbased, systems-oriented support to EU policies so as to protect the citizen against economic and technological risk. The Institute maintains and develops its expertise and networks in information, communication, space and engineering technologies in support of its mission. The strong crossfertilisation between its nuclear and non-nuclear activities strengthens the expertise it can bring to the benefit of customers in both domains.

European Commission
Joint Research Centre
Institute for the Protection and Security of the Citizen

Contact information

Address: Joint Research Centre, IPSC-AGRICULTURE, TP 266, I-21020 Ispra (VA), Italy
E-mail: simon.kay@jrc.it
Tel.: +39 0332 78 9702
Fax: +39 0332 78 5162

<http://ipsc.jrc.ec.europa.eu>
<http://www.jrc.ec.europa.eu>

Legal Notice

Neither the European Commission nor any person acting on behalf of the Commission is responsible for the use which might be made of this publication.

A great deal of additional information on the European Union is available on the Internet. It can be accessed through the Europa server
<http://europa.eu/>

MARS Ref : JRC IPSC/G03/P/SKA/asi D(2007)(8503)

PUBSY JRC 40462

EUR 22160 EN

Luxembourg: Office for Official Publications of the European Communities

© European Communities, 2007

Reproduction is authorised provided the source is acknowledged

Printed in Italy

Geographical Information in support of the Common Agricultural Policy

Proceedings of the 12th MARS PAC Annual Conference, 2006

Edited by: **Simon Kay, Aleksandra Sima, Philippe Loudjani**

Contents:

Conference Abstract	3
Acknowledgements	3
Peer review process and committee	5
Session 2: New services relying on agricultural graphical data	7
A. Gobin, L. Brodsky, B. Tychon, E. Andersen, P. Campling, J. Van Orshoven: <i>PROTECTION AND MAINTENANCE OF PERMANENT PASTURES</i>	7
S. Oszczak, A. Ciecko: <i>PROPOSED PROCEDURE OF VALIDATION AND CERTIFICATION OF GNSS INSTRUMENTS AND OBSERVERS</i>	13
S. Gacichevic, O. Mihailescu: <i>CONTROL WITH REMOTE SENSING CAMPAIGN ROMANIA 2007</i>	17
Session 3: Benchmarking of satellites and airborne instruments, trials and studies	21
V. Vassilev, S. Popova, A. Garnier, M. Mangolini, T. Westin, P. Åstrand, P. Milenov: <i>ORTHORECTIFIED FORMOSAT-2 DATA PERFORMANCE IN THE CWRS CAMPAIGN 2006 AND FUTURE APPLICATIONS</i>	21
E. Ingebos, C. Bouguin, I. Muquet: <i>IMPACT DE L'UTILISATION D'IMAGES DMC EN PIAO TESTS SUR 2 ZONES DE CONTROLES 2006 EN FRANCE</i>	25
D. Kristóf, D. Neidert: <i>MONITORING OF AGRICULTURAL PRACTICE BY JOINT ANALYSIS OF VHR IMAGES AND MODIS TIME SERIES</i>	29
V. Vassilev, P. Milenov, R. Radkov, S. Popova, K. Stefanov: <i>CREATION OF DIGITAL ORTHOIMAGE MAP ON THE BASE OF VHR SATELLITE IMAGES FOR THE BULGARIAN LPIS</i>	35
Session 4: IACS: sharing data online	41
P. Milenov, S. Kay: <i>STATUS OF THE IMPLEMENTATION OF LPIS IN THE EU MEMBER STATES</i>	41
J. Garinet: <i>IACS NEW GENERATION ARCHITECTURES</i>	49
R. Araújo, L. Nascimento, R. Roquette, A. Campos: <i>iSIP – LPIS ON-LINE</i>	53
A. Petitjean, E. de Laroche: <i>L'UTILISATION DES DONNÉES GÉOGRAPHIQUES EN FRANCE POUR LE SIGC, 2007</i>	57
Final Conference Programme.....	62

Conference Abstract

The 2006 Annual Conference, jointly organised between the MARS PAC action of the Joint Research Centre in ISPRA and the new *Agence Unique de Paiement*, (AUP) of the French Ministry of Agriculture and Fisheries, covered not only the Control with Remote sensing Activities but also technical aspects of Land Parcel Identification Systems (LPIS or APIS) and ortho-imagery use in all the CAP management and control procedures. The conference was the 12th organised by MARS PAC to review this important and still growing area of technical activity, in support of the Common Agricultural Policy implementation.

The program was structured into 2 days of plenary sessions (Monday 27th and Wednesday 29th November) and one day (Tuesday 28th November) with parallel sessions, including a restricted session for national and regional administrations. Around 340 persons from over 30 countries attended.

The presentations were made available on line within some days of the conference, 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 MARS PAC action, would like to express sincere thanks to the *Agence Unique de Paiement*, of the French Ministry of Agriculture, for both material and logistical support in the organisation and hosting of this successful and popular meeting. Many persons from the French administration were involved, without whom the conference could not even have taken place, but we would like to specifically thank Bruno Hot, Emmanuel de Laroche and Alain Petitjean for their 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

Each of the past 11 years MARS PAC has produced a "proceedings" of 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 a 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 try and encourage better quality presentations by:

- i) reviewing the proposed abstracts carefully, to a shortlist of 28 presentation slots
- ii) selecting the best twelve with the possibility of including a conference-style paper in a special JRC publication

To achieve credibility on this publication, a peer-review committee was assembled, mostly external to the JRC. Prof Francis Sévila, Dean of ENSAT (Toulouse) was invited to lead the committee through the abstract and presentation stage. 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:

- Prof Francis Sévila, École Nationale Supérieure Agronomique de Toulouse, FR sevila@ensat.fr
- Marc Bernard, Spot Image, FR marc.bernard@spotimage.fr
- Prof Stanislaw Białousz, Warsaw University of Technology, PL s.bialousz@gik.pw.edu.pl
- Chrystel Fermond, Agence Unique de Paiement, FR c.fermond@onigc.fr
- Olivier Léo, Joint Research Centre, EC olivier.leo@jrc.it
- Prof Jorge Miguel Miranda, Lisboa University, PT jmmiranda@fc.ul.pt

Session 2: New services relying on agricultural graphical data

PROTECTION AND MAINTENANCE OF PERMANENT PASTURES

B. Gobin¹, L. Brodsky², B. Tychon³, E. Andersen⁴, P. Campling¹, J. Van Orshoven¹

¹Spatial Applications Division Leuven (SADL), K.U.Leuven R&D, Celestijnenlaan 200 E
3001 Leuven, Belgium; <http://www.sadl.kuleuven.be>

²GISAT s.r.o., Charkovska 7, 101 00 Praha 10, Czech Republic; <http://www.gisat.cz>

³Université de Liège, Campus d'Arlon, Avenue de Longwy, 185, B-6700 Arlon; <http://www.dsge.ulg.ac.be/arlon/>

⁴Danish Centre for Forest, Landscape and Planning, KVL; Rolighedsvej 23, 1958 Frederiksberg C, Denmark;
<http://www.kvl.dk>

KEY WORDS: permanent pastures, GAEC, monitoring, control, spatio-temporal analysis

ABSTRACT:

All farmers receiving direct payments are subject to compulsory cross-compliance which includes standards related to the maintenance and protection of permanent pastures. Questionnaire techniques and spatio-temporal analyses demonstrated that the ratio of permanent pasture area to agricultural land provides a simple tool for monitoring and controlling the protection of permanent pastures at the regional to Member State level. Huge variations in the ratio across Europe were related to the importance of permanent pastures, the interpretation of definitions, sources of information used, differences in calculation, and the presence of protective and/or sensitive zones. Precautionary or complementary measures are in place in most Member States in order to prevent decreases in the ratio. The implementation of GAEC standards related to permanent pastures overlaps with the standard management requirements, national legislation and current agri-environmental programmes. The study advocates the establishment of a comprehensive geo-information platform consisting of a topologically correct inventory of all permanent pasture parcels in a 1:1 geo-referenced relation between IACS and LPIS; ancillary spatially explicit data such as orthophotos, remote sensing images and other thematic geo-databases; and, geo-databases with parcel information compiled for other monitoring purposes such as those within the framework of the Nitrates Directive or 2nd pillar support.

1. INTRODUCTION

The overall extent of permanent pastures in Europe has been estimated to be approximately 55 million hectares, with a decline of around 17% in EU-15 during 1975 - 2001 mainly due to afforestation, intensive farming methods, abandonment and urbanisation (Soldi et al., 2004). However, in many parts of the EU the trend has been stabilised in recent years and an increase in permanent pastures can even be observed in some regions.

Since the beginning of 2005, all farmers receiving direct payments have been subject to compulsory cross-compliance (Council Regulation No 1782/2003 and Commission Regulation No 796/2004), following the principle that farmers should comply with environmental protection requirements as a condition for benefiting from financial support. Beneficiaries of direct payments are obliged to keep land in good agricultural and environmental condition. The so-called GAEC standards are defined by Member States, and include standards related to the protection and maintenance of permanent pastures. In addition, Member States ensure that there is no significant decrease in their ratio of permanent pasture area to agricultural land, if necessary by prohibiting the conversion of permanent pastures to arable land.

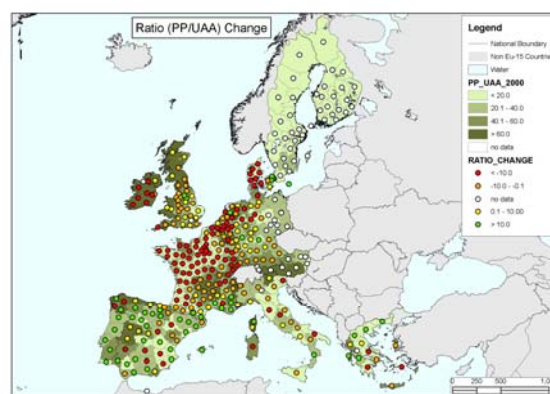


Figure 1. Regional distribution of the ratio permanent pasture to utilised agricultural area in 2000 and ratio change from 1990-2000 for EU-15

(Source: Eurostat Farm Structure Survey data)

The study objectives were:

1. to analyse the strategies defined by Member States for monitoring and controlling the protection and maintenance of permanent pastures;
2. to assess the technical and administrative issues to gather information on the ratio between the area under permanent pastures and total agricultural land; and,
3. to provide recommendations on ways to improve the existing systems to monitor the evolution of permanent pastures and the implementation and control obligations for individual farmers.

Detailed examples are drawn from Denmark, the Czech Republic, Belgium (Flanders and Wallonia).

2. METHODS

2.1. Eliciting strategies

The strategies for monitoring and controlling the protection and maintenance of permanent pastures were elicited using a questionnaire sent to the different national or regional administrations across Europe. Eighteen Member States responded. National statistical data, IACS data and Farm Structure Survey (Eurostat) data were compared for the Member States that responded.

2.2. Spatio-temporal analysis

Spatio-temporal analysis using ArcGIS (ESRI™) was carried out on detailed farm land use data from IACS/LPIS databases and ancillary geographic data from the administrations of Denmark, the Czech Republic, Flanders (Belgium) and Wallonia (Belgium).

3. RESULTS

3.1. Overview of strategies

All Member States regard the maintenance and protection of permanent pastures as socially and environmentally beneficial. The reported benefits include diversified landscapes, nature conservation, soil conservation, maintenance of biodiversity, carbon sequestration, lower agro-chemical inputs, agricultural extensification and preservation of cultural heritage. Farm abandonment and farm intensification are the two main pressures identified that can threaten the maintenance and preservation of permanent pastures.

The implementation of GAEC standards related to permanent pastures overlaps with statutory management requirements (e.g. Fauna Flora & Habitats Directives, Nitrate Directive), national legislation and current agri-environmental programmes. In some Member States, a high percentage of farmers receiving direct payments also take part in the agri-environmental programme (e.g. Austria with 95% participation).

The ratio of permanent pasture area to total agricultural land provides a simple tool for monitoring and controlling the protection of permanent pastures at regional or Member State level. Numerical variations in the ratio of permanent pasture areas to agricultural land depend on a number of factors such as the importance of permanent pasture, interpretation of definitions, sources of information used (IACS-LPIS, national statistics, Eurostat statistics), time of reporting between the different data sources and differences in the calculation of the ratio. In most Member States the area of permanent pastures according to statistical data is larger than the declared area of

permanent pastures according to the IACS data (the legal reference for the ration calculation).

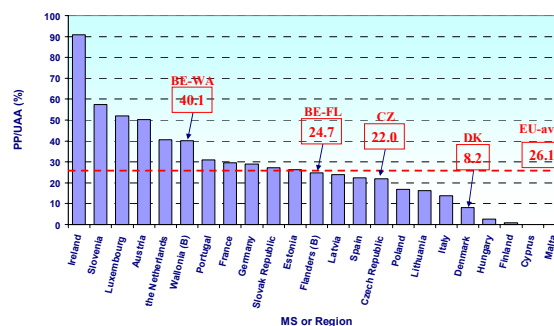


Figure 2. 2005 Ratio of permanent pasture to total agricultural land in different Member States

Precautionary or complementary measures are in place in most Member States in order to prevent decreases in the ratio of permanent pastures to agricultural land. Different threshold values are linked to warnings, restrictions, obligations and sanctions. To date no Member State has had to enforce any measures or sanctions. In the Netherlands, an enormous increase in permanent pasture area of up to 68% has occurred, mainly due to new applications of dairy farmers applying, for the first time, for area aid.

At farm level, some Member States have implemented a farm reference ratio in order to monitor transfers of permanent pastures at the individual level (e.g. the Flanders region in Belgium). Regular controls are performed according to the procedures laid out in the Single Area Payment Schemes, but the percentages of farmers controlled vary between Member States. The percentage of on-the-spot checks is particularly high in Finland (50%) which can be explained by the low ratio of permanent pastures to agricultural land. None of the Member States reported the implementation of sanctions to date, but a strict follow-up by means of warnings was already implemented in some Member States.

At field level, Member States have to ensure that farmers provide a minimum level of maintenance and avoid deterioration of habitats. However, in none of the Member States, was it possible to distinguish between permanent pastures with or without high nature value. Some Member States organise special controls for parcels that are located within Natura 2000 sites. Records are not always kept of permanent pastures that are no longer declared due to transition to other land use such as nature conservation or abandonment.

3.2. Spatio-temporal analysis

3.2.1. Wallonia

The permanent pasture area in Wallonia, which regressed steadily from 1977 to 1995, has been stable since 1995 due to the effect of linking cattle subsidies to forage area; since then, utilised agricultural area has remained nearly constant. Almost all farmers receive direct payments and almost all utilised agricultural area is declared. Comparing different sources of information, it appears that at least 10% of permanent pasture land is not declared as it belongs to non-farmers, corresponds to very small parcels (< 0.5 ha) or is declared as temporary pasture. The permanent pasture ratio in Wallonia is 40.55%, which is higher than the EU average. However, in the different agricultural sub-regions the importance of permanent pasture can vary from 15% to 90%.

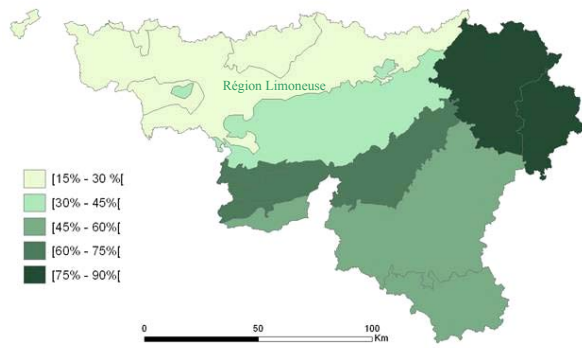


Figure 3. Importance of permanent pastures in the Walloon agricultural regions

At the communal level, more differences become apparent. In Wallonia, the smallest unit of registration within IACS is the agricultural parcel, which allows for detailed spatio-temporal analysis. Nearly all the high to very high decreases, so-called “hot spot” classes, are located in communities with very low ratios where the conversion of a few hectares of permanent pastures to arable land has a high impact on the ratio. Natura 2000 zones contribute to more favourable and stable ratios.

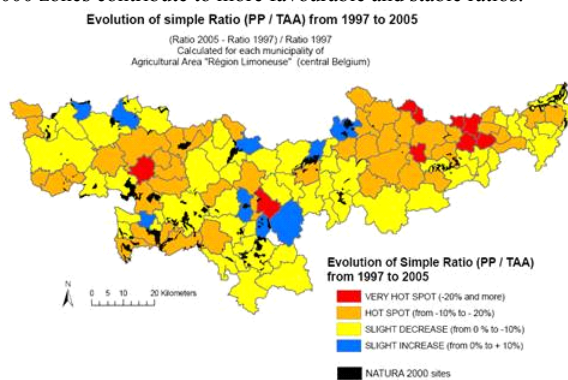


Figure 4. Evolution of the ratio of permanent pastures to total agricultural area in the communes of the agricultural region ‘Région Limoneuse’ from 1997 to 2005

The permanent pasture ratio is calculated by the administration according to the formula provided in the EC regulation with the afforested land term set equal to zero. In order to avoid a decrease of more than 10% of this ratio, the following measures are applied:

- If the ratio decreases with less than 5% a geographical check is undertaken but no actions will be carried out at the farm level;
- If the ratio decreases between 5% and 7.5% a general warning will be communicated to farmers through specialist media; the farmer has to ask for an authorisation before converting permanent pasture to crops; the farmer can be allowed to plough up permanent pasture land if an equivalent area is sown in another place;
- If the ratio decreases with more than 7.5 % the farmer who has converted permanent pasture land has to re-sow an area of grassland in order to re-establish his farm permanent pasture reference area, without being obliged to re-convert exactly the same parcels that were ploughed up.

In the IACS, permanent pasture parcels are grouped in a layer and identified by a code that is provided to the farmer with the

application folder every year. In case of exchanges of parcels, the code follows the parcel and obliges the new holder. The administration calculates the annual ratio on the basis of administrative declared data. If a ratio reduction greater than 7.5% is observed, a graphical procedure will be undertaken. It consists of overlaying the parcels layer with the reference permanent pasture layer. This provides the total parcel area that will have to be converted to permanent pasture.

3.2.2. Flanders

In the decade 1990-2000 and according to the National Institute for Statistics, the permanent pastures area in Flanders has reduced with more than 324 km² (about 15%) mainly due to substitution with forage crops, maize, temporary pasture and industrial crops. A part of the permanent pastures in Flanders is categorised as historical permanent pasture and has been protected from ploughing in specific zones since 1997.

The permanent pasture reference ratio is calculated according to the EC regulation, based on declarations made by farmers. The reference ratio, accounting for 24.77% of the total utilised agricultural area, is slightly less than the EU average. The permanent pasture area calculated by the IACS data is 14.7% lower than when calculated on the basis of national statistics. According to these statistics, the total permanent pasture area decreased with 7.0 % from 2003 to 2005, while for the same period IACS data show a decrease of only 0.29%. The main explanation for the differences is that the statistical data are census based and that IACS data only include farmers who apply for financial support. Farmers newly entering the IACS system obviously affect the ratio.

In Flanders each farmer who applies for financial EU-support, has to maintain the reference area of permanent pastures that has been attributed to them for the reference year of 2003. Each year the administration delivers documents and orthophotos to the farmer and provides the reference permanent pasture area that must be maintained on the farm. This farm reference area takes into account variations due to the transfer of land to or from another farmer in the previous year. Farmers are allowed to convert permanent pasture in arable land only if the parcel is not part of the Flemish Ecological Network or Natura 2000 sites, and if they guarantee the maintenance of their reference area by establishing new pastures on parcels that they have to manage as pasture at least for the following five years.

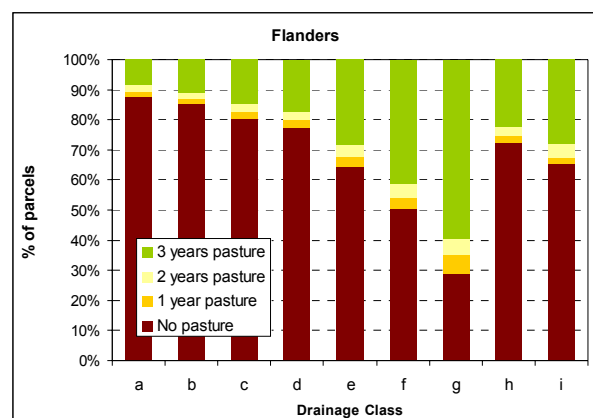


Figure 5. Increasing percentage of permanent pasture parcels with decreasing drainage of the soil profile (a to g) and presence of perched water table regimes (h & i)

In Flanders, the smallest unit of registration within IACS is the agricultural parcel, which allows for detailed spatio-temporal analysis. Permanent pastures are often located on marginal land characterised by poorly drained soils or by the presence of permanently high water tables. Land on well-drained soil profiles is therefore more at risk of being converted to arable use.

The average density of permanent pastures is 29.5 ha/km² for the Flemish Ecological Network, 13 ha/km² for sites belonging to the Birds Directive and 10.4 ha/km² for sites belonging to the Habitats Directive. In total 22,768 hectares or 15.4 % of the permanent pastures are located in these zones. The implication for the ratio is that this percentage is guaranteed to remain permanent pasture, as a result of the above-mentioned restrictions on conversion in these areas.

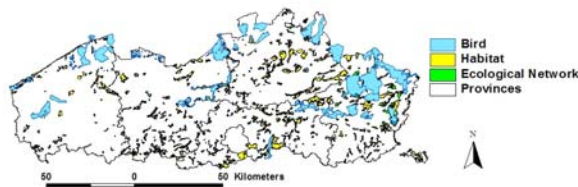


Figure 6. Protective zones for permanent pastures in Flanders

In Flanders each farmer is controlled on the maintenance of the reference ratio. In case of non-compliance, sanctions are possible, including the obligation of re-sowing the area needed to meet the farm's reference ratio and potential loss of eligibility. Trends during 2003-2005 confirmed a substantial stability in the permanent pasture area.

3.2.3. Czech Republic

In the Czech Republic, permanent pastures are mainly located in extensive agricultural areas at high altitude. In regions of foothills and mountains they can represent up to 80% of the total agricultural area. However, in regions of intensive agriculture permanent pastures represent less than 3% of the agricultural area. Since 1992 a growing trend in pasture areas has been observed. In recent years the conversion of pasture into arable land has been prohibited for farmers joining the national agricultural subsidy system (first pillar). The unit of registration in IACS/LPIS is a "block" of land use meaning that spatio-temporal analysis and links with ancillary geographic layers are more difficult to establish.

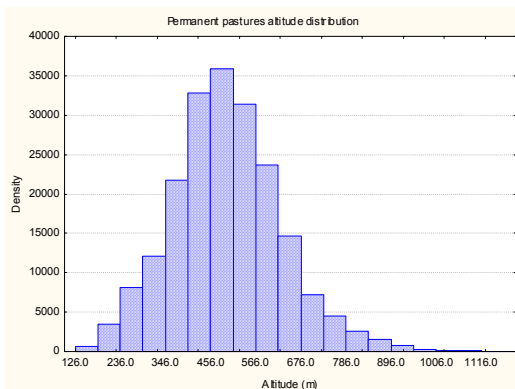


Figure 7. Altitude distribution of parcels under permanent pastures in the Czech Republic

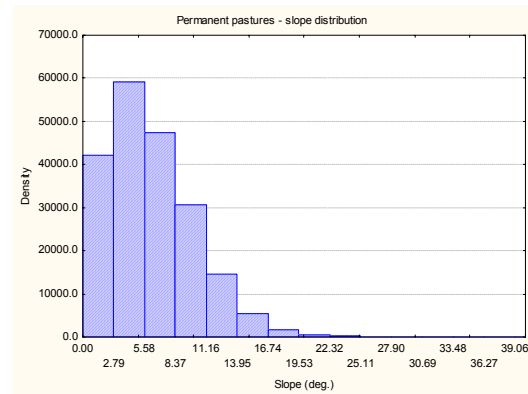


Figure 8. Slope distribution of parcels under permanent pastures in the Czech Republic

As a new Member State the EC regulation is applicable since 2005. In the initial LPIS definition, two types of grassland, i.e. meadows and pastures, were distinguished, but since 2005 in the SAPS declaration grasslands are being treated as permanent pasture according to the EC regulation. The permanent pasture reference ratio is 22.04%. However, this average ratio does not give the real picture of permanent pastures in the country, which varies regionally between 0.6 and 82%.

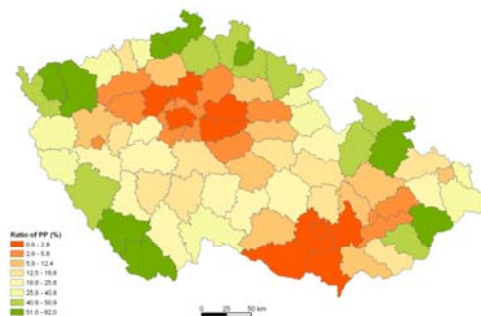


Figure 9. Regional variation in the ratio permanent pastures to agricultural land in the Czech Republic

Farmers who do not want to commit themselves to keep their grassland for five years or more under permanent pastures are not motivated to apply for subsidies for their grassland parcels. Conditions for farmers to apply for the conversion of declared permanent pasture into arable land are currently under discussion and there are no specific obligations to take into account different levels of decrease of the permanent pasture ratio. At the moment farmers are not allowed to convert permanent pastures, which can only be ploughed up once every five years for re-sowing grass in order to improve the pasture. According to current legislation ploughed permanent pastures must be converted back to grassland. The sanctions linked to the reference ratio have not been established yet.

In the period 2003-2006 the conversion of pasture to arable land has been strongly reduced and this is a good indication of the commitment of the farmers to the CAP. Conversions between arable land and pasture are not related to any specific topography features such as altitude and slope, but rather to soil fertility and agricultural growing region. Permanent pasture parcels located on fertile soils such as chernozems, or in the potato and sugarbeet growing regions, are under threat of being converted to arable land.

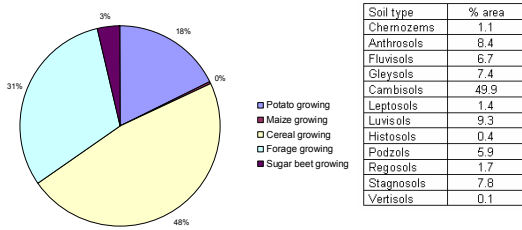


Figure 10. Percentage of permanent pasture areas in different agricultural growing regions and on different soils in the Czech Republic

3.2.4. Denmark

In Denmark permanent pastures are the most important habitat in intensively used agricultural landscapes and two thirds of them are protected against ploughing up under the Nature Protection Act. The area of permanent pasture, drastically reduced since the 2nd World War, has stabilised in the last decade, but it is one of the smallest in Europe in relation to the total agricultural area.

The definition of permanent pastures has often changed and only since 2005 has been aligned with the definition applied in the EU regulation. The regulation is interpreted to include grassland that is re-sown more often than every five years provided that it is on the same area. From 2006, the definition also implies that permanent pastures should be either grazed or mown at least once every second year. In Denmark the unit of registration in IACS/LPIS is a “block” of land use; the link between the units of declaration and the definition of permanent pastures that ought to be kept for five years is therefore more difficult to establish.

The permanent pasture reference ratio is calculated according to EU regulation without taking into account the afforested land term. Afforestation on permanent pastures is negligible due to the protection of pastures and the design of afforestation schemes. If the ratio is reduced with 5% from the reference level, permanent pasture can be taken into rotation only after permission from the Ministry of Agriculture. If the ratio falls below 10% farmers that have ploughed up permanent pasture in the last 24 months have to re-establish them.

From 2003 to 2005 the permanent pasture ratio has increased by 2.8% and if we consider the lowest administrative levels, few municipalities showed a very limited decrease while in all five administrative regions the ratio increased.

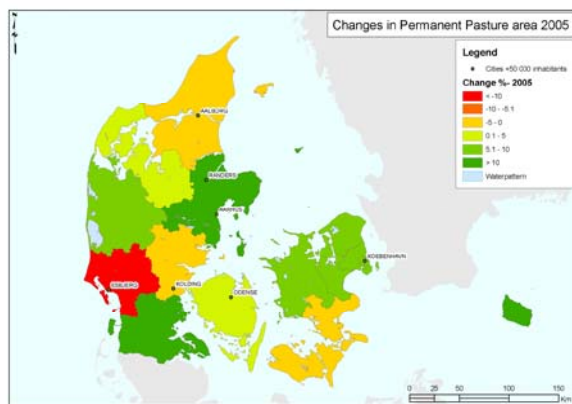


Figure 11. Regional distribution of changes in permanent pasture area

At the field level the increase of the permanent pasture ratio is the combined effect of new permanent pasture and the ploughing up of existing ones: permanent pastures loss mainly happened in favour of temporary grassland (46%), arable crops (31% cereals, 7% other arable crops) and to a lesser extent abandonment (11%). A minor share of the changed area (3%) has gone into nature conservation projects.

New permanent pasture parcels established from 2003 to 2005 are generally larger than permanent pasture parcels that have been ploughed up in the same period. The overall increase of permanent pasture is mainly concentrated in the area protected under the Nature Protection Act and in Natura 2000 areas.

3.3. Recommendations

In order to improve the management of monitoring and control of permanent pastures, a comprehensive geo-information platform should be created. The IACS data should be linked to databases compiled for other monitoring purposes and to ancillary spatially explicit data such as orthophotos, remote sensing and other geographical layers in a geo-database. This requires the set-up of a spatially explicit and topologically correct inventory of all permanent pasture parcels in a 1:1 geo-referenced relation between IACS and LPIS and with explicit reference to the number of years the parcels are kept as pasture. In addition, historical IACS-LPIS data at the parcel level should be linked with databases compiled for other monitoring purposes such as those within the framework of the Nitrates Directive or pillar II support. An effective approach would be to identify different zones on the basis of IACS-LPIS information in combination with ancillary geographic information. A comprehensive geo-information platform in combination enables spatio-temporal risk analysis on the basis of which sensitive zones can be identified.

A spatially explicit inventory should be made of all types of grassland. More focus should be put on re-establishing the management of abandoned permanent pastures in order to maximise nature conservation benefits. Member States should use other options available to ensure the maintenance of permanent pasture in areas with specific interests/vulnerability, for example obligatory approval of conversion in Natura 2000 areas or in areas under agri-environmental schemes (2nd pillar support).

All the relevant authorities are recommended to initiate a precautionary action scheme where farmers have to apply for permission to convert permanent pasture when the ratio decreases with more than 5% and where measures are taken to re-establish permanent pasture from a decrease of ratio with more than 7.5%. Alternatively, ratios at farm level may be monitored. In addition, actions should be taken to detail sanctions in order to ensure transparency to the farmer. It must be clarified if and how 2nd pillar support schemes can be used in relation to the precautionary actions linked to the obligation to maintain permanent pastures.

A typology could be made based on *inter alia* the ratio percentage of a Member State. Typologies would cluster Member States with similar characteristics in relation to the maintenance of permanent pastures. However, the creation of such a typology should be subject to further research as it will be necessary to include in-depth spatio-temporal data analysis and geographic supporting data. A typology would help directing recommendations in the different situations that Member States find themselves in with respect to the maintenance of permanent pastures.

4. CONCLUSIONS

The ratio of permanent pasture area to agricultural land provides a simple tool for monitoring and controlling the protection of permanent pastures at the regional to Member State level. The national ratio of permanent pastures to agricultural land can be stable, but this number can mask regional differences. Regional variations may be influenced by various agro-ecological and socio-economic factors. The importance of creating sensitive zones is that they provide an indication of zones where permanent pastures are at risk of being converted to arable land, such as areas with high potential for growing profitable crops. The implication for the ratio of conservation zones such as Natura2000 sites is that the percentage of permanent pastures located in Nature Protection areas is protected from change.

The management of monitoring and control of permanent pastures requires the creation of a comprehensive geo-information platform that allows for spatio-temporal analysis to monitor changes, account for protective zones, keep record of abandoned pastures and establish sensitive zones. In cases where the smallest unit of registration within IACS is the parcel, the link between units of declaration, the definition of permanent pastures that ought to be kept for five years and ancillary geographic information is an unambiguous 1:1 georeferenced relationship. In cases of IACS registration according to physical blocks, lots or cadastral references in LPIS, the geographic relationships are more difficult to

establish and subject to errors in spatio-temporal analyses which could be avoided with a spatially explicit inventory for permanent pasture.

5. REFERENCES AND SELECTED BIBLIOGRAPHY

Gobin, A., Brodsky, L., Andersen, E., Tychon, B., Campling, P., Longueville, F., Claes, S., Van Orshoven, J., Analysis of the new monitoring and control requirements of Permanent Pastures related to the Good Agricultural and Environmental Condition regulations. Final report of the study MARS PAC Action No. 2005/S 172-170363, 2007, pp 220.

Soldi, R., Torta, G. and Kirk, G., European Pasture Monography and Pasture Knowledge Base. European Communities, Luxembourg, 2004 .

6. ACKNOWLEDGEMENTS

The study was carried out on behalf of MARS PAC Action No. 2005/S 172-170363. The MARS PAC unit at the DG-JRC has supported the project with valuable comments. The authors would like to acknowledge the assistance of the administrations in Belgium, the Czech Republic and Denmark.

PROPOSED PROCEDURE OF VALIDATION AND CERTIFICATION OF GNSS INSTRUMENTS AND OBSERVERS

S. Oszczak¹, A. Ciecko¹

¹ Chair of Satellite Geodesy and Navigation, University of Warmia and Mazury in Olsztyn, Heweliusza 5, 10-724 Olsztyn, Poland; <http://kgsin.pl>

KEY WORDS: IACS on-the-spot checks, precise farming, GNSS positioning, validation, certification

ABSTRACT

The paper presents some proposals for procedure of validation of GPS equipment to ensure the required level of accuracy and reliability for parcel area measurements during on-the-spot control for IACS and for precise farming. The proposed procedure and programme of training of observers for certification of proficiency to confirm the minimum required professional skill is also discussed.

1. INTRODUCTION

The area aid applications across the 27 EU member states cover almost 128 million hectares. According to EU regulations the area of agricultural fields must be checked against claims to ensure that farmers receive the right amount of subsidies. The checks can be made with the use of remote sensing technology as well as with a great help of GNSS (Global Navigation Satellite Systems) systems. Many member states have steadily been adopting handheld GNSS receivers as the quickest and most effective means of measurement for their land-based teams. The use of stand-alone GPS system for parcel measurement by farmers and national/regional Administration started in 2001. This evolution was possible by the removal of the Selective Availability in May 2000, in addition to the general geomatics technological progress. Positioning and measurement of an area is essential for obtaining proper and up-to-date information about declared parcels. In addition it can also give valuable and up-to-date information for LPIS database update, it is used for declaration of ineligible areas, agri-environmental features and other features connected with farming. The perimeter of the area is needed to calculate the tolerance of parcel's area. The difference between declared and checked area should be less or equal than the tolerance.

The wide variety of GNSS receivers and applications for field measurement are available on the market, starting from the simplest navigational handhelds (eg. Garmin; 300-600 €) where area measurement is possible, but limited in many aspects (limited number of records, no "pause" during measurement, etc.). A second group of units, most commonly in use nowadays, is based on SiRF Star III technology (GPS receiver) often combined with PDA and WindowsCE operating system. In this group of units we can find a large number of hardware developments (cable connections, data card connections, wireless Bluetooth or all-in-one devices) as well as a great number of software applications running under WindowsCE. The cost of the hardware is between 200-800 €, while the cost of the software depends mainly on complexity. The next group of the units comprises of more sophisticated receivers and GIS

software. The usage of this kind of equipment by the farmers is rather limited due the high cost of hardware/software starting from around 5000 €. Using this kind of equipment we can achieve accurate and reliable measurements in particular using local Differential GPS corrections applied to GNSS measurements. In this case an additional wireless transmission system (VHS radiomodem, FM/RDS, GSM/GPRS/UMTS) is needed to operate in real time.

According to Directive 2004/22/EC of the European Parliament and of the Council of 31 March 2004 on measuring instruments, devices and systems used for measurement for reasons of levying of taxes and duties, public interest, protection of the environment, protection of consumers have to satisfy the requirements given by the Directive. The measurement method is not dependent only upon GPS but also upon the equipment. The detailed requirements to be fulfilled by GNSS receiver to be used for on-the-spot checks are prepared by Joint Research Centre (JRC) of the European Commission. At the moment there is a strong need of a standardized way of checking that equipment works properly - validation protocol.

Based on our previous experience concerning, among the others, the tests and validation of GNSS methods and receivers for ARMA (paying agency) in Poland (2004), and validation of methods for measurement of land parcel areas (GPS Part) commissioned by JRC (2005), we have developed a proposal of such a validation protocol for different kinds of GNSS receivers willing to fulfil requirements of the European Commission and paying agencies. The validation procedures must include a wide range of testing conditions, including stringent tests of difficult measurement conditions. Different size and shape of the parcels should also be taken into consideration.

2. LAND PARCELS

The test field should consist of at least 6 parcels with various size, shape and obstructions of celestial sphere. The test parcels

should include parcels with: good and bad borders (e.g. obstructed horizon by forest causes bad border). An example of reference parcels which could be used in validation procedure is given in Figure. 1.

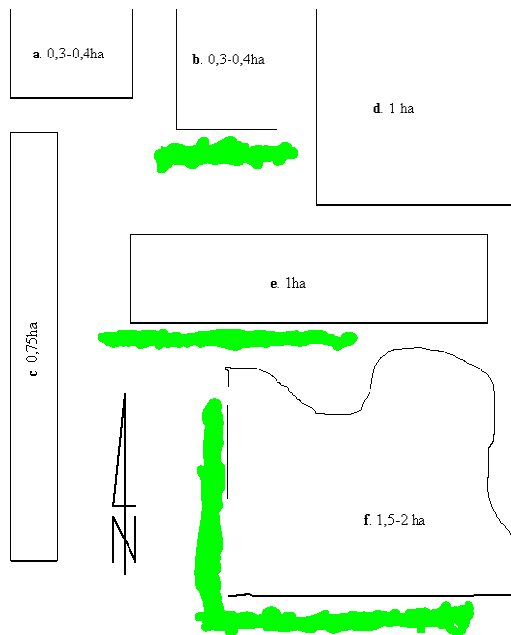


Figure. 1 Suggested land parcels schema for the validation procedure

For the needs of validation testing, “artificial parcels” – marked with wooden stakes – are prepared and used instead of real parcels, since natural borders are sometimes confusing and can introduce an error to observations. The stakes on the corners should be one meter long and the stakes about 35cm long should be placed every 15-20 meters along the borders. Each parcel should have its own colour of stakes, which is especially important when the borders of two parcels are close to each other. It is important that no border can be the same for two parcels, since this would cause confusions and errors. The minimum distance between two parcel borders should be 10 meters; although in some situations intersection of borders is acceptable. After establishing all the stakes in the field the parcels should be precisely measured using geodetic techniques, e.g. Total Station. All measurements should be tied to the ETRF’89 system of coordinates.

3. FIELD TESTS

Before an actual test of GNSS equipment, one should check technical specification of the receiver. Especially important for the measurement and inspections purposes are: good quality graphic display, long enough battery capacity (min. 8 hours), memory enabling storage of at least 2-3 days of measurements, dust/water resistance, EGNOS capability.

The test should last for at least 6 days (each day the measurements should be performed at the same time) and every day each parcel must be measured at least 4 times. Having one receiver and following the land parcels schema given in fig. 1 the proposed order of measurements is given in Table 1. Before the measurements the operator should get extensive instructions on how to measure parcel with given receiver, and he or she should also be familiar with the parcels established in the field. Following the proposed schema of field measurement, the measurement will last about 4 hours a day. All collected

data must be stored in GIS format for further calculations and statistical analyses.

Measurement Schedule	Day 1, Day 4		Day 2, Day 5		Day 3, Day 6						
	morning	afternoon	morning	afternoon	morning	afternoon					
	a	b	a	b	c	d	c	d	e	f	e
b	c	b	c	d	e	d	e	f	a	f	a
c	d	c	d	e	f	e	f	a	b	a	b
d	e	d	e	f	a	f	a	b	c	b	c
e	f	e	f	a	b	a	b	c	d	c	d
f	a	f	a	b	c	b	c	d	e	d	e

Table 1. Measurement schedule for single receiver testing

Until EGNOS (The European Geostationary Navigation Overlay System) is not fully operational (FOC Full Operational Capability Status) it is recommended not to use EGNOS corrections during the test, since EGNOS data can introduce errors and confusing results.

4. STATISTICAL ANALYSES

After collection of all necessary measurement data in the field an extensive statistical elaboration of the collected results is required. The statistical studies should be performed rigorously according to the ISO – 5725-2 standard – “Accuracy (trueness and precision) of measurement methods and results - Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method”

The first step in statistical approach is detection of the outliers among collected results of measurements. The pooling factor in case of field tests of GPS receivers is day of observation. Different days implement reproduction of the measurements in different conditions when there is no other significant factor.

The Mandel's test statistics are computed for each day of measurements. Critical values are taken into account at 1 % level and at 5 % level of χ^2 distribution.

The Cochran's test is designed to check if the variances between replicates are equal for each day of survey for a given parcel. If the test statistic is greater than its 1 % critical value, the measurement tested is a statistical outlier and is removed from the data. The critical values are taken from χ^2 distribution.

The Grubb's test assumes a set of data arranged in ascending order $x_1, x_2 \dots x_n$ with mean m_i and standard deviation σ_i . The extreme value x_1 if $G = G_m$ or x_n if $G = G_{max}$ is called a straggler if G is greater than its 5% critical value and less than or equal to its 1% critical value. It is called an outlier if G is greater than its 1% critical value. The critical values are taken from χ^2 distribution.

After detection of outliers one can calculate and model a wide range of statistical parameters such as: parcel area error, bias of the receiver, standard deviation for all parcels, buffer value and point position error. These calculations finalise the statistical approach and this results give the answer if the receiver can be certified.

In spite of testing and validation of the GNSS equipment it must be stressed that proper qualification of the operator of the instrument is essential. It is especially important in case of official field inspectors, who should have received sufficient instructions and certified training and get official certification of proficiency.

5. TRAINING OF OBSERVERS

The proper qualification of the operators of GNSS equipment measuring the parcel is no less important than the validation of receivers. The operator must understand „art & science” - the theory and practice of satellite measurements.

The theoretical training of the inspector should include the following subjects:

Basic definitions: Reference surfaces: WGS'84 ellipsoid, reference horizontal plane; Reference coordinates frames: WGS'84 geographical coordinates, cartesian 3D system; projections onto the plane, cartesian 2D system, grid coordinates systems; Local, national and global coordinate systems; Transformation between the different systems of coordinates; Fundamentals of satellite positioning.

Design of survey: Selection of proper methods of measurement: classical – tape, Total Station, others; Satellite – GPS stand- alone, EGNOS, DGPS, RTK; Remote sensing photogrammetric methods.

GPS/EGNOS positioning: System architecture, signals, measurements and receivers; Differential GPS (DGPS/RTK) ground-base systems; EGNOS/WAAS satellite-base augmentation; Error sources; Estimation of position and accuracy.

GPS/EGNOS parcel area measurements: Stop-and-go method of border points positioning; Continuous/kinematic measurement of an area and parcel perimeter; Combined classical + satellite methods; Estimation of accuracy; Determination of acceptable buffer zone = perimeter · assumed positioning accuracy factor.

Processing of measurement data: Downloading measurement data; Software for managing the data; Visualization; Transformations between different coordinate systems; Quality control (QC) of data and solutions; Creating data bases/archiving.

Estimation of accuracy and reliability of the results: Accuracy = Precision + Systematic Errors; Estimation of precision via Least Squares Method assuming normal distribution of random errors; Effect of Geometrical Dilution of Precision; Systematic errors reduction via mathematical modelling of physical errors and using differential DGPS technique; Estimation of reliability via QC of solutions, independent redundant checks of GNSS determinations.

Theoretical lectures must be supplemented by practical examples of using the GNSS receivers in the field. Course participants should get extensive field training of parcel area measurements, as well as detailed information on the preparation of technical documents needed for the on-the-spot check protocol.

6. CONCLUSIONS

According to Art.23 of R.796/2004, on-the-spot checks shall be made in such a way as to ensure effective verification of compliance with the terms under which aid is granted. GNSS area measurements made by single systems (standalone) must work using a parcel-perimeter approach. Nowadays the tolerance to be applied is up to 1.25m times the perimeter of the parcel. Recently, it is recommended by the European Commission that a systematic test of a particular receiver/system should be performed and in the near future the validation of GNSS equipment is expected to be obligatory.

In spite of testing and validation of the GNSS equipment it must be stressed that proper qualification of the operator of the instrument is essential. The inspector should have received sufficient instructions and certified training, and should be largely able to undertake the work autonomously.

7. REFERENCES AND SELECTED BIBLIOGRAPHY

Bogaert, P., Delincé, J., Kay S., Assessing the error of polygonal area measurements: a general formulation with applications to agriculture, *Meas. Sci. Technol.* 16 (2005) 1170–1178.

Ciecko, A., Oszczak, S., Validation of Methods for Measurement of Land Parcel Areas: GPS Results, Presentation at the GPS Workshop, Wageningen, Netherlands, 5 - 6 October 2005, http://agrifish.jrc.it/marspac/LPIS/meetings/GPSWorkshop2005/Ciecko_Oszczak_JRC_Workshop.pdf

Directive 2004/22/EC Of The European Parliament and of the Council of 31 March 2004 on Measuring Instruments, *Official Journal of the European Union*, L 135/1, 30.4.2004

Hejmanowska, B., Validation of methods for measurement of land parcel areas. Final report. 2005, http://agrifish.jrc.it/Documents/lpis/ValidationMethodFinalVer2_2.pdf

Kay S., Field Area Checks Using GPS, *GIM International*, July 2005, Volume 19, Issue 7, http://www.gim-international.com/issues/articles/id502-ield_Area_Checks_Using_GPS.html

Kay S., Field Area Checks Using GPS (2), *GIM International*, January 2006, Volume 20, Issue 1, http://www.gim-international.com/issues/articles/id602-Field_Area_Checks_Using_GPS.html

Kay, S., Technical tolerances for On the Spot checks v2.1. Technical Information Document, <http://agrifish.jrc.it/documents/control/recommendations/5834.pdf>

Oszczak, S. et al, Assessment and development of selection criteria for GPS measurement methods and equipment to ensure required accuracy and reliability of area-based subsidies control in IACS. Report for ARMA, Poland, 2004.

CONTROL WITH REMOTE SENSING CAMPAIGN ROMANIA 2007

S. Gacichevic¹, O. Mihailescu²

¹Romanian Paying and Intervention Agency for Agriculture, Director of IACS Directorate

²GAUSS Ltd, RO, Department Manager

1. STATUS OF LPIS IN ROMANIA - OUTLINE

- Reference Parcel / Input Data
- Reference parcel in Romania: Physical Blocks based on Orthophoto.
- Orthophotos:
 - Delivered by the National Agency for Cadastre
 - Color, scale 1:5.000, pixel resolution 0.5m, accuracy of +/-1.5m
 - Acquired through 7 different aero-photogrammetric projects between 2002-2005
 - ♦ The most complex situation due to: scattered coverage per project, heterogeneous quality of images

2. INPUT DATA

- Status of orthophoto provision:
- 99.43% (237638 sq km) of images delivered
 - about 99.23% retained
 - about 0.20 % returned for quality problems
 - ♦ Part of them have to be reprocessed
 - ♦ Part of them have to be entirely re-flown and processed
- 0.37 % of images are missing
- Solutions:
 - Use of HR images
 - Use of cadastre maps scale 1:5000

3. DIGITIZATION OF PHYSICAL BLOCKS

- Under completion by 4 external contractors + 1 external quality controller.
- Deliverables by municipality: tile mosaics, physical block coverage with attributes, 1:10.000 printed maps of municipalities, 1:5.000 digital (*.PDF) files with physical blocks, Hard disc drive with images and physical blocks of the Judet and neighboring Judets
- So far: 2692 municipalities digitized and approved by the external quality controller
 - out of a total of 3.183

4. FIRST UPDATE OF THE PHYSICAL BLOCKS

- Based on the verification of the observation forms, at the end of the linkage campaign, the blocks suggested for correction will be divided into three categories:
 - physical blocks that can be corrected only based on the observation templates (e.g. change of land use category)
 - physical blocks that can be corrected only after meeting the farmers again, based on the more detailed 1:5000 maps of the physical blocks. (E.g. change of certain block limits, splits or reunions of blocks, etc)
 - physical blocks that can be corrected only after going on-the-spot for measurements (e.g.: different shape of a border or, creation of some new blocks)

- The first category of blocks will be updated beginning December 2006
- The second and third category of blocks will be updated during the on-the-spot campaign of the next year.

5. LINK WITH THE FARMER, NATIONWIDE CAMPAIGN INVOLVING MORE THAN 2.000 STAFF MEMBERS OF THE PIAA

- Input data:
 - maps from digitization
 - Farm registration templates filled by the farmer
 - ♦ march 2006: 1.4 million farmers registered, out of expected 1.5 million, the rest can register during the linkage campaign.
 - ♦ Contact info about the farmer
 - ♦ List of parcels and location by municipality
- Output data:
 - Updating the registration information
 - Corresponding Physical block number for each parcel to be completed during the link with the farmer
 - Systematic collection of farmers' observations about the physical blocks
- Results:
 - out of the 2520 municipalities delivered so far (24.11.2006) by the digitizers (with corresponding mosaics, physical blocks and maps), the link with the farmer has been finalized in 2227 municipalities (24.11.2006).
 - Expected ending date for linkage in the last municipality is December 2006. (Phase 1)
- The campaign is designed to run in 2 phases.
- Phase 1 – is implemented in each municipality as soon as the map(s) become available, a PIAA team goes there for 2-3 weeks to meet the farmers. (jun. 2006 – dec. 2006)
- Phase 2 – will be implemented at the county office.
- Objective:
 - Completion of the parcel identification process
 - Correction of errors for up to 60 % of the registered area
 - Quality control to be performed with all farmers in Romania > 50 ha approximately 13.000 farms representing round about 6 Mio. Ha of agricultural land
- Organization:
 - Three trained staff members per Judet
 - Start of the campaign: 04. December 2006
 - End of the campaign: at latest mid of March 2007
- Necessary input:
 - Three trained staff members
 - Three working stations
 - LAFIS LFK installed
 - Hard disc drive with images and physical blocks of the Judet and neighboring Judets
 - Originally filled templates and print out of the data

- Working on-screen with the farmer to identify the parcels
- Possibility to measure parcels of the farmer

Function	No. of teams	Average no. of farms per day	No. of days for controls	Medium/ Maximum no. of Controls	Capacity of controls in % of total applications
Field Inspections (6ha/farm)	500	1.75	86	75000	5.0%
CwRS (18ha/farm)				45000	3.0%
				105000	8.0%
Supervisory and complains controls / quality controls for CwRS	50	1.5	86	6400	
Method of control	On the Spot Checks		Control with Remote Sensing		
	5.0 %		3.0 %		
	75.000		45.000		
	500.000		800.000		

Table 1. OTS checks in Romania 2007

6. OTS CONTROL IN ROMANIA 2007

On-the-spot controls – at county level executed by teams of:

- Internal inspectors (permanent staff) –500 internal inspectors (10-12 inspectors/county) and extra 500 outsourced to contractors
 - Another 210 permanent staff - preparing and processing of documentation
- Another 42 teams are for supervisory controls which will be done for 2% from all applicants checked and also 8 supervisory teams for controls to solve complains.
- Procedures are elaborated at central level
- An adequate training for all the internal field inspectors started in November 2006
- Central level will include a special team for supervisory and quality controls for CwRS
- 500 of the contractors employees shall be trained and tested in April and May 2007
- The complex team is composed of a PIAA inspector and a contractors employee

7. 2007 CwRS CAMPAIGN

- An official letter was sent to JRC at the end of July requesting satellite quota for next year’s campaign for 20 sites
- JRC was notified for the participation of Romania in the EU call for tender in November 2006
- PIAA planned the budget of CwRS 2007 for the tender launched by JRC by the mid of November 2006
- The technical processing of the imagery will be made by private contractors
- Based on the findings of the Pilot project a National Addendum will be prepared by PIAA including any specialities related to the Romanian situation which are not covered by Common Technical Specification (JRC)

8. SITE SELECTION FOR 2007 CwRS CAMPAIGN

CwRS control zone selection based on farm registry data:

Description:

1. Fix grid with 30 Km x 30 Km cells is defined (grid_nol)
2. grid intersected with communes boundaries

3. Communes linked to grid if more than 80% of commune area falls within grid.
4. farmers that have more than 80% of their area in the communes belonging to one grid are selected
5. total area of farms, number of parcel and average area of farms within the grid is calculated

Grids highlighted:

- a. area that can be controlled is larger than 23000 ha in the grid
- b. average farm area in the grid is larger than 16 hectares



Area that can be controlled by remote sensing	639869 hectares
Number of dossiers that can be controlled by remote sensing	25782
Number of parcels to be checked	124270
Average area of controlled farms	24.8 hectares
Average parcel size	5.1 hectares
Average controlled per grid	31993 hectares
Average controlled dossiers per grid	1289

9. PILOT PROJECT FOR CwRS -2006

- The Pilot testing for the two sites (Lupsanu and Valea Calugareasca) was executed by GAUSS Ltd, RO with two secondary contractors: Maieutika Ltd, HU and MedSoftOrg Ltd, HU, special thanks to Dr.Daniel Kristof from Szent Istvan University, Institute of Environmental Management Department of Geomatics, and Prof.univ.dr.ing. Dima Nicolae and prof.univ.dr.ing. Herbei Octavian from Petrosani University.
- Lupsanu: 50 claims – area and crop control is done with CAPI, on a VHR QuickBird and 4 SPOT multispectral images
- Valea Calugareasca: 71 claims - area control is done with CAPI, on a VHR QuickBird, crop control was managed with on the spot control (OTS) with GPS measurements

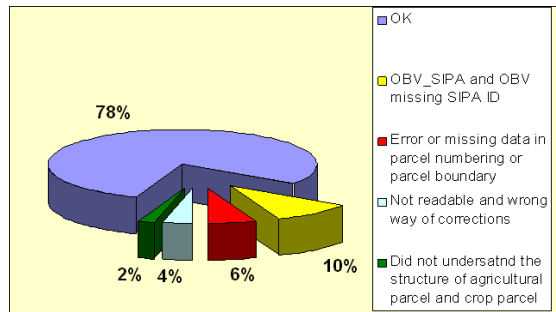
10. RESULTS OF OTS PILOT PROJECT LUPSANU & VALEA CALUGAREASCA

- OTS proved that the physical blocks were well digitized
- An increased quality of parcel identification will induce a significant reduce of over-declarations

- Measuring two medium farms per day is a realistic subject
- The results will be used in the remote sensing procedures manual and in the dimensioning structure of the follow – up personnel

Statistics of the claim evaluation based on crop parcel

- 78 % of the crop parcels are OK, can go to administrative and on-the-spot control
- 10% can be solved by the administration, with the use of the LPIS or other database - manual work, takes time
- 12% needs a contact with the farmer, or not usable claim data



Summary of the result of linking the claim data and the parcels on the blockmap - percentage of the parcels

Statistics of the claim evaluation based on dossiers

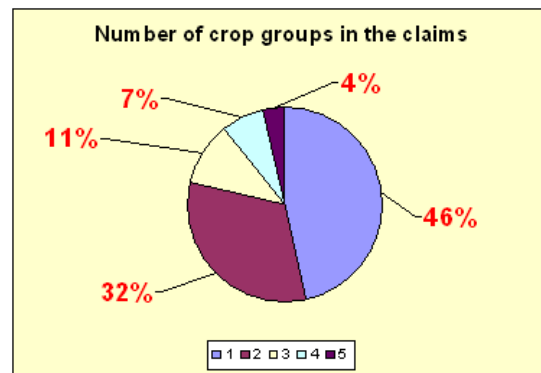
- 66 % of the claim has no problem during the data capturing, parcel claim rows and drawings are OK, can go to control
- 34 % needs some procedure before the control step:
 - 21 % has an obvious error, so the administration has to deal with manually
 - 14 % of the claim has an error only the farmer can correct - contact to the farmer
 - 17 % has both obvious +not correctable errors

Documenting the parcels errors to the PIA for follow-up

- 18 % of the eligible area of the physical blocks were OVERDECLARED
- 3, 17 % of the crop parcels are affected by the 12 % slope problem (GAEC).

The result on dossier level after the compensation inside the crop groups

- 36 % of the dossiers were over declared in their area, and 18 % of the dossier has higher over declaration then 5%
- There are 13 crop groups SAPS+12 CNDP categories



Result on dossier level	% of the dossiers	
Under declared = declared less area of crops, then found, AREA OK	54%	64%
Area of crops declared and found are the same AREA OK	11%	
Area over declaration from 1-5 %	18%	36%
Area over declaration from 5,01-10 %	4%	
Area over declaration from 10,01-20 %	7%	
Area over declaration from 20,01-50 %	7%	

11. CONCLUSIONS – CwRS

- The RS control was managed based on the EU CTS rules, and specific error codes for Top-up and GAEC were defined
- The help of the cluster map was important to support the CAPI
- There is need for early spring and spring images in 2007 to be able to:
 - control better the grasslands and the GAEC criteria's
 - verify the eligibility criteria (January 2007)
- To apply RS control in 2007 is the only way to complete the control rate in a 3-4 month period
- More efficient to apply the VHR+time series of HR images method rather then VHR+RFV or OTS - this is more time consuming and more expensive.
- Serious actions must be taken to decrease the errors:
 - managing an area over declaration control before May 2007, and informing the farmers
 - make the farmers aware of the importance of crop type (because of the top-up) and the precision required during defining the area of the parcels.

Session 3: Benchmarking of satellites and airborne instruments, trials and studies

ORTHORECTIFIED FORMOSAT-2 DATA PERFORMANCE IN THE CWRs CAMPAIGN 2006 AND FUTURE APPLICATIONS

V. Vassilev¹, S. Popova¹, A. Garnier², M. Mangolini², T. Westin³, P. Åstrand⁴, P. Milenov⁴

¹Remote Sensing Application Center – ReSAC, 61, Tzar Assen Str., 1463 Sofia, Bulgaria, <http://www.resac-bg.org/>, resac@techno-link.com

²Spot Image, 5 rue des satellites, BP 14359, F-31030 Toulouse Cedex 4, <http://www.spotimage.fr>, alexandra.garnier@spotimage.fr, marc.mangolini@spotimage.fr

³Spacemetric AB, Tingsv. 19, SE-19161 Sollentuna, Sweden, <http://www.spacemetric.com>, tw@spacemetric.com

⁴European Commission JRC, IPSC, Agriculture and Fisheries Unit, TP266, I-21020 Ispra (VA), Italy <http://agrifish.jrc.it/>, par-johan.astrand@jrc.it, pavel.milenov@jrc.it

KEY WORDS: FORMOSAT-2, Very High Resolution, geometry, rigorous modelling, accuracy, Independent Check Points (ICP)

ABSTRACT

FORMOSAT-2 (NSPO, Taiwan) was launched on 21st of May, 2004. FORMOSAT-2 was programmed as Very High Resolution (VHR) backup sensor for the 2006 years CwRS Campaign over 12 control zones (7.474 km²). The area success rate was as high as 87.5% (10/12 sites). The delivery of cloud free imagery was more than acceptable (88.9% < 5%, 11.1 % 5%-8 % Cloud Cover). Delivery of Level 1A radiometrically corrected sites worked very smoothly with average image production time of 4 days. Difficulties were however encountered to reach the required location accuracy in production of Level 3 orthorectified imagery (3.5 RMSE_{1D}, [ref 1]) for the sites. A presentation at Toulouse CwRS Conference [ref 2] deals with the difficulties encountered over the control sites, which resulted in embarking on the present study on the Sofia F2 imagery. This study makes robust modelling using 4 software suites on near nadir F2 imagery, making use of GCPs from DGPS measurements, and from orthoimagery, separately allowing accordingly the examination of the effect of accuracy measurements, and the effect of point distribution on orthorectification. Results are promising, demonstrating that it is possible to perform good orthorectification using standard software packages reaching results inside the CwRS requirements. Future tests should however be carried out as to define the optimal number of GCPs to be used when orthorectifying F2 images on a routine basis. Furthermore, the effect of the incidence angle on the accuracy of the orthorectification should also be studied.

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 Control with Remote Sensing where aim is to identify irregularities in subsidy claims. Taking into account the enlargement of EU to 27 Member States and subsequent increased number of the sites to be controlled with use of satellite imagery, the possibility to include new sensors like FORMOSAT-2 have to be explored. This will increase the 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 could be used as backup of the “prime” dedicated VHR sensors IKONOS and Quickbird.

The study objectives were:

1. to determine a reliable, operational, approach for orthorectification of the FORMOSAT-2;
2. to perform the orthorectification with different vendor-specific and off-the-shelf image processing software suites and to compare the results.

1.2. Study site

The study area covers the extent of Sofia City - the capital of Bulgaria, - and the Northern hillsides of Vitosha Mountain. The capital is situated in Sofia Valley which is an important for the agricultural plain. The average elevation inside the city is 550m a.s.l., while the nearest highest point is Cherni Vrah (“Black Peak”), 2290m, located to the South, in the Vitosha Mountain. The study area presents various landscapes and terrain variations, thus being a suitable test site for orthorectification and geometry quality assessment.

1.3. Study Instrument and Acquired Imagery

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. F2 has a sun and geosynchronous orbit of 14 fixed orbits/day, and the sensor can be tilted ± 45°

along and across track which results in a daily revisit time within the corridor covered.

For the present study the imagery with the highest spatial resolution was considered, i.e. the panchromatic one, as it requires greater accuracy for the orthorectification result. The image is delivered as raw imagery, Level 1A, with basic radiometric normalisation for detector's calibration, but with no geometric correction. The product is 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 attitudes, refined focal plane calibration). Other specific data are given in Table 1 below.

Instrument	FORMOSAT-2
Acquisition	
Date	006-09-08
Time	08:48:06.263983
Processing	Level 1A – system radiometric and geometric correction
Radiometric Resolution	8-bit PAN
Spatial Resolution	1200x1200 pixel 2m
Viewing Angles	
Along-track	0.245404
Across-track	-6.453257
Satellite Angles	
Incidence	7.367684
Azimuth	102.202983
Satellite Altitude	895851.71817027032 m

Table 1. General characteristics of imagery acquired for the City of Sofia test area

The location of the imagery is given on Figure 1 below.



Figure 1. Location of imagery acquired for the study site. The dark-grey rectangle with white border defines the 24km footprint of the FORMOSAT-2 imagery.

2. METHODS

2.1 Software

Given that the objective of the study was to determine whether FORMOSAT-2 imagery could be used in operational mode for farmers' subsidies monitoring, the main internationally recognised software platforms were 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 vendor specific software suites – PRODIGEO of EADS and SIPOrtho of Spacemetric. PCI (Toutin, 2004), ERDAS, PRODIGEO, and SIPOrtho have a dedicated FORMOSAT-2 rigorous physical model, available upon loading the original GeoTIFF image file. These applications read image metadata supplied in the DIMAP

format. PCI, however, 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.

2.2 Reference Data

For refining the exterior orientation and for quality control of the ortho product 22 points measured by survey-precise Differential GPS equipment (Table 2) were utilised. They were relatively well distributed over the entire test area acquired by FORMOSAT-2 (Figure 2).

ACC X	ACC Y	ACC Z	DEM Discr
0.020	0.018	0.045	2.968

Table 2. Mean accuracy for the GCPs originating from DGPS points along with the average discrepancy of the Reference3D as compared to the DGPS data available in ReSAC's database for the study area.

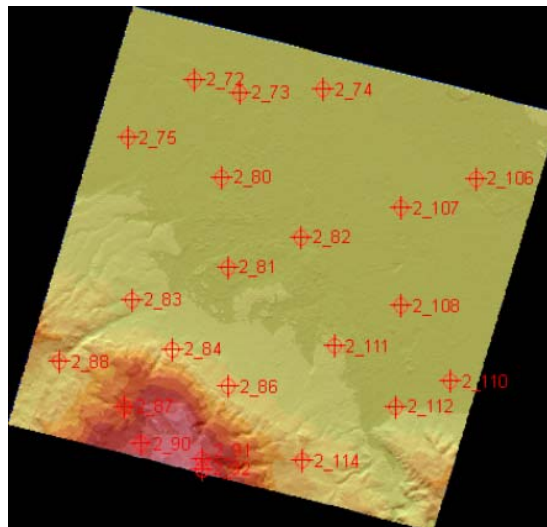


Figure 2. Distribution of the GCPs measured by DGPS system over the Reference 3D DEM clipped with the FORMOSAT-2 test scene extent.

In order to produce a refined georeferenced product through the process of orthorectification a Digital Elevation Model (DEM) was utilised. It ascertains that the distortions caused by the terrain are removed, making the scale constant across the image regardless of the changes in elevation. 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 (Figure 3). The absolute elevation accuracy of the Reference3D product is 10 metres (confidence level 90%) for a slope less than 20 degrees, while the planimetric accuracy is as good as 15 metres. In Table 2 it is shown that Reference3D even exceeds its specifications, therefore being rather suitable for orthorectification of VHR satellite imageries.

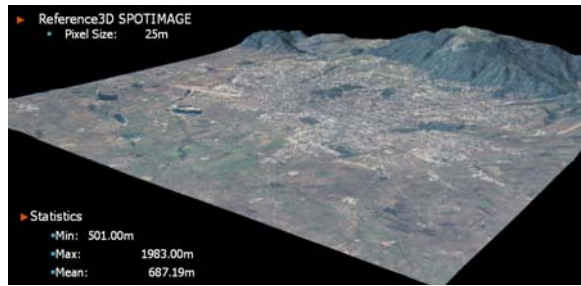


Figure 3. Overview of the terrain across the test area. For orientation IKONOS orthophoto was draped over the Reference3D DEM.

An additional test was carried out by employing GCPs and Independent Check Points (ICPs) derived from 5 IKONOS orthophotos. These images were acquired in the year-period 2003-2005, and covered the extent of the FORMOSAT test image entirely. They have a planimetric error averaging to 1.02m. The IKONOS orthophotos were chosen because they were geometrically corrected with the same GCPs as those used in the present experiment, and therefore would assure consistency of the results.

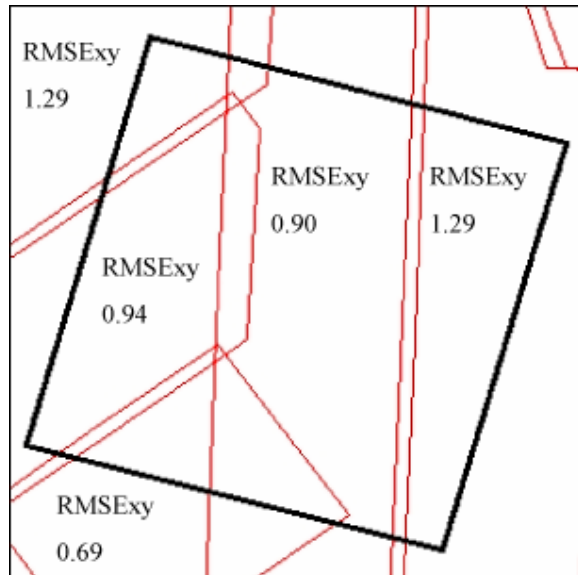


Figure 4. IKONOS ortho images' extents (red line) as opposed to the extent of the FORMOSAT test image (black bolded line). Each IKONOS orthophoto is provided along with its planimetric error.

2.3 Orthorectification

The FORMOSAT-2 image was orthorectified with PCI Geomatica 10 and ERDAS Imagine 9.1, and also with PRODIGEO and 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 coordinates were transferred via import, to avoid interpretation errors during the tests.

In order to eliminate the influence of the DEM accuracy over the orthorectification results the best available elevation dataset over the area was chosen; in this case the Reference3D product by Spot Image. It is clear that if the reference data used is of sufficient proven quality, then the results of the orthorectification will be mainly influenced by the accuracy of the geometrical model and not by external factors.

The geometric assessment that was undertaken is systematic and conforms to the standard method developed by the JRC (European Commission, 2006b). This method applies strict use of points other than the one used in the orthorectification, i.e. ICPs, for the evaluation of image correction performance, which allows the comparative robustness between different processing methods.

3. ORTHORECTIFICATION RESULTS

3.1. Geocoding by Robust Modelling

A series of tests were performed using the two main approaches – GCPs from DGPS measurements, and GCPs from IKONOS orthoimage. In the first approach the accuracy of the GCPs is very high, but the distribution is fixed and not the best for the particular scene involved in this study. On the contrary, in the second approach the best distributed GCPs were selected but their accuracy is restricted by the geometric quality of the IKONOS orthoimage. Accordingly, the first approach examines the effect of the accuracy of the measurements, while the second tests the effect of the distribution of the points on the orthorectification results.

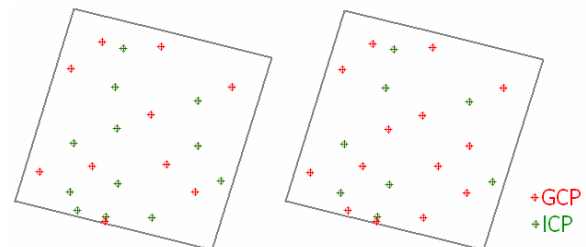


Figure 5. Distribution of Ground Control Points and Independent Check Points chosen for the orthorectification with 10 GCPs / 12 ICPs (left) and 14 GCPs / 8 ICPs (right) all measured with DGPS equipment.

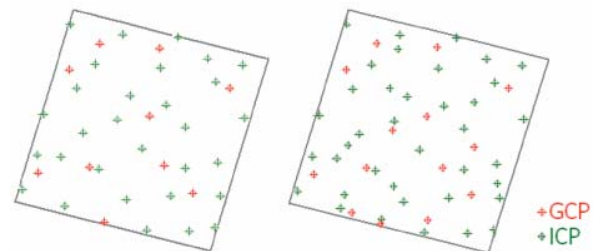


Figure 6. Distribution of Ground Control Points and Independent Check Points chosen for the orthorectification with 10 GCPs / 30 ICPs and 14 GCPs / 30 ICPs where GCPs are measured with DGPS equipment and ICPs are originating from the IKONOS reference orthoimage

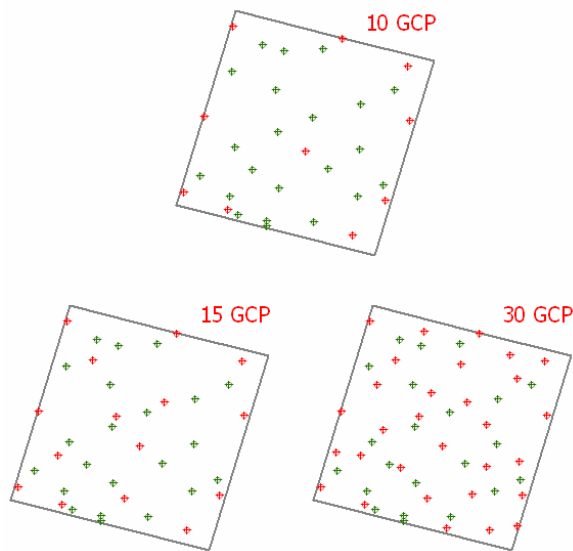


Figure 7. Distribution of Ground Control Points and Independent Check Points chosen for the orthorectification with 10 GCPs / 22 ICPs (top), 15 GCPs / 22 ICPs (left), and 30 GCPs / 22 ICPs (right). In this experiment the GCPs originate from the IKONOS reference orthoimage, and the ICPs are the measured with DGPS equipment.

Points Number and Origin				PCI Geomatica		ERDAS Imagine	
GCPs	GCPs' Origin	ICPs	ICPs' Origin	RMSE X [m]	RMSE Y [m]	RMSE X [m]	RMSE Y [m]
10	DGPS	12	DGPS	4.22	2.79	2.82	4.44
14	DGPS	8	DGPS	2.7	2.79	2.17	2.47
10	DGPS	30	IKONOS	4.99	2.59	3.69	4.8
14	DGPS	30	IKONOS	3.17	2.51	2.1	2.88
10	IKONOS	22	DGPS	2.84	1.97	2.16	2.85
15	IKONOS	22	DGPS	2.35	2.33	1.84	2.21
30	IKONOS	22	DGPS	2.37	1.75	1.93	2.18

Table 3. Root Mean Square Error (RMSE) for Easting (X) and Northing (Y) directions observed for the orthorectified image in each of the software packages PCI Geomatica 10 and ERDAS Imagine 9.0.

The orthorectification with PRODIGEO and SIPOrtho and quality check of the resulting orthoimages has been performed using the points from DGPS only.

Points Number and Origin				PRODIGEO	
GCPs	GCPs' Origin	ICPs	ICPs' Origin	RMSE X [m]	RMSE Y [m]
10	DGPS	12	DGPS	1.832	1.5
14	DGPS	8	DGPS	1.878	1.291

Points Number and Origin				SIPOrtho	
GCPs	GCPs' Origin	ICPs	ICPs' Origin	RMSE X [m]	RMSE Y [m]
10	DGPS	12	DGPS	1.36	2.2
14	DGPS	8	DGPS	1.37	1.14

Table 4. Root Mean Square Error (RMSE) for Easting (X) and Northing (Y) directions observed for the orthorectified image in each of the software packages PRODIGEO and SIPOrtho.

3.1. Orthorectification Summary

It was demonstrated, that it was possible to perform good orthorectification using standard software packages. It should be mentioned that in both cases, the FORMOSAT-2 specific satellite models used were relatively new and therefore it is likely that they will improve with time.

4. CONCLUSIONS

A series of orthorectification tests were carried out in order to evaluate the operational performance of the FORMOSAT-2 sensor in the production of orthoimages. Our study shows that it was comparatively straightforward to produce reliable products, well inside the expected performance for the CwRS requirements; 3.5 RMSE1D (i.e. in either Northing or Easting directions).

Future research should be carried out as to define the optimal number of GCPs to be used when orthorectifying FORMOSAT-2 images on a routine basis. Furthermore, the effect of the incidence angle (along-track, across-track) on the accuracy of the orthorectification should also be studied. These further investigations must be performed for both PCI Geomatica and ERDAS Imagine software packages, as it is likely that diverse models behave differently. Such analysis could aid a speedy and quality optimised orthorectification production.

5. REFERENCES AND SELECTED BIBLIOGRAPHY

European Commission, Guidelines for Best Practice and Quality Checking of Ortho Imagery, 2006, available online at http://agrifish.jrc.it/Documents/lpis/2402v2_5.pdf

Formosat 2 performance in the CwRS Campaign 2006, and future, GISCAP, Toulouse, 27-29 November 2006, <http://agrifish.jrc.it/marspac/meetings/Toulouse2006/programme.htm>

Toutin, T., Geometric processing of remote sensing images: models, algorithms and methods. *Int. J. Remote Sensing*, 20 May, 2004, Vol.25, No10, pp 1893-1924.

IMPACT DE L'UTILISATION D'IMAGES DMC EN PIAO TESTS SUR 2 ZONES DE CONTROLES 2006 EN FRANCE

E. Ingebos, C. Bouguin, I. Muquet

ABSTRACT :

Impact of using DMC on CAPI in two sites in France

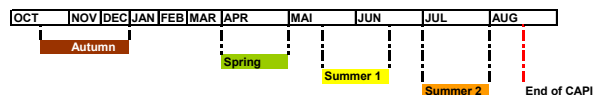
Making us of the DMC sensor could be an interesting opportunity in order to acquire *Summer 2* images earlier.

In order to evaluate the impact on CAPI in using this new sensor, we carried out a test on two sites in 2006 campaign. These two sites have different landscapes, summer crops rates and agricultural practices. The presentation describes the results of this study and illustrates the main difficulties of using DMC in these sites.

93 applications were re-interpreted with the DMC as Summer 2 HR instead of the original image (IRS in one site and SPOT5 in the second). For each application, the two diagnoses were compared and the differences analyzed. Only a few diagnoses at application level were changed, but depending on the site 6% and 16% diagnoses at parcel level were modified. Where the *ilots* contained several crops (summer crop and set aside, several summer crops) it was often not possible using the DMC images to distinguish multiple land use types.

1. OBJECTIF DE L'ÉTUDE

En France 80% des contrôles des demandes d'aide sont réalisés par télédétection soit par campagne environ 18.000 contrôles sur 45 sites. Ces contrôles sont réalisés dans 19 unités de photo-interprétation (17 unités régionales de l'AUP et 2 unités de sociétés prestataires). Le photo interprète dispose de 4 images multi temporelles pour identifier le couvert et d'une image à 1 mètre de résolution pour mesurer les parcelles et placer les découpes éventuelles.



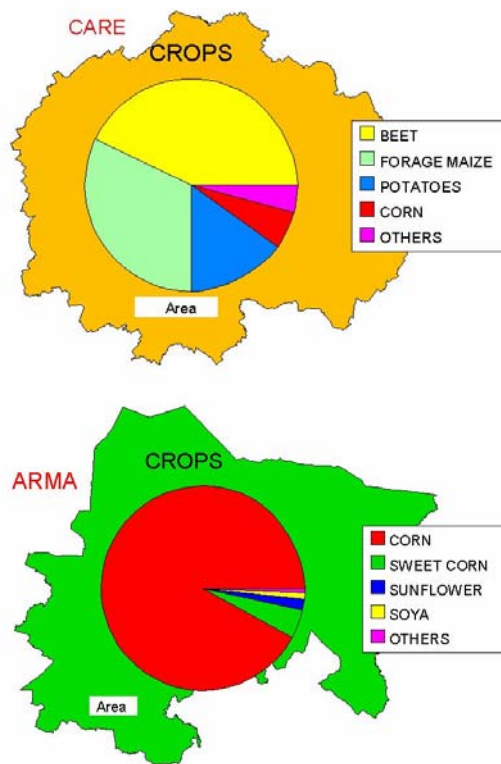
La campagne de PIAO (Photo-interprétation Assistée par Ordinateur) débute mi-juin avec l'arrivée des dossiers et se termine le 15 août. Or la dernière image multi temporelle, l'image été 2, est programmée entre le 1er et le 31 juillet. Ainsi si nous rencontrons des difficultés à obtenir cette dernière image, nous risquons de ne pas respecter le calendrier, en particulier dans les zones où le taux de culture d'été est important.

Les images DMC (Disaster Monitoring Constellation) couvrant de très larges surfaces avec une fréquence d'acquisition quotidienne pouvaient donc présenter un intérêt pour notre processus de PIAO en sécurisant l'acquisition de l'image été 2 à condition que la très faible résolution de ce type d'image, 32 mètres, ne pénalise pas l'interprétation spatiale.

L'objectif de cette étude était donc de vérifier si une image DMC pouvait être utilisée comme image de secours (back up) sur la période Été 2.

2. CARACTÉRISTIQUES DES 2 SITES TEST

Quatre sites avaient été présélectionnés pour cette étude présentant des taux de cultures d'été et un parcellaire différents. Seules 2 images ont pu être acquises sur la fenêtre Été 2 sur les sites de ARMA et de CARE.



ARMA est une zone située en Aquitaine dans une région de monoculture de maïs avec un parcellaire assez grand (8 ha en moyenne). CARE dans le Nord de la France, au contraire, présente des parcelles plus petites (3 ha en moyenne) avec des cultures d'été plus diversifiées (betteraves, maïs ensilage, pommes de terre). Ces deux zones présentaient les conditions minimales pour l'utilisation des images DMC recommandées par le CCR soit des parcelles en moyenne supérieures à 2,5 ha.

	ARMA	CARE
Area (km ²)	1 100	444
Summer crop rate	66%	20%
Main summer crops	Corn, sweet corn	Beet, forage maize, potatoes, corn,
Average size of summer crop parcel	8 ha	2,9 ha

3. TRAITEMENT DES IMAGES DMC RÉALISÉ PAR NOS PRESTATAIRES

Nos prestataires SIRS et CS ont réceptionnés et traités les images DMC (CARE et ARMA respectivement). Le tableau suivant présente une synthèse des traitements effectués. De façon générale, nos prestataires ont souligné la **bonne radiométrie et la bonne qualité géométrique des ces images.**

Scene subset :	CARE Subset from delivered scene : 395 km x 287 km	ARMA Delivered Scene : 80 km x 80 km
Reprojection (new coordinate system)	NO	System: UTM datum WGS 84 Projection: Lambert 2 étendue Datum NTF
Delivered product quality checks :	Readable files, format, radiometry, referencing and orthorectification	Readable files, format, radiometry, referencing and orthorectification
Radiometric treatment:	Spectral enhancement of the whole image : linear stretch on each 3 spectral bands	Spectral enhancement of the whole image : linear stretch on each 3 spectral bands
Referencement / orthorectification : noted shift :	About one pixel Good global referencement	About 1 to 2 pixels towards the N-NE

4. METHODOLOGIE UTILISEE

Le principe adopté a été de re-interpréter les parcelles en culture d'été d'un échantillon de dossiers dans chacun des sites CARE et ARMA.

Un traitement informatique a permis de réinitialiser la photo interprétation des cultures d'été (découpe et affectation du couvert). Puis un ensemble de dossiers a été sélectionné dans chaque site sur la base d'un taux minimal de culture d'été. Ces dossiers ont été réinterprétés dans les mêmes unités de photo-interprétation que les dossiers de référence mais, dans la mesure du possible, par un photo-interprète différent. Enfin les résultats ont été comparé aux diagnostics de l'image de référence (IRS pour ARMA et Spot 5 pour CARE).

	ARMA	CARE
Reference image	IRS	SPOT 5
Resolution	20 m	10 m
Date of acquisition	24/07/06	13/07/06
DMC Date of acquisition	02/07/06	02/07/06

Une des difficultés de cette étude a été la différence de dates d'acquisition entre les images DMC et les images de référence. Les images DMC ont été obtenues, selon le site, 11 ou 22 jours avant l'image de référence, le signal des cultures d'été était par conséquent plus faible sur les images DMC.

Lors de la comparaison des diagnostics nous avons tenté de ne pas prendre en compte les différences d'interprétation qui semblaient liées à cette différence de dates d'acquisition entre les images.

5. RESULTATS

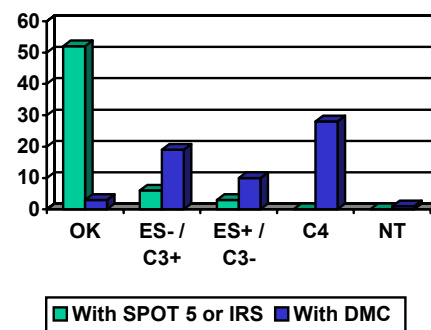
55 demandes d'aide ont été réinterprétées avec l'image DMC sur le site d'ARMA et 38 sur le site de CARE. Peu de changements de diagnostic au niveau du dossier ont été identifiés (entre 1 et 4 selon le site). Cependant au niveau de la parcelle, 9 changements ont été observés sur 153 parcelles dans le site d'ARMA soit 6%. Un taux de changement supérieure a été observé pour le site de CARE (16 %) avec 52 changements sur 320 parcelles.

	ARMA	CARE
Nb. of applications	55	38
Summer crop rate in test applications	85%	30%
Nb. of changes in diagnosis at application level	1	4
Nb. of summer crop parcels	153	320
Nb. of changes in diagnosis at parcel level	9 i.e. 6%	52 i.e. 16%

Ces résultats s'expliquent par un parcellaire plus petit dans la zone de CARE avec des cultures d'été plus diversifiées. Le fait que l'image de référence sur CARE (Spot 5) était encore plus précise que l'IRS peut également expliquer cet écart.

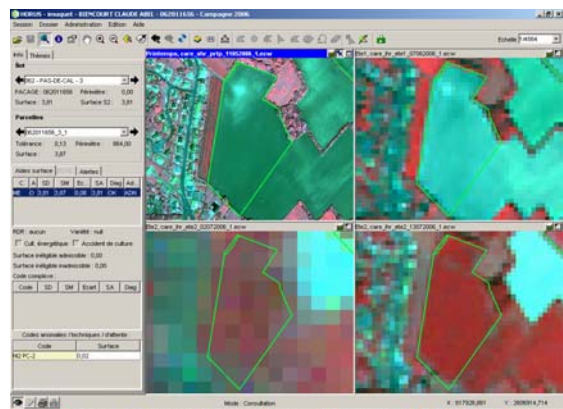
Les changements de diagnostic conduisent quasi-systématiquement à poser des anomalies supplémentaires car le photo - interprète doute davantage avec l'image DMC. Ainsi sur les 61 parcelles dont le diagnostic change, 51 avaient un diagnostic OK au vu des images de référence mais sont refusées au vu de l'image DMC. Sur trois parcelles l'anomalie identifiée sur l'image de référence n'est plus visible sur l'image DMC. Enfin, le nombre d'anomalies C4 « Photo-interprétation impossible » qui traduit le doute du photo- interprète passe de 0 à 29 avec l'image DMC.

5.1. Comparaison des diagnostics obtenus entre les images DMC et les images de reference

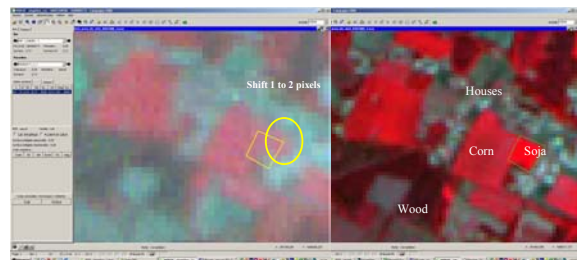


Les captures d'écran suivantes permettent d'illustrer quelques exemples.

Cas 1 : Pour les îlots monocultureux l'image DMC permet de confirmer la présence d'une culture d'été.

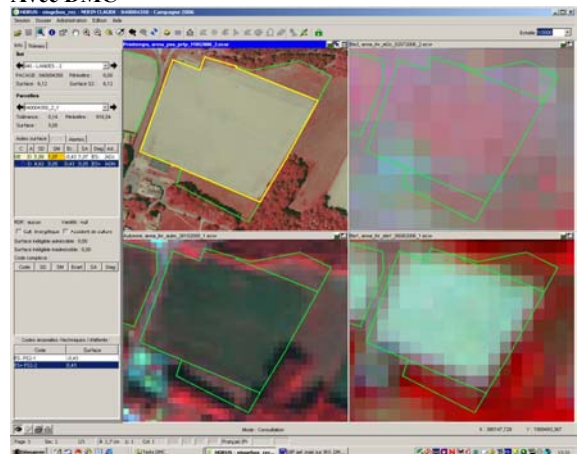


Cas 2 : La distinction de deux culture d'été (maïs et soja sur cet exemple) n'est pas possible sur les images DMC dont nous disposons alors que elle était possible sur l'image IRS.

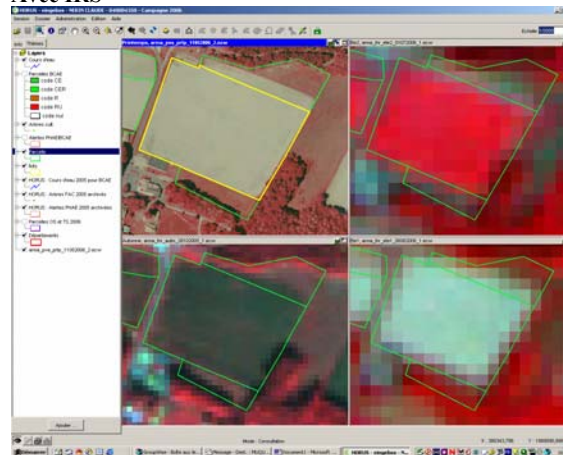


Cas 3 : L'image d'été2 est utilisée pour confirmer la présence des culture d'été mais également pour confirmer en juillet les découpes réalisées sur l'image à un mètre de résolution qui date généralement du mois de mai. Sur cet exemple il n'est pas possible d'identifier la limite entre le gel et le maïs sur l'image DMC alors que l'IRS avait permis de réajuster cette découpe.

Avec DMC



Avec IRS



6. CONCLUSION

Les images DMC peuvent être utilisées comme image de secours sur la fenêtre été2 en cas de grands parcelles mais ne peuvent pas, en France, remplacer les images HR disponibles actuellement (Spot, IRS).

Les utilisations d'images DMC en PIAO entraînent davantage de doutes et donc de « fausses anomalies », moins de possibilités de mesurages par télédétection. Par conséquent le taux de vérification et de mesurage augmente sensiblement.

MONITORING OF AGRICULTURAL PRACTICE BY JOINT ANALYSIS OF VHR IMAGES AND MODIS TIME SERIES

D. Kristóf¹, D. Neidert¹

¹Institute of Environmental and Landscape Management, Szent István University, Páter Károly u.
1., Gödöllő, H-2103 HUNGARY, www.kti.szie.hu, kristof.daniel@kti.szie.hu, neidert.dora@kti.szie.hu

KEY WORDS: MODIS, IKONOS, time-series, preprocessing, harvesting, mowing, linear unmixing

ABSTRACT:

The primary objective of this work is to determine harvesting and mowing dates of crops and grasslands by integrating VHR (IKONOS) and low spatial resolution (MODIS) images. Although in many cases VHR images are required to delineate surface objects in a precise manner, the extremely limited availability of these images is a major hindrance for using them in continuous monitoring (e. g. to determine harvesting and mowing dates). On the other hand, a large number of low-resolution satellite images (e. g. MODIS) are available free of charge, offering daily revisits at a resolution of several hundreds of meters. Moreover, a tremendous amount of corrected MODIS scientific data sets are available for downloading including corrected surface reflectance data, which is ideal for change detection and time-series analysis.

In this study, two IKONOS images were used to delineate crop parcels and to determine land cover types over a 10 by 10 km study area in southern Hungary. Then, a daily time-series of MODIS 250-m surface reflectance grids covering most of the vegetation period in 2006 was analysed to determine harvesting and mowing dates for the previously detected parcels. The applied methods include image segmentation, classification, linear unmixing and trend analysis. The first results showed that special attention must be paid on the preprocessing of the gridded MODIS products prior to trend analysis. Therefore, an important part of this paper is dedicated to the review of MODIS-related literature in order to enlighten the particularities of these data and the MODIS processing chain. We then propose a methodology to cope with the above-mentioned issues. Although we are still working to have the final practical results, we hope that this paper is a useful starting point for those who would like to use MODIS data for such purposes.

1. INTRODUCTION

1.1. General introduction

Remote sensing data can be divided into different spatial and temporal observation scales. Nowadays, in most cases, a very frequent (daily) temporal coverage means a relatively lower spatial resolution of several hundreds of meters, whereas high spatial resolution (HR) implies a limited temporal coverage. Moreover, from a financial point of view, HR images are still rather expensive while some lower resolution images such as MODIS can be acquired free of charge. Although these latter were originally dedicated to studies on global and continental scales, it would be reasonable to exploit their availability in regional and local studies where temporal characteristics of smaller surface objects have to be examined more in detail. On the other hand, remotely sensed data are increasingly used in a quantitative way, i. e. to assess the characteristics of or to quantify the changes occurring on the surface of the Earth. However, numerous experimental and natural effects can cause important radiometric differences not linked to real surface characteristics: variation of viewing and illumination angles, anisotropic reflectance and different atmospheric conditions, among others. Numerous analytical and empirical methods have been developed to cope with these issues, but in most cases they require auxiliary information and thorough processing. MODIS Land Surface products, that have been available in continuously developing versions since 2000, may offer an alternative. They provide an estimate of the surface spectral reflectance for each band as it would be measured at ground level in the absence of atmospheric scattering or absorption. A correction scheme also identifies atmospheric gases, aerosols, and thin cirrus clouds (Vermote and Vermeulen, 1999). With all these corrections done in an operational manner, the resulting surface reflectance products

are theoretically free of most disturbing effects mentioned above. Therefore, they are ideal candidates for monitoring and time-series analysis. The principal aim of this study is thus to investigate the possibilities of integrating temporal information from MODIS daily time series and spatial information from high-resolution satellite images.

1.2. Context and study site

This research is being carried within the frame of the LIFE Nature project entitled „Conservation of *Falco vespertinus* in the Pannonian Region” (period: 2005-2009, ID: LIFE05 NAT/H/000122). The main objective of this project is to assess habitat preferences of Red-footed Falcon (*Falco vespertinus*). As a part of this project, a 10 by 10 km square-shaped study site was selected in the south-eastern part of Hungary near the village of Kardoskút, where one of the most important Red-rooted Falcon populations resides (see Figure 1.).



Figure 1. The location of the study area within Hungary.

The study area is characterized by a mixed land use with nearly equal proportions of arable fields and grasslands. In this area, animal localisation data has been collected by radiotelemetric observations. Detailed and up-to-date habitat maps are crucial for reliable habitat preference calculations. Agricultural activities such as harvesting and mowing are also critical, as both have large influence on the abundance of prey. The monitoring of agricultural practice is thus another most important input for assessing habitat preferences of Red-rooted Falcon. Consequently, detailed habitat mapping is carried out in each year of the project by acquiring very high resolution (VHR) satellite imagery. Monitoring of harvesting and mowing is being done by time-series of freely available moderate resolution (MODIS) imagery.

2. SATELLITE IMAGERY

2.1. VHR IKONOS images

In the first project year (2006), two IKONOS images were acquired over the study area for detailed habitat mapping. Both images are panchromatic and multispectral (Pan+MS) bundle “Geo Ortho” products, resampled to a ground pixel size of 1 m (Pan) and 4 m (MS). Both multispectral images contain four spectral bands including three visible (red, green, blue) and one near-infrared (NIR) band.



Figure 2. False colour composite of the IKONOS image acquired on 19/06/2006. Image copyright European Space Imaging (2006).



Figure 3. False colour composite of the IKONOS image acquired on 12/09/2006. Image copyright European Space Imaging (2006).

(For more details, see http://www.geoeye.com/products/imagery/ikonos/geo_ortho.htm). The acquisition dates were chosen to yield a maximum contrast in the agricultural fields to enhance the separability of the main crop types. The two images are shown on Figures 2 and 3.

2.2. MODIS reflectance data

The Moderate Resolution Imaging Spectroradiometer (MODIS) instruments mounted on NASA’s Terra and Aqua satellites provide observations on 36 spectral bands between 0.405 and 14.385 micrometers, with three spatial resolutions: with 250m, 500m and 1km nominal pixel size at nadir. The large swath width (2330 km) and the orbit of the two satellites make it possible to acquire imagery over the entire surface of the Earth every one to two days (depending on the latitude: at mid-to-high latitudes, multiple observations per day are possible).

(For more information, visit <http://modis.gsfc.nasa.gov/>). MODIS data are made available free of charge to the scientific community. Besides the original observations, a whole suite of derived products is produced in a systematic manner and can be used for research purposes (Tan et al., 2006). Atmospheric and BRDF correction algorithms based on MODIS observations and other inputs are used to derive surface reflectance (Vermeulen and Vermeulen, 1999), and more complex algorithms are used to compute other surface properties and processes. The MODIS processing chain algorithms are improved in a continuous manner, and all the archived datasets are reprocessed regularly. The different versions are referred to as “collections”. Starting from January 2007, all newly acquired MODIS data are processed into Collection 5. The reprocessing of the archived data has started and will be finished by September 2008. However, for most products, Collection 4 is the most up-to-date version at the creation date of this paper (March 2007). (Refer to the above MODIS website for more details).

Due to the relatively small size of the objects to be monitored (see Table 2) and the temporal resolution required, we have chosen the MODIS products with the best available temporal and spatial resolution, the daily 250-m reflectances: MOD09GQK (Terra) and MYD09GQK (Aqua) from Collection 4. (In Collection 5, data structure has changed, and the similar products are named MOD09GQ and MYD09GQ, respectively). These products include MODIS bands 1 (red) and 2 (NIR), which should be sufficient for such monitoring studies. All data were ordered through the EOS Data Gateway (<http://redhook.gsfc.nasa.gov/~imswww/pub/imswelcome/>). The most important characteristics of the reflectance products are shown in Table 1.

Product name	MOD09GQK (Terra), MYD09GQK (Aqua)
Physical quantity	Surface reflectance
Corrected for	Atmospheric effects: gases, aerosol, thin cirrus clouds (from MODIS bands and climatology) View and solar angles: BRDF without topography
Cell size	250 m
Bands	Band 1 (red), Band 2 (NIR)
Theoretical radiometric accuracy	Band 1: 0.005 (10-33%) Band 2: 0.014 (3-6%)
Metadata (for each cell)	QC: Quality flag Num_obs: Number of observations Orb_cov: Orbital coverage
Time period	01/06/2006-31/08/2006

Table 1. Characteristics of the MODIS reflectance products used in this study

3. METHODS

3.1. Processing of VHR images to create the land use/land cover map

3.1.1. Orthorectification

Both IKONOS images being Geo Ortho products with topographic displacements uncorrected, we first carried out their orthorectification by using a digital elevation model, ground control points taken from aerial orthophotos, and appropriate image processing software (Leica Geosystems/ERDAS Imagine™).

3.1.2. Pan-sharpening

Panchromatic and multispectral images acquired simultaneously for both dates were fused with the High-pass Filter (HPF) algorithm (Chavez et al., 1991). Although the pan-sharpened images were not used directly in the subsequent digital interpretation steps, they facilitated visual inspection and the detection of field boundaries (see below).

3.1.3. Field data collection

Prior to interpretation and thematic data extraction, intensive field campaigns were carried out to collect ground truth data at dates close to image acquisition timeframes. More than 300 ground truth sample points were identified during this GPS-assisted fieldwork. Land use/land cover and crop types were described and field photographs were taken for each location. Moreover, harvesting and mowing dates were also registered for over 50 agricultural fields and grassland patches.

3.1.4. Image interpretation

Image segmentation was carried out on the two-date stack of IKONOS data using Definiens Professional™ software to identify homogeneous image objects (image segments). Altogether more than 20000 homogeneous image segments were identified in the research area.

Then, training samples were selected by using the ground truth dataset. Altogether 106 subclasses were defined to represent the main classes: cereals, row crops, alfalfa, fallow land, grassland, built-up areas and surface waters. A maximum likelihood classification was then carried out by using the radiometric values (mean and standard deviation) of the image segments delineated in the previous step. The numerous resulting classes were then aggregated to represent the main classes listed above.

To enhance reliability and permit habitat preference calculations, it was decided to aggregate the classification results on field level. Therefore, field boundaries were digitised by visually interpreting the two-date pan-sharpened imagery. Segment-level classification results were then aggregated on field level by calculating majority, majority fraction and diversity values for each field. The majority class value was assigned for each field with the majority fraction above 0.7 (i.e. the dominant class occupied more than 70% of the field). The remaining fields showing lower majority fraction values, and especially those with high diversity, were visually interpreted. As a result, a detailed and reliable land cover map was obtained, with the scale and thematic content sufficient for habitat preference calculations.

3.2. Processing of MODIS surface reflectance products

3.2.1. Particularities of MODIS data

As already mentioned in Chapter 2.2, MODIS data have some intrinsic characteristics that make their processing a delicate issue. Wolfe et al. (1998) and Tan et al. (2006) give a detailed description of these characteristics and assess their effects for the MODIS sensor. Here we give a brief overview to underline the importance of careful processing.

6. First of all, we have to mention that the moderate resolution, wide field of view sensors like MODIS are primarily dedicated to global and continental-scale studies. Here we try to use the data on local scales, and to monitor objects with a size close to or below pixel size. Therefore, a number of effects that can be neglected when using more appropriate resolutions have to be dealt with. For comparison, the problem can be regarded as if we tried to monitor objects of the size of a car with the current VHR images.

7. Due to the wide field of view, the across-track scan angle of MODIS ranges from 0 to 55 degrees. The curvature of the Earth elongates the scan line to 2340 km, and makes the view zenith angle larger than the scan angle. With the view zenith angle increasing, the observation dimensions also increase both in along-track and along-scan directions, leading to an increasing overlap of the observations as the view zenith angle increases (“bow-tie effect”), among others (Tan et al., 2006; Wolfe et al., 1998).

8. In remote sensing, we generally assume that the information content of a pixel originates from its footprint. However, in an actual remotely sensed image, a substantial portion of each pixel comes from its surrounding. Atmospheric effects, instrument optics and electronics and image resampling are the main factors, which can be characterised by the point spread function (PSF) for each sensor (Huang et al., 2002). This becomes extremely important when the size of the studied objects is close to or below pixel size – which is the case in our study. The image motion PSF, caused by the motion of the scan mirror during the measurement time integration, is the most important component of the MODIS PSF. The shape of the MODIS PSF is triangular (Tan et al., 2006) or can be represented by a Gauss curve (Huang et al., 2002). Tan et al. (2006) state that for a MODIS pixel, approximately 25% of the signal is originating from adjacent pixels while 75% comes from the nominal observation area.

9. Although geometric accuracy is an important issue in remote sensing in general, it is even more important when, again, the size of the observation targets and the pixel size are close to each other. The geolocation error of MODIS has been quantified by Wolfe et al. (2002), and was found to be relatively modest: 50 m at 1 sigma at nadir.

10. The MODIS gridding process also has a large influence on the resulting grids of MODIS data. The MODIS Data Processing System (MODAPS) uses predefined grids for storing and processing MODIS observations. The predefined MODIS grid cells have a size corresponding to the nominal observation dimensions at nadir. In the gridding process, all observations (image pixels) are stored in a grid cell based on a nearest neighbour resampling algorithm. Therefore, close to the swath edge, several adjacent grid cells will share the same observation (see Figure 4). Moreover, the average overlap between grid cells and “real” observations (referred to as “observation coverage”) is less than 30% (Tan et al., 2006). The typical values vary between 5% (at swath

edge) and 65% (at nadir) for the reflectance products used in our study.

11. Lastly, the raster data model itself has some limitations. A raster dataset, by definition, cannot store observations with varying dimensions without the need of resampling and thus modifying the data itself. All kinds of resampling carried out due to the fixed cell size inevitably result in artefacts in the data.

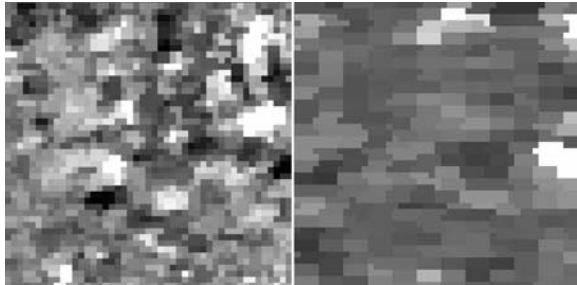


Figure 4. Illustration of the effects of the view angle and gridding artefacts: the 10 by 10 km study site with near-nadir (left) and off-nadir (close to swath edge -right) observations. Images copyright NASA (2006).

3.2.2. MODIS data processing

All MODIS reflectance products (MOD09GQK and MYD09GQK) were downloaded in EOS HDF format and sinusoidal projection. The subsetting to the extent of the study area was carried out by using the MODIS Reprojection Tool (<http://edcdaac.usgs.gov/landdaac/tools/modis/index.asp>). We have kept all data in the original (sinusoidal) projection to avoid double resampling. The most important contents of the above-mentioned data are reflectance values for MODIS bands 1 and 2, and quality flag (QC) data for each pixel.

A quality filtering had to be carried out on each pixel prior to using it for monitoring purposes. The meaning of different QA codes can be found at the following address:

http://edcdaac.usgs.gov/modis/moyd09gqk_qa_v4.asp.

From our point of view, the most important code is 4096 as it means the best quality regarding atmospheric conditions and zenith angle and all corrections performed. Therefore, all data were filtered to retain only good-quality pixels with QA=4096.

In the next step, observation coverage values were examined in detail. Although the grid values are chosen to retain the maximum view zenith angle observations for each day, it is common to have adjacent pixel blocks with the same values due to larger observation dimensions close to the swath edge (see above). The observation coverage (“obscov”) values are provided in separate MODIS “observation pointer” products named MODPTQKM (Terra) and MYDPTQKM (Aqua). [We note here that the “obscov” values are now included in the new Collection 5 surface reflectance data products themselves]. After downloading these data for each grid, we have carried out minimal obscov filtering with several different threshold values. At the end, Terra and Aqua data were combined to obtain a maximum of observations. Here we used the observations with the maximum obscov value for each cell and for each day.

3.3. Determining harvesting and mowing dates

3.3.1. Theoretical bases

Every change in the characteristics of a surface has influence on its reflective properties, and is thus detectable by remote sensing. The question whether the change is detectable is

related to the spatial, spectral, radiometric and temporal extent of the change and can be answered according to the characteristics of the instrument. Interventions such as harvesting and mowing have an immediate and significant influence on the reflectance of a field, especially in the NIR domain. Moreover, in most cases they affect an entire field at once. By comparing the average size of the fields (Table 2) and the pixel size of MODIS band 1 and 2 (6.25 ha), it can be assumed that it is possible to detect such changes with MODIS. Figure 5 gives an overview of the general principle.

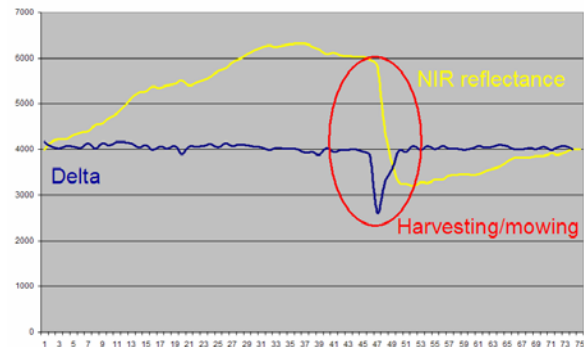


Figure 5. Theoretical curves representing the supposed effect of harvesting/mowing on the average near infrared reflectance (yellow line) of a field. The blue line represents the change between two consecutive days. The horizontal axis contains observation days whereas the vertical axis contains reflectance values (multiplied by 10000).

The resolution of MODIS and the average parcel size implies that a large amount of mixed pixels have to be treated. Therefore, a subpixel unmixing approach was chosen, similarly to numerous previous studies (Braswell et al., 2003; Lobell et al., 2004; Doraiswamy et al., 2004). The basic principle behind this approach is that the reflectance of each pixel can be calculated from the area-weighted sum of the reflectance of the landscape elements they contain (see Figure 6).

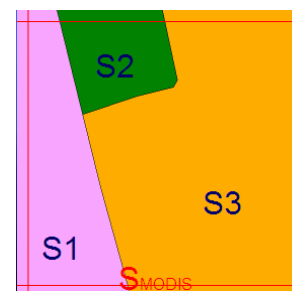


Figure 6. Example of a MODIS pixel and the underlying landscape pattern. SMODIS stands for the area of the MODIS pixel, S1/S2/S3 for the proportional areas of the different landscape elements within the MODIS pixel.

The reflectance of a MODIS pixel as represented on Figure 6 can be expressed at a given wavelength as follows:

$$R_{MODIS} \approx \sum_{i=1}^n \frac{S_i \cdot R_i}{S_{MODIS}}$$

where R_{MODIS} is the reflectance of the MODIS pixel, n is the number of distinct landscape objects, S_i is the proportional area of the homogeneous landscape object within the MODIS pixel, R_i is the average reflectance of the object at the given wavelength, S_{MODIS} is the area of the MODIS pixel.

4. RESULTS AND DISCUSSION

The proportional area of the landscape objects within each MODIS pixel can be calculated by intersecting the MODIS grid with the object boundaries yielded by the analysis of the VHR images. Moreover, a probable harvesting period can be assigned to each parcel, e.g. June for winter cereals, etc. The typical reflectance values (“endmembers”) can be estimated from “pure” MODIS cells located on large contiguous areas, and from the corresponding spectral bands of the VHR images. Endmembers should include bare soil, full green vegetation cover, non-photosynthetic vegetation cover and stubble, among others. Then, by applying the above equation, land cover percentages can be calculated over each MODIS cell. Harvesting and mowing dates can be found when the “bare soil” or “stubble” classes show a significant and persistent increase along with a decrease in vegetation classes.

3.3.2. Practical steps

As a first step, we have intersected the polygon layer containing the land use/land cover with the MODIS grid (see Figure 7). In the resulting polygon layer, each polygon contains the land cover class and a MODIS grid ID. Then, time-series of the preprocessed MODIS reflectance data (see 3.2.2) was joined to the attribute table, with each day becoming an attribute field. MODIS cells within large contiguous areas were selected and endmember values were collected for the endmember classes listed above.

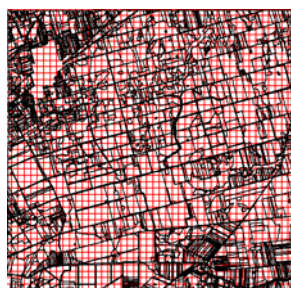


Figure 7. Intersection of the landscape object boundaries with the MODIS grid.

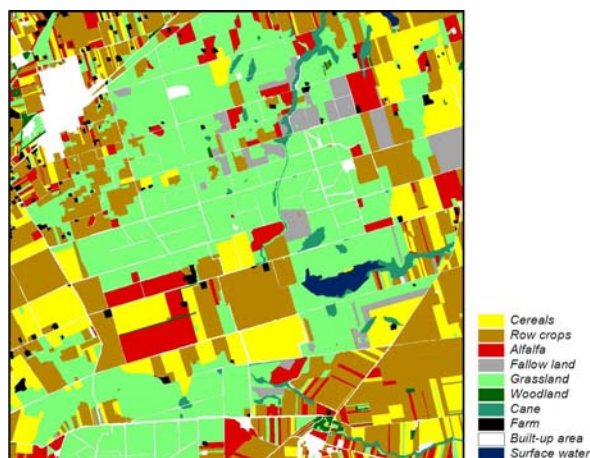


Figure 8. Field-level land use/land cover map resulting from the digital interpretation of the two-date IKONOS image pair

The land use/land cover map resulting from the analysis of VHR images is shown on Figure 8, and its statistics are contained in Table 2 (see below).

Class	Total area (ha)	Number of patches	Average parcel size (ha)
Cereals	1438.24	261	5.51
Row crops	2554.77	752	3.39
Alfalfa	825.32	294	2.81
Fallow land	15.21	4	9.94
Grassland	3888.34	882	4.41
Woodland	64.38	54	21.46
Cane	209.31	75	2.79
Farm	124.65	122	1.02
Built-up area	806.73		
Surface water	73.05		

Table 2. The distribution of area, number of patches and average parcel size among the land cover classes. The classes used for harvesting and mowing analysis are shown in bold.

Our results show that the average patch size has a high variability depending on land cover class. For the classes included in the harvesting/mowing analysis, the patch size varies between 2.81 ha (alfalfa) and 5.51 ha (cereals). They are all smaller than the 6.25 ha nominal pixel size of MODIS.

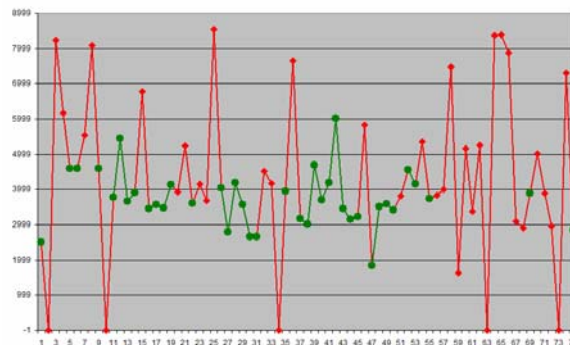


Figure 9. Time-series example: MODIS pixel values for a “clear” pixel in the middle of a large contiguous cereal field (area: 72.4 hectares). The horizontal axis represents days, the vertical axis contains NIR reflectance values (multiplied by 10000). The values shown in red were rejected during QC and obscov filtering, the green values were retained.

Figure 9 shows preliminary results on a “clear cereal” MODIS pixel. It is clear that although the preliminary corrections removed a substantial amount of noise, this time series is still not suitable for the exact monitoring of agricultural practice. This is partly due to the fact that some pixels containing clouds and cloud shadows were retained after QC filtering. (It is worth noting that cloud masks are refined in MODIS Collection 5 data, and cloud edges are now included in the masks). Unfortunately (at least from the remote sensing point of view) the observed period in 2006 was particularly rainy with high cloud cover, which results in a considerable loss of data. Moreover, our correction scheme does not include the correction of some important error sources listed in 3.2.1. For example mixtures caused by triangular or Gauss curve-shaped PSF is not treated by any of the methods applied.

It is also evident that due to the resolution and the particularities of MODIS data, additional efforts are needed.

5. CONCLUSIONS AND FUTURE DIRECTIONS

The following conclusions can be drawn from the results so far:

- The two-date VHR imagery and field data collection and the methods chosen (image segmentation, supervised classification, delineation of field boundaries, field-level data aggregation) made it possible to create an accurate field-based land use/land cover map in a highly automated manner.
- Although the preprocessing of the MODIS surface reflectance time series diminished the noise, it was insufficient for carrying out the unmixing-based monitoring as it was planned. Further efforts are needed in this respect.

The current work being carried out and the future perspectives of this study are listed below:

- We are currently working on the implementation of the PSF deconvolution method proposed by Huang et al. (2002). The difficulties here reside in restoring the “original” image, as the convolution has to be carried out on the “raw” image (before resampling it to the predefined grid cells). Fortunately, thanks to the mindful processing of MODIS data in MODAPS, this is possible: the nearest neighbour resampling does not mix pixel values, and the original coordinates of each pixel are stored in the observation pointer products.
- We aggregate the original data on different spatial and temporal resolutions, as carried out for creating the higher-level composited and aggregated MODIS products, and also proposed by Tan et al. (2006). The principal problem here is the loss of spatial and/or temporal resolution. Nevertheless, we are carrying out the cost/benefit analysis of this solution.
- We are also experimenting with MODIS level 1 radiance images (MOD02QKM/MYD02QKM), which can be downloaded through the LAADS web at <http://ladsweb.nascom.nasa.gov/data/search.html>. These images are not yet resampled to the MODIS grid and are still in the coordinate system of the “raw” images, but can be geometrically corrected using the corresponding MODIS Geolocation datasets (MOD03) with the MODIS Swath Reprojection Tool, downloadable from <http://edcdaac.usgs.gov/landdaac/tools/mrts swath/>.
- Finally, we try to implement a correction scheme based on vector instead of raster data model. For each pixel in the raw image coordinate system, we calculate the shape of the area it really covers on the surface of the Earth based on the equations in Appendix B of Tan et al. (2006), where they describe how to determine the observation dimensions according to observation angles.

6. REFERENCES AND SELECTED BIBLIOGRAPHY

Braswell, B.H., S.C. Hagen, S.E. Froking, W.A. Salas, A multivariable approach for mapping sub-pixel land cover distributions using MISR and MODIS: Application in the Brazilian Amazon region. *Remote Sensing of Environment* 87(2003): pp 243–256.

Chavez, P.S. Jr., S.C. Sides and J.A. Anderson, Comparison of three different methods to merge multi-resolution and multispectral data: Landsat TM and SPOT Panchromatic,

Photogrammetric Engineering and Remote Sensing, 57(3), 1991: pp 295-303.

Doraiswamy, P.C., J.L. Hatfield, T.J. Jackson, B. Akhmedov, J. Prueger, A. Stern, Crop condition and yield simulations using Landsat and MODIS. *Remote Sensing of Environment* 92(2004): pp 548–559.

Huang, C., John R.G. Townshend, Shunlin Liang, Satya N.V. Kalluri, Ruth S. DeFries, Impact of a sensor’s point spread function on land cover characterization: assessment and deconvolution. *Remote Sensing of Environment*, 80(2002): pp 203-212.

Lobell, David B., Gregory P. Asner, Cropland distributions from temporal unmixing of MODIS data. *Remote Sensing of Environment*, 93(2004): pp 412–422

Tan, B., C.E. Woodcock, J. Hu, P. Zhang, M. Ozdogan, D. Huang, W. Yang, Y. Knyazikhin and R.B. Myneni, The impact of gridding artifacts on the local spatial properties of MODIS data: Implications for validation, compositing, and band-to-band registration across resolutions. *Remote Sensing of Environment*, 105(2006): pp 98-114.

Vermote, E. and Vermeulen, A., Atmospheric correction algorithm: Spectral reflectances (MOD09). MODIS Algorithm Technical Background Document (ATBD), Version 4.0, April 1999, NASA.

Wolfe, R.E., D.P. Roy and E. Vermote, MODIS land data storage, gridding and compositing methodology: Level 2 grid. *IEEE Transactions on Geoscience and Remote Sensing*, (36), 1998: pp 1324-1338.

Wolfe, R. E., Nishihama, M., Fleig, A. J., Kuyper, J. A., Roy, D. P., Storey, J. C. et al., Achieving sub-pixel geolocation accuracy in support of MODIS land science. *Remote Sensing of Environment* (83), 2002: pp 31–49.

7. ACKNOWLEDGEMENTS

This research was partly financed the European Union’s LIFE Nature project entitled „Conservation of Falco vespertinus in the Pannonian Region” (LIFE05 NAT/H/000122).

The authors wish to thank Péter Palatitz, Szabolcs Solt, Péter Fehérvári from Birdlife Hungary and László Kotymán from Körös-Maros National Park Directorate for their contribution in the field campaigns as well as for the continuous collaboration while carrying out this research.

CREATION OF DIGITAL ORTHOIMAGE MAP ON THE BASE OF VHR SATELLITE IMAGES FOR THE BULGARIAN LPIS

V. Vassilev¹, P. Milenov¹, R. Radkov¹, S. Popova¹, K. Stefanov¹

¹Remote Sensing Application Center – ReSAC, Agency for Sustainable Development and Eurointegration – ASDE
61, Tzar Assen Str., 1463 Sofia, Bulgaria
<http://www.resac-bg.org/>, resac@techno-link.com

KEY WORDS: LPIS, Orthoimage map, VHR satellite data, orthorectification, quality check.

ABSTRACT:

The current report presents the work and the results achieved during the realisation of the assignment for creation of a digital orthoimage map derived from archived satellite imageries (2003-2005) covering part of the territory of Republic of Bulgaria. The digital orthoimage map preparation is for the purposes of Land Parcel Identification System – LPIS creation in the Ministry of Agriculture and Forestry. For the later task imageries from satellites with very high spatial resolution, namely Ikonos and QuickBird, were used.

As a source for the digital elevation model (DEM) the French product Reference3D of Spot Image was implemented. During the process of orthorectification for Ground Control Points (GCPs) GPS field measurements are utilised, acquired with DGPS instruments with very high accuracy. The territory covered by the project is roughly estimated to 33 000 sq.km and is one of its kind, resulting in such large extent orthoimage map with archived imageries. The chosen approach for the image processing is single scene orthorectification, as well as for certain regions strips expanding the usual single scene extents were used. The main image processing software used are ERDAS Imagine v.9.0 and PCI Geomatica v.10.

The contract was awarded to a consortium lead by the Agency for Sustainable Development and Eurointegration – Ecoregions (ASDE), which was responsible for the project management, orthoimage processing and internal quality control. The other partners were European Space Imaging, Eurimage, Spot Image and the local geodetic company Dian Zlatev Ltd. The pre-processing and the orthorectification were done by ASDE and its expert group from the Remote Sensing Application Center (ReSAC) - Bulgaria.

1. INTRODUCTION

1.1. Project history

In 2005-2006 as an accession country in the European Union, Bulgaria was required to acquire the “acquis communautaire” before its integration. Concerning agriculture, the Bulgarian government should reorganise the institutions, and adopt EU procedures to be fully compatible with the Common Agricultural Policy. One of the most important milestones is the development of the appropriate management tools. The Integrated Administrative Control System (IACS) is one of them, and it represents a lot of difficulties in terms of techniques and budget. IACS has to be linked to a geographic database of the agricultural parcels, for graphic declaration of farmers and controls. For that purpose each EU member state, should develop the so-called Land Parcel Identification System (LPIS), which has to describe with enough cartographic detail and accuracy (equal to 1:10 000 scale) the reference parcels, used by the farmers to prepare their aid declarations. LPIS should cover the entire country and should maintain the actual status of the agriculture land and the corresponding land use. This information could be extracted efficiently from orthorectified aerial or satellite images, not older than 5 years at the year of the declaration.

In the process of preparation of the accession of Bulgaria in EU, the institution responsible for the creation of the LPIS is the Ministry of Agriculture and Forestry. Due to a delay of the

aerial acquisition and orthophoto production in Bulgaria, the European Commission suggested to the government the use of archive VHR satellite data, in order to speed up the parcel/block creation.

A national tender was launched in the beginning of 2006 for the delivery of satellite orthoimages for at least 30 000 sq. km. of the territory of the country in an extremely short period of 3 months (due to the importance and urgency of the completion of the LPIS).

The contract was awarded to a consortium lead by the Agency for Sustainable Development and Eurointegration – Ecoregions (ASDE), which was responsible for the project management, orthoimage processing and internal quality control. The other consortium partners were:

- European Space Imaging (delivery of the archive dataset of Ikonos, including the datasets of Space Imaging, USA and INTA Space Turk),
- Eurimage (delivery of the archive dataset of QuickBird),
- Spot Image (delivery of Ref3D),
- Dian Zlatev Ltd. (measurement and delivery of GCPs).

It was the first time when such dedicated partnership between the major satellite image providers in the world has been established. The purpose was through direct cooperation between parties fast delivery of high quality product to be achieved.

The pre-processing and the orthorectification were done by ASDE and its expert group from the Remote Sensing Application Center - ReSAC.

1.2. Project tasks

The total budget of the project was €1M with an overall project aim to deliver the following:

- Orthoimage map for 32,985 sq.km. (finally 33,364 sq.km.were delivered) for the Southern part of Bulgaria;
- 2,600 Orthoimage tiles according to the 4x4 km grid of the aerophoto grid
- Digital Elevation Model – Reference 3D for 34,000 sq.km.;
- Quality Check and Metadata Reports for the Orthoimages and DEM;
- Final Report describing the work done.

After an initial kick-off meeting between the consortium partners the following subtasks were identified, to be completed in the respective time schedule in order to prepare the main deliverables within the terms of the project:

- Choice of the satellite images from the distributors archives based on the Contract specifications;
- Delivery of the raw images;
- Delivery of the DEM;
- Determination of the GCP/CP location, number and distribution on the raw images on the base of JRC recommendations;
- Conducting DGPS measurements necessary for orthorectification and QC of the processed images;
- Orthorectification of the delivered images;
- Image enhancement and preparation in format suitable for delivery to MAF;
- Tiling of the Orthoimage map on predefined grid (4x4 km) compatible with the aerophoto grid;
- QC Reports preparation for the orthoimages and DEM based on the JRC recommendations;
- Delivery of the orthoimages, DEM and QC reports to MAF.

All this processes had to be very detailed and precisely managed, because any delay of some of the processes could have caused a delay of the whole project. The short timeframe of the project and the big number of the images which had to be processed (185 images from Ikonos and QuickBird) put the need of use of different and innovative approaches – such as use of long strips, RPC or Bundle Block Adjustment based on the type of satellite and relief, etc.

1.3. Study site

The territory subject of the project was determined by the MAF. It contains the area of 11 NUTS3 regions in the southern part of Bulgaria with a total area of 48,633 sq.km (Figure 1).

The archive Ikonos and QuickBird images selected covered a territory of 33,364 sq.km., or approximately 30% of the country. In this area all type of landscapes and terrain variations found all over Bulgaria were present. Therefore, the imageries contained Black Sea coastal areas as well as abrupt mountain regions such as Pirin Mountain, which includes peaks with average of 2,500 meters height a.s.l., which is only about 400m lower than the highest peak of the Balkan Peninsula, peak Musala, at 2,925 meters in Rila Mountain, again in Bulgaria.

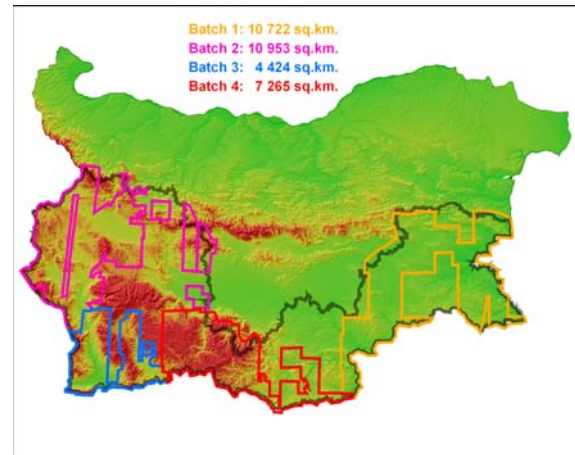


Figure 1. Location of the study area with the VHR coverage separated in 4 batches.

1.4. Satellite imagery used

LPIS creation requires satellite imagery with very high resolution (VHR) as to provide high cartographic detail for accurate delineation of parcels in farmers' declarations. Accordingly the satellite orthoimages originate from Ikonos and QuickBird sensors. Ikonos can provide at best in colour a spatial detail of 1m and QuickBird – 0.7m. This is achieved by fusing the better spectral and spatial resolutions respectively of the multispectral and the panchromatic imageries in a pansharpened product. Finally the result is 4-band imagery with the spatial detail of the panchromatic channel of Ikonos (1m) or QuickBird (0.7m).

IKONOS was ordered as a Geo Ortho Kit product – a 1m panchromatic band plus 4m multispectral bands (Red, Green, Blue, and Near Infrared) in a "Bundle", while QuickBird was ordered as Standard Ortho-Ready Pan-sharpened product – 4 bands (Red, Green, Blue, and Near Infrared).

The imagery was delivered in four batches. Some of them were delivered as single scenes, others – as long strips (see Table 3), all accompanied by Rational Polynomial Coefficients (RPC files for Ikonos and RPB for QuickBird) for rational functions modelling. Although RPC files allow for good georeferencing in absence of adequate GCPs, adding ground control in the model can greatly improve the final ortho results to as accurate as a product of rigorous geometric modelling (Robertson, 2003).

Instrument	QuickBird	Ikonos
Acquisition		
Product	Archive imageries	
Date Period	1 March ÷ 30 Nov.	
Year Period	2003 ÷ 2005	
Image Quality	Good radiometry and visibility	
Product Type	Standard Ortho Ready (OR)	Geo Ortho Kit
Option	Pansharpened	Bundle
Spatial Resolution	0.7m Pan-Sharpended	1.0m
Off-Nadir	≤30°	
Colour Depth	16 bits	
Cloud Cover	≤25%	

Table 1. General characteristics of imageries acquired for the Bulgarian LPIS

The location and overlap of the whole satellite dataset is given in Figure 1.

1.5. DEM used

In order to produce a refined georeferenced product through the process of orthorectification a Digital Elevation Model (DEM) was utilised. It ascertains that the distortions caused by the terrain are removed, making the scale constant across the image regardless of the changes in elevation. The DEM used in this study was the first information layer of the product of Spot Image – Reference3D – acquired by the SPOT-5 HRS instrument. For the latitude of Bulgaria this layer has a spatial resolution of about 25m. The absolute elevation accuracy of Reference3D is 10 metres with confidence of 90% for a slope less than 20 degrees, while the planimetric accuracy is as good as 15 metres. The practice shows that Reference3D even exceeds its specifications, therefore being rather suitable for orthorectification of VHR satellite imageries. The Spot Image product contains two more types of information – one is a panchromatic orthoimagery for quick orientation from the HRS sensor with a spatial resolution of 5 meters, for the latitude of Bulgaria, and a third information layer with quality and traceability metadata for the DEM and orthoimage generation.

1.6. DGPS measurements used

According to the "Guidelines for Best Practice and Quality Checking of Ortho Imagery" (JRC, 2006), GCPs should be three times more precise than the target specification, e.g. in the case of a target 2.5m RMSE, as required by the LPIS ortho data, the GCPs should have a specification of 0.8m RMSE or better. Therefore, the GCPs were measured on the field with survey-precision Differential GPS receivers. The system used was a Topcon kit, which comprised of two wireless integrated GPS receivers – base (LEGACY-E GGD BASE SYSTEM) and rover (HiPer+) – and antenna for better communication (PG-A1).

Three teams of 2 persons acquired a total number of about 1500 GPS measurements for a period of 1 ½ – 2 ½ weeks per batch (depending on the terrain). The average accuracy was about 2cm in the plain and 4.5cm in height. To see more specifically the accuracy of the measurement per batch delivery and direction, see Table 2 below:

Batch No.	Number of GPS measurements	Accuracy X (m)	Accuracy Y (m)	Accuracy Z (m)
1	563	0.019	0.016	0.030
2	476	0.017	0.015	0.027
3	151	0.013	0.010	0.029
4	296	0.048	0.035	0.094

Table 2. Accuracy of the DGPS measurements

2. METHODS

2.1. Software

Within the project the following software was used for the image processing and quality check of the images and DEM:

- 1 license of ArcInfo Workstation V9.1 and 3 licenses of ArcView V9.1;
- 1 license for ERDAS Imagine Professional V9.0 and 2 licenses for ERDAS Imagine Advantage V9.0;
- 1 license for PCI Geomatica V10.0 with OrthoEngine.

ArcGIS software was used for the preparation of the distribution of the DGPS measurements, QC files, shape files for tiling the orthoimage map and all other vector data needed. ERDAS Imagine software was used for the image import, decreasing of pixel depth, single scene orthorectification using RPC model for Ikonos and QuickBird, image enhancement, mosaicking and tiling and final export of the images to format requested from MAF. A custom module was developed in ERDAS by ReSAC to speed up the workflow, to minimize the user input errors and to standardise the work done by the operators.

PCI Geomatica was used for pansharping of Ikonos data and for the orthorectification of QuickBird data using Bundle Block Adjustment (BBA).

3. PROJECT RESULTS

3.1. Digital Orthoimage map

In the frame of the project, almost all Ikonos images were ordered as large strips – not single scenes. QuickBird images for the plain areas were ordered also on strip (not larger than two standard scenes). Orthorectification of strips rely from one side on the accuracy of the RPC of the satellite and from the other side on the accuracy of the DEM used.

In order to get best results in the orthorectification for the two different models for orthorectification, different software packages were used: ERDAS Imagine V9.0 for the RPC approach, and PCI Geomatica V10.0 for the Bundle Block Adjustment. In both applications the Reference3D was easily integrated and the data were used without any additional pre-processing which assures the utilisation of its maximal accuracy.

At least 4 GCPs were used for images up to 200 sq.km. and 2 more were added for additional 100 sq.km. For example for the large Ikonos strips (some of which 50-55 km. long) the number of GCPs was 10-12. For QuickBird images which were orthorectified using BBA at least 7-8 GCPs for single scene were selected, because BBA was used for the images which covered mountainous areas where more GCPs were needed. At least 10 check points (CPs) were measured for each scene for the control of the RPC orthorectified products. For the scenes which were orthorectified using the BBA at least 5 CPs were measured. The tables below show the accuracy of the orthorectification – in general the RMSE2D accuracy of the orthorectified products meet the specification of 2.5 m RMSE2D.

Batch No.	Number of Quickbird/Ikonos scenes/strips			
	Quickbird Single scene	Strip	Ikonos Single scene	Strip
1	22	11	10	16
2	30	5	5	14
3	0	2	2	21
4	38	0	7	2

Table 3. Number of orthorectified VHR scenes/strips

Batch No.	Number of Quickbird/Ikonos scenes/strips			
	Quickbird		Ikonos	
	RPC (ERDAS)	BBA (PCI)	RPC (ERDAS)	BBA (PCI)
1	33	0	26	0
2	4	31	19	0
3	2	0	23	0
4	0	38	9	0

Table 4. Number of VHR scenes/strips orthorectified by the two methods – RPC in ERDAS and Block Adjustment in PCI Geomatica



Figure 2. Mosaic of the orthorectified images.

The final orthoimages were delivered in natural colour composite (3 channels – Red, Green, Blue, Fig. 2) with 0.7 or 1m spatial resolution depending on the sensor (IKONOS or QuickBird). The total average accuracy requested from the MAF was RMSE1D ≤ 2.5 meters. The images were colour balanced with Linear Stretch, Standard Deviation or Custom Breakpoint as appropriate per scene. They were supplied in GeoTIFF format with dynamic range of 8 bits on a DVD or CD media. The reference projection was UTM WGS84 Zone 35 or BNCs 1970 as required.

Batch No.	RMSE _{2D} [m]
1	1.61
2	1.6
3	0.99
4	1.54

Table 5. Achieved orthorectification accuracy.

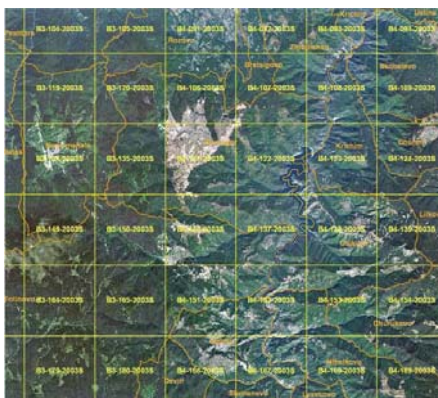


Figure 3. 2,600 orthoimage tiles 4x4 km were delivered compatible with the aerophoto grid.

3.2. Reference3D product

One of the bottlenecks for extensive use of satellite data in Bulgaria was the lack of precise enough DEM. Although the territory of Bulgaria is covered with topographic maps starting from scale 1:5,000, the available DEM with national coverage in digital format (created in the Military Topographic Service) is in scale 1:50,000. Some recent studies made by ReSAC with the support of JRC, showed that this dataset could not fulfill the requirement for the orthorectification of VHR satellite suitable for the LPIS (the RMSEz based on independent GPS measurements is around 7m). Another study showed also that with this DEM the accuracy of the ortho image could not meet the 2.5m RMSE1D.

In 2005 ReSAC completed a Pilot Project on Preparation of the LPIS for Bulgaria, on the base of test area of Assenovgrad using VHR satellite data. The project was commissioned by MAF and supported by JRC. In the frame of this project Reference 3D was tested for the orthorectification of QuickBird data for semi-mountainous area (elevation ranges between 178 to 1571m.). The results showed that only Reference 3D product meet all the requirements - < 5 m. RMSEz and the accuracy of the resulting ortho image < 2.5 m RMSE1D.

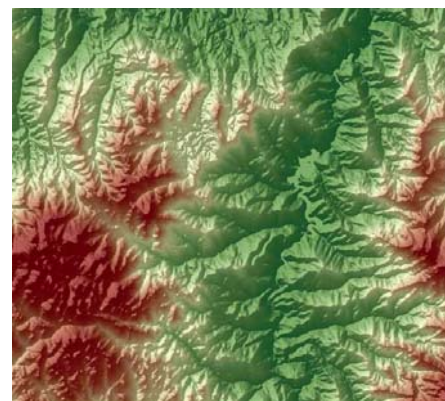


Figure 4. Painted relief of the Reference 3D product.

Within the frame of the current project the Reference 3D product showed very good accuracy (based on ~1500 CPs) and the RMSEz for all of the batches was ≤ 5 m (with an average value of 3.86m) (Table 6).

Batch No.	Number of CPs	Acc.y Z of CP(m)	RMSEz of the DEM (m)	Zmin – Zmax of the CP (m)
1	563	0.030	2.52	37 - 841
2	476	0.027	3.68	228 - 1960
3	151	0.029	4.22	120 - 1405
4	296	0.094	5.00	196 - 2006

Table 6. Accuracy of the Reference3D DEM tested with the DGPS measurements.

Reference3D was delivered on a DVD media in GeoTIFF format. The DEM was supplied in three different projections - Geographic Lat Lon / UTM WGS84 Zone 35, BNCs 1970 with a pixel cell of about 25m



Figure 5. Panchromatic orthoimagery from the HRS sensor with a spatial resolution of 5 meters, part of the Reference 3D product.

3.3. QC and metadata reports

Quality Checking (QC) was done in all stages of the project for all of the intermediate and final products. The QC procedures were based on the JRC/EC recommendations to be compatible with these used in the CAP.

QC done during the project could be summarized in three major subdivisions:

- QC of the products during the project: which includes QC of the raw images, DEM, measured GPS points, orthorectified images; delivery to the MAF
- Internal QC reports: which include QC reports on the raw and ortho images, DEM and GPS measurements;
- QC reports delivered to MAF: two main QC reports for Data for the control of the quality of the raw and orthorectified satellite images, and Data for the control of the quality of the Digital Elevation Model

The final QC reports delivered to MAF contained also all the necessary metadata for the raw and orthorectified images as well as for the DEM datasets. They were prepared for each single scene/strip and present the following detailed information:

- Containing info for the raw and orthoimage – all important parameters;
- Number, distribution, photos of GCPs and CPs on the ground and on the satellite image;
- Accuracy of the ortho image;
- Final format for delivery.

4. CONCLUSIONS

The Project is unique based on its goals, tasks and terms. With this available dataset, the Ministry of Agriculture and Forestry was able to start the block creations and to catch up on the plan of the LPIS creation – one of the most important projects for Bulgaria on her way towards EU accession.

The project is one of the few cases where the European satellite distributors are working together on a consortium base. The project was subsequently accomplished within a very narrow time frame and with a competitive budget for such projects.

From a technical aspect, the project demonstrated the use of several datasets and techniques for the first time for the LPIS database generation: SPOT Reference 3D product for the purposes of orthorectification, the use of large strips (up to 55 km) from Ikonos and strip based orthorectification of QuickBird (not more than 2 standard scenes for the plain areas). It is one of only a few projects where such a large area is covered with orthoimage map from images from different dates and seasons.

With the accomplishment of the project, Bulgaria joins the countries with a proven high-tech and scientifically-applicable capacity in the processing and use of satellite images for the purposes of agriculture, environmental issues, monitoring of natural disasters and emergencies as well as security.

5. REFERENCES AND SELECTED BIBLIOGRAPHY

Robertson, B.C., Rigorous geometric modeling and correction of QuickBird imagery. Geoscience and Remote Sensing Symposium, 2003. IGARSS apos;03. Proceedings. 2003 IEEE International. Volume 2, Issue , 21-25 July 2003, pp 797 - 802 vol.2

JRC IPSC, 2005, Guidelines for Best Practice and Quality Checking of Ortho Imagery, First issued: Ispra, 20th November 2003, JRC IPSC/G03/P/SKA/ska D(2003)(2402)

Session 4: IACS: sharing data online

STATUS OF THE IMPLEMENTATION OF LPIS IN THE EU MEMBER STATES

P. Milenov¹ S. Kay¹,

European Commission DG-JRC, IPSC, Agriculture and Fisheries Unit, TP266, I-21020 Ispra (VA), Italy
<http://agrifish.jrc.it/>, simon.kay@jrc.it, pavel.milenov@jrc.it

KEY WORDS: LPIS, reference parcel, rule 75/90%, orthophoto, OTSC

ABSTRACT:

In order to better assist the EU Member States in the proper updating of IACS-GIS, the MARS-PAC action of JRC has collected systematic up-to-date information on the status of the implementation of LPIS from the MS Administrations. This includes information on the orthophoto (orthoimage) coverage at national level; the definition of the reference parcel; the workflow established for the LPIS update; tolerances introduced; actors involved, statistics provided, etc. To be able to define the appropriate measures and recommendations, the information collected should be organized in a certain way, enabling comparative analysis and review. Recently the MARS-PAC team elaborated a study on the status of the LPIS implementation in the EU MS, based on preliminary defined questionnaire and extensive data collection.

1. INTRODUCTION

1.1. Study aim

The purpose of the study was to make a short analysis of the data collected from the Administrations of the EU Member States on their strategy, methodological approach and organization of the workflow for the update of the Land Parcel Identification System. Attention is given also to some specific topics as the update of orthoimagery, block boundaries updating and application of rule 75&90% (Commission Regulation 796/04, Art 6.2)

Apart from the general information requested, the aim of this inquiry was also to put a focus on some pending questions among the EU Member States as:

- Is the sample a good way to evaluate the LPIS for Art. 6 (2) of Commission Regulation 796 / 2004?
- Is the risk analysis for the OTS a good approach to derive the sample?
- To what extent could the random selection of dossiers to check and the results obtained from this control be used as input to evaluate the quality of the LPIS, regarding Art. 6 (2)?
- Is it feasible to do a 100% check on eligibility? Or, is using the surrogate of “claimed” land good enough? If yes, could we use directly the results from OTS to evaluate LPIS for Art. 6 (2)?
- Is Art 6 (2) a good or useful management tool for the Member States? Or is there a need to update the regulation?

- Is the LPIS primary a supporting tool for the IACS and other domains? Has the LPIS become in fact a “Land Management Information System”? How many countries have this approach?
- At what extent is Art.6 (2) compliant with the latest developments of the CAP reform?

1.2. Data Sources

There is an extensive data pool available in MARS-PAC, where various information on the IACS-GIS development in EU MS is available. This data is collected during different technical missions, workshops, pilot studies and communications with the EU MS administrations. However it was decided that a new and systematic inquiry among the MS will provide better-structured and homogeneous up-to-date information on status of the LPIS in all EU member states.

One of the challenging tasks was the identification of the appropriate operational body and contact person(s) in the MS Administration, to approach for the inquiry. In the case of some MS, different persons in different organizations have been identified to answer on specific part of the inquiry. Due to the short timeframe, the direct contacts were (in most of the cases) limited to the high-level managing persons, who were helpful to take the task of collecting and providing the necessary information from their organizations.

For that reason, there are still some points remaining to be clarified on more detailed technical level, which could be discussed directly with the technical experts and staff.

2. METHODOLOGY

2.1. Collection Methods Used

In order to facilitate the collection of the information, the inquiry was organized as a questionnaire with a limited set of focussed and well-defined questions. Taking into account that the inquiry had to be made in one of the busiest period for the administration, linked to the processing of aid declarations, the questionnaire had to be kept simple and easy to fill. It was developed and posted on the Web, with additional possibility to be filled online. This saved time and effort for both sides, regarding e-mail communication and data processing.

The questionnaire was divided in two sections – general information of LPIS and topics specific to the LPIS update and the methods estimating its currency. Part of the questions had a list of possible answers; for others, more than one answer could be provided. The aim was to define the questions in a way to provide clear and unambiguous feedback on the issues identified for evaluation.

The internal JRC document, regarding the status of the orthophoto coverage and the future plans of the EU MS regarding was redesigned (especially the section for the Web LPIS) and sent to the MS Administration for update. Some new fields/parameters, related to the specifications of the orthophoto have been added.

2.2. Tools for analysis and visualization

The data retrieved from the questionnaire was exported in XLS format. Excel was used for the preparation of the statistics and the generation the charts. As some information had to be presented geographically, the alphanumeric data was geocoded (linked) to the country polygons, used as reference geographical objects. The ArcView GIS was used for the geographical representation. The same tools were used for the updated data on the orthophoto and the Web LPIS.

2.3. Accuracy and Reliability of the results

The following factors have (in a different degree) impact on the accuracy of the data provided and the final interpretation of the results:

- The collection methods and tools were not rigorous enough to avoid the users of making typing mistakes in the questionnaire or in the table for the status of orthophoto
- Some questions were not precise enough to ensure that the answers will be unambiguous. Probably, they had to be accompanied with some additional description or glossary.
- In some cases the technical expertise of the contacted persons was not enough to provide clear and correct answers on some of the questions
- In few cases, the contact persons identified, were not the most appropriate to provide answer to some specific set of questions.

For that reason, additional discussions and clarifications were made with some MS on the dataset collected, especially after the presentation of the first results of the study during the LPIS workshop in October 2006. Also part of the data provided in the questionnaire was validated against the existing information in MARS-PAC (previous reports and workshops).

Another important point was that part of the data requested was missing, because either it is not collected by the appropriate MS or was not available at the moment.

Due to the factors mentioned above, the interpretation of some data was difficult, without further discussion of some organizational/technical details with the MS Administration. Thus, this study put its focus to describe the overall picture of the status of the LPIS and to present the general trends for the future strategies, without trying to go deeper in the complexity of this matter.

3. RESULTS FROM THE STUDY

3.1. General comments

At the time of the data collection, Bulgaria and Romania were not yet members of the EU, so they were not included in the list of countries, asking to fill the questionnaire. However, at later stage, information on the final orthophoto coverage and the LPIS completion were retrieved and they were included in the statistics (fully presented for the orthophoto and partially for the LPIS).

The German administration kindly provided separate information for some Landers (Bavaria and Baden-Wurtemberg). The UK also kindly sent separate information sheets for Paying Agencies in England, Wales, Scotland and Northern Ireland. In order to keep the reference scale on Member State level, this additional information is only partly presented in this article.

3.1.1. Legislative framework and institutions responsible

The EC defines clearly the legal framework of the IACS-GIS in several Council and Commission regulations. However many MS have decided to set their own legal base (compliant with the EC regulations) in order to define better the responsibilities of the governmental institutions and their interaction with the farmers. For example in Czech Republic, the local regulation clearly describes the obligation of the farmers, regarding their role in the annual update of the LPIS.

It is interesting that all new MS from the last two enlargements (2004 and 2007) have implemented their own national legal framework on the LPIS. From the old 15 MS, the countries having their own legislation on the matter are: Italy, Spain, Germany, Luxemburg, Finland and Belgium (Flanders).

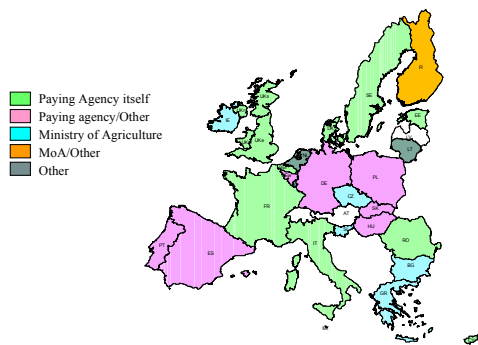


Figure.1. Institution responsible for the LPIS update in the EU MS

Usually the institution responsible in the MS for the LPIS is either the Paying Agency or the Ministry of Agriculture, but in some cases the technical tasks for the LPIS management and update are delegated to different body inside the government (FOMI in Hungary) or are outsourced to a private company (in Finland and Lithuania). In those MS, where the reference parcel is the cadastral one (as Poland or some German Landers), the regional geodetic services are also involved in the update of the LPIS.

3.1.2. Reference parcel defined

The most commonly used reference parcel in the EU MS is the “physical block” (including BG and RO). It is the most generalised reference object to be used, but it is rather stable in time and simpler regarding the update. MS used also the agriculture parcel or the farmer block (in equal proportions) as reference parcels. Their choice might be more appropriate, from the point of view of facilitating the administrative cross-check, but it is more complex and time consuming regarding the LPIS update. Those MS, which set their LPIS on the base of the cadastre, use the cadastral parcels as reference ones (Poland, Spain, Italy and some Landers in Germany).

The choice of the reference parcel depends mainly on the historical development of the land management in the country and the usual farmer practices. In other hand, this choice is crucial for the development of the IACS and the organization of the control. It is also linked to the way the LPIS was initially created. The LPIS based on the cadastre, have specific problems due to the different philosophy of the cadastral parcel (based on ownership) comparing to the other LPIS reference parcels (based on land use).

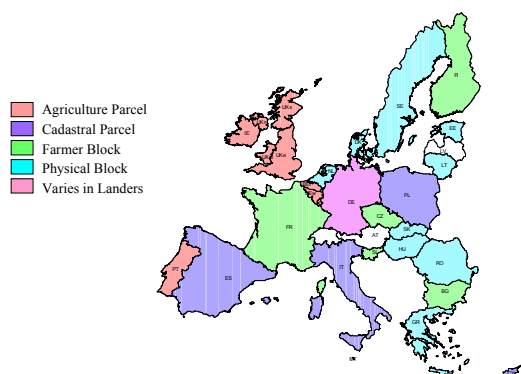


Figure 2. Type of reference parcel on which the LPIS is based in EU MS

3.1.3. Initial creation of the LPIS

It was not surprising that almost all the MS relied on the existing or new orthophoto coverage to create the reference parcels. It was done mainly by computer – assisted photointerpretation (CAPI) or through a contact with the farmers, who assisted by an operator, delineate on screen or printed copy the blocks they are cultivating. In some countries (CZ, Flanders, Germany and Bulgaria) additional field measurement have been taken to validate the parcels delineated by the operators or farmers.

Some countries, like Italy, UK, Spain, Denmark and Poland used also other datasets for the creation of the LPIS as: cadastral maps, land redistribution plans, topomaps. In all cases when such data is used as a basic layer to derive the reference parcels, a follow-up validation and checking is performed with archive or new orthoimages. The only exception is UK, where the Administration announced that the Ordnance Survey maps used are correct enough and the use of orthophoto is not necessary. The method for creation of the LPIS in Germany varies from Lander to Lander.

In a few MS, archive or new VHR satellite data was extensively used for the creation of LPIS as a backup of the aerial orthophoto, delayed for various reasons (GR, PL, CY, RO and BG). The use of VHR data is considered very appropriate to cover border or other areas where flight restrictions are applied.

3.1.4. Use and dissemination of LPIS data

It became evident recently that the LPIS data is no more strictly dedicated to support the aid declaration and subsequent control. In fact the information stored in the LPIS is already broadly used by other external users. This is because, the reference parcels, together with the orthophotos and the attribute information on the land use, form the basic set of components, necessary for any decision regarding the land management. In addition, apart from the reference parcels themselves, the LPIS database contains other layers of information (or at least is able to overlay them on-the-fly), which together could be made broadly available through simple Web interface. Only 5 MS out of 27 (IT, NL, IE, Flanders and DE) do not provide LPIS data to external organizations or users.

3.1.5. Data used and methods applied for LPIS update

Nearly all MS use the regularly updated part of the orthoimage coverage (mainly through aerial flights) as a basic source for the update of the LPIS. The only exceptions were Greece and UK, which at the time of the inquiry didn't declare the use of orthophoto for the LPIS update. However, the recently launched tender in Greece for new orthophoto coverage of the country (both aerial and VHR), points out the intentions of the Greek administration to benefit from this data source for the revision of the reference parcels.

The results of the OTSC are also a very important source of information for the update of the LPIS. The on-the-spot checks are very convenient updating mechanism as they are running every year and are ensured from the point of view of budget and personnel by the appropriate paying agencies. Another important point is the fact that the OTSC doesn't provide only recent information on certain set of parcels, selected for control, but through the results of the findings, could also indicate potential problems or trends in the development of the LPIS. The results of the OTSC could be used even more efficient, if the risk analysis to define the control sample takes into account the areas where the LPIS should be updated.

The information from the updated orthocoverage is not sufficient itself for the actualization of the LPIS, without a proper interpretation of the land cover/land use. It could be done by CAPI in the office (in case of physical blocks), but in most of the cases the information provided by the farmer is more accurate and significant. For that reason, most of the MS use the interaction with the farmers during the preparation of the aid declaration or regularly during the year to obtain this vital information. For example, in CZ the farmer are obliged to report in the LPIS any change of parcel or land use in due time.

In those countries, where the reference parcel is based on the cadastral one, the recent data on land consolidation and change of property is providing additional input to the process of LPIS update.

The systematic execution of field checks (apart of the OTSC), although used by some MS, is not considered a primary method for LPIS update, due to its complexity and the need of allocating huge administrative and technical resources. Some MS are using it as support to the other tools they are using or as quality control of the CAPI of the newly provided orthophoto coverage.

3.1.6. Assessment of the currency of the reference parcels

A clear analysis of this topic at this stage is very difficult mainly due to the complex interpretation of the results from the

questionnaire. A deeper examination of the cross links and correlations between the assessment of the currency of the LPIS, the actual process of update and the definition of the reference parcel is necessary. More some answers received were not clear enough, or even contradictory.

For example, several MS stated that one of the methods they are using to assess the currency of the reference parcels is based on the summary information from the regular field check. This is not corresponding to their answers on the previous question, regarding the tools used for LPIS update, where the conduction of systematic field checks is missing. Obviously these MS put different meaning on the term “field checks”, comparing to definition in the questionnaire. An example of possible confusion of the terminology used, could be the terms “risk analysis” and “random sample”, which in the questionnaire are referring to the sample used to evaluate the currency of the LPIS parcels and not to the sample declarations to control.

Nonetheless, the general impression is that most of the MS are estimating the currency of the reference parcels, using all possible data sources and activities during the year with a predominance of the systematic analysis of the new orthophotos and review of the results from the OTSC/administrative control. Regarding the use of recent orthocoverage, this evaluation is done on a selected part or on the whole set of reference parcels for which a new data is available and not on predefined statistically represented set on regional or national level.

Some MS (Ireland, Flanders, Wallonia and Cyprus) are using statistically representative set of parcels to evaluate the currency of the LPIS, based on risk analysis. A few (Finland, Greece and also Cyprus) are using a random sample. However, it was not clear from their answers, if the “risk analysis” and “random” samples differ from those prepared for the OTSC or are the same. More than 70% of the MS, assess the currency of the reference parcels by applying the rule 75/90% (Art. 6 (2) of Commission Regulation 796/2004). Most of them implement the rule on national level. DE and UK apply the rule on regional level (Landers, or Country Governments). PL declared to apply the rule on a selected geographical area (probably where the orthophotos are most recent). FI and GR noted both national and regional level, while IE points all three possibilities. Apparently this topic could be further investigated.

3.1.7. LPIS update and farmers’ declarations

Considering the importance of the data provided by the farmers for the update of the LPIS, it was necessary to understand when this data is introduced in the system. In most of the MS, this action is conducted at the time of the preparation of the farmer application.

However, many MS have opened also the option to the farmers to provide information on their parcels during the whole year. This data, if declared after certain deadline is considered valid for the next campaign.

Many MS provided additional comments and notes, regarding the information provided by the farmers for the LPIS update, from which is evident that the organization of the aid declarations and pre-registrations of the parcels is specific for each country. In Germany, each of the Bundesländer has to set up its own rules, depending on the type of reference system.

3.1.8. LPIS update and OTSC

Point (k) of Art. 27 (2) of R. 796/04 gives a list of “other factors defined by the MS”, which could be included in the risk analysis for the selection of dossiers to control. The ones most relevant to the update of the LPIS are as follows:

- Area claimed is less than 90% of the gross LPIS reference
- No control for previous 4 years is made
- Claiming Set-aside and not inspected in the last three years
- Land under permanent pasture

The control of some GAECs is also related to some specific land features recorded in the LPIS (single trees, hedges, wall, monuments, etc.). Even limited to only 1% of the claims, this control could provide some important indications of the currency of certain part of the LPIS.

Only 4 MS (EE, IE, PL and LU in future) declared that in the risk analysis for OTSC, they consider the areas where LPIS needs to be updated. This is not surprising, taking into account that the most important factors in the selection of the dossiers to control are linked with the amount of aid and the size of the farm. Many countries also didn’t provide any input on that issue, which brings the need to discuss this topic more in detail at later stage.

3.2. Role of the Orthoimagery

3.2.1. The orthoimagery in the EU MS, sensors used

All the inquired MS provided updated information on the status of the orthoimagery. From the data received, it became evident that all countries are using orthoimagery except UK, which administration is declaring that no orthophotos are used either for the LPIS or for the control. Although that no official communication was made with Austria, Malta and Latvia, MARS-PAC has information from other sources that these countries are using orthophotos as well.

The orthoimages in the MS varies from the point of view of resolution, origin, scale, radiometry and coverage. This is probably due to the multipurpose character of this dataset, dedicated to be used for various needs with specific requirements. The observed heterogeneity of the orthocoverage among the MS, from the point of view of the specifications, is due also to other reasons like: different institutions responsible, historical development, economic and security issues, etc.

The main source for the production of nation-wide orthoimagery remains the aerial acquisition. Some MS opened already the option for the use of aerial digital cameras (frame or pushbroom). Although the digital technology provides better quality in terms of radiometry and detail, there are some specific limitations, regarding the height of the flight and the processing chain. Also some MS still face difficulties in applying declassification of the raw digital data, as the relevant military authorities in the country requested.

Some MS (IT, DE, PL, BG, Flanders and Greece) are using also VHR satellite data together with the aerial orthophotos for part of their countries. Due to flight restrictions, CY is using VHR satellite data only for the LPIS preparation. IE has in addition to the aerial, a complete VHR coverage from 2006.

3.2.2. Resolution and radiometry

The minimum scale for the cartographic information used to create and update the LPIS is 1: 10 000, which corresponds to an orthoimagery of at least 1 meter resolution. However, most of the orthoimages used in the LPIS are with ground sampling distance (GSD) of 50 cm. Half of the MS have orthophotos with GSD in the range of 40 – 60 cm. Germany has orthoimages with broad range of resolution – from 25 cm to 1 meter, as each Lander has its own strategy for the orthoimage production. Poland has the same range of resolution, caused by the fact that the country coverage was made in the frame of several projects with different specifications. Sweden and Ireland have an orthophoto at the largest possible pixel of 1 meter, while Italy decided to be on 80 cm. Spain and Slovenia have orthophotos with resolution below 50 cm with a lower limit of 25 cm.

More than 50% of the EU MS have complete coverage of colour orthoimages. Some of them (SI, CY and Wallonia) have also parts containing infrared channel (IR). Two MS (Sweden and Greece) have only black and white orthophotos, but they both have recent plans to migrate to colour. 25% of the MS have mixed set of colour and B&W orthophotos. Finland has predominantly IR with some smaller parts of natural colour and B&W. They also started recently to update their coverage.

BG and RO also completed their orthoimage coverage recently (aerial, 50 cm, colour). The Bulgarian authorities ordered in addition last year VHR satellite data (IKONOS and Quickbird) on a territory of 33 000 km² to backup the delays in the orthophoto production. They still currently use this VHR dataset. RO will use VHR for some small gaps in the orthophoto (0.2-0.7 % of the country).

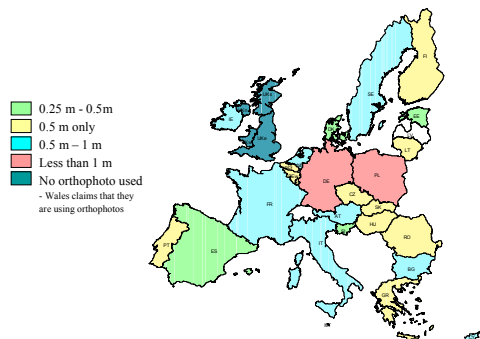


Figure 3. Ground sampling distance of the orthophoto used in the EU MS

3.2.3. Period of production and coverage

In general the orthophotos used for the LPIS should not be more than 5 years old. As their production is time consuming task, from the point of view of organization, implementation and budget, the creation of orthoimage coverage at national scale required usually several years (especially for large countries). 60% of the MS have orthoimagery elaborated in the period 2002 – 2006. However some MS (HU, NL, BG, LT and PT) have managed to create/update their orthophotos in a short timeframe of 1 or 2 years. There are also cases of MS with quite outdated parts of the orthoimagery, as SE, IT and GR, having some orthophotos from the late 90s. SI, NL and Flanders have the most recent complete coverage orthophotos, made in 2006.

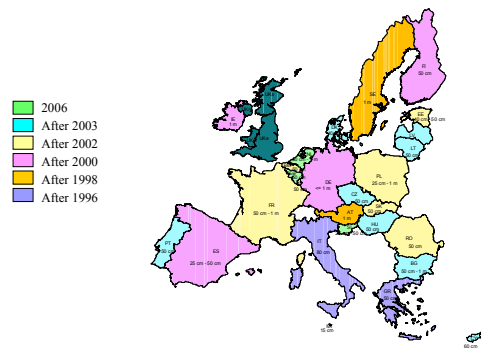


Figure 4. Year of production of the orthophoto used in the EU MS

3.2.4. Plans and strategies for the orthoimage update, potential constraints

The planning of the MS for the future update of the orthoimagery is in compliance with the LPIS requirements. Considering that an annual update of 20-30% of the country is feasible from the technical, financial and organizational point of view, most of the MS have plans to update the entire orthophoto coverage in 3 to 5 years. NL, IE and DK have more ambitious programs to cover their territories with new orthophotos in 2 years. GR and LU claimed that they will have new coverage in 2007. In Germany the strategies varies in the different Landers (with an existing orthoimagery from 2001 – 2006).

Although all MS have straightforward strategy for the updating of the orthoimage coverage, there are some issues which could put constraints on the smooth updating process. Many MS have still complicated flight clearance procedures (imposed by the relevant military authorities). These administrative requirements create complications also for the tendering process and the preparation of the technical specifications. Another problem is that in many countries, the Ministry of Agriculture or the Paying agency are not entitled to handle the process of orthophoto update, but this task is at the responsibility of other authorities, like the Cadastre Agency (the case in RO). These institutions might have their own approach and planning, sometimes not coherent with the strategy for the LPIS update.

Some MS provided additional information, regarding their plans for orthophoto update. IT has an objective to increase the resolution of the orthophoto to 50 cm. PT plans to use the VHR satellite data from the CwRS campaign to update the orthoimagery.

3.3. The Web LPIS

3.3.1. LPIS available through the Web

Even if the LPIS is considered only a tool to support the IACS, the data needs to be available to a relatively large user community (farmers, agriculture associations, governmental institutions). The easiest way to provide the LPS dataset is through Web-enabled services. 20 MS have already built such Web systems.

Most the Web LPIS are restricted to farmers and the administration. Some of the restricted Web LPIS are available also to other “non-CAP related” institutions in the government. Only 6 MS (FR, EE, LV, ES, SI and SK) have Web-enable systems opened to public access. In DE, some Landers have public available Web LPIS, while some other have it restricted.

In BE (Wallonia and Flanders), the Web LPIS is under development and will be operational in 2007-2008, restricted only to farmers. LT implemented in 2006 a Web LPIS in a pilot stage. GR plans to provide LPIS data through internet in future (together with online claims).

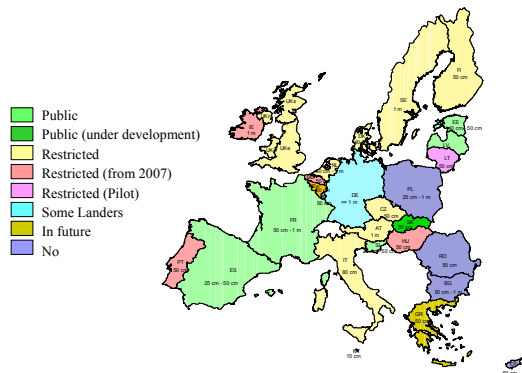


Figure 5. Web LPIS – Web Sites Available in the EU MS

3.3.2. Online claims

There is already a significant number of MS (DK, FR, IT, NL, SE, ES, SI and BE-Flanders) who made the next step toward better optimization of the aid declaration process by implementing online claims. This could show also a high degree of the development of the e-government, as all the legal and organizational base necessary for these electronic services have been adopted. HU, PT and IE will introduce online claims from 2007. SK and BE-Wallonia are still developing this option. In DE, some Landers like Baden-Württemberg and Bavaria have online claims enabled.

3.4. Additional Statistical Data

3.4.1. Introduction

A special section in the questionnaire was dedicated to some statistical data from the 2005 declaration campaign, which could be used to evaluate the currency of the reference parcels. It is probably the most interesting part of the study, but unfortunately most of the MS were not able to provide such statistics due to the fact that either they don't generate any summarized data or they were still preparing it at the time of the inquiry.

The information received from some of the MS is very interesting, but sometimes not very clear or contradictory. This was probably because it was not possible to provide correct figures without clarifying in advance the definition of eligibility, the impact of the reference parcel used and the statistical method applied by the particular MS. Further discussions with each country are needed in order to understand better the information provided.

In this respect, it is not possible yet to summarize the data and make some correct evaluation on EU level. However, some preliminary observations are given in the paragraphs below (presented separately for each type of reference parcel).

3.4.2. Results for LPIS based on physical block

All MS show a difference between the total area claimed inside the reference parcels and the total national summary of eligible

area. There is 10% to 30% of eligible area, which remains not claimed by the farmers. This could be mainly because a certain number of farmers have not participated in the campaign, but also might indicate that some reference parcels need to be updated. 10% to 35% of the physical blocks were fully claimed, while the reference parcels not claimed at all vary from 20% to 40%.

3.4.3. Results for LPIS based on farmer's block (ilot)

For this type of reference parcel, the data provided was quite sparse, however from the information available it could be concluded that the rate of the total area claimed inside the reference parcel, against the national summary of eligible area is much higher, comparing to the physical block system. This could be explained also with the different definition of the farmer block, than the physical one. The reference parcels fully claimed are more than 90% with very few parcels not claimed at all. In CZ, the area claimed is slightly more than national total, probably due to the fact that new farmers, not presented in the in the LPIS, have provided declarations during the campaign.

3.4.4. Results for LPIS based on agriculture parcel

Here, as the previous case, the rate of the total area claimed inside the reference parcel, against the national summary of eligible area is also high (about 90%). However the percentage of the reference parcel fully claimed is much lower for some MS. It is not possible to make clear assumptions on the reason for this observation, without further discussions with the MS administrations.

3.4.5. Results for LPIS based on cadastral parcel

Statistical information is provided for CY and PL. The cadastral parcels fully claimed in CY are 36%, while in PL they are 76%. It should be discussed with these MS, if these statistics are based on the total number of cadastral parcels or only on those containing some eligible land (more probable). Further analysis on the figures provided for the cadastral LPIS might bring more light to efficiency of using such reference parcels for the declaration process and control.

3.4.6. Results of Art 6 (2) testing for 2005

A number of EU MS have provided statistical data on the results of Art 6 (2) testing for 2005, regarding the respect of rule 75%/90%. All of them claimed to have fulfilled it on national, regional (DE, UK and BE) or selected area level (PL). The figures vary from 75% to 100% of the reference parcels having at least 90% eligible area.

There is no detailed information about the methods, the MS Administrations used to evaluate the 75%/90% rule. The only exception is FI, which described that the testing of the rule was made according ISO 2859 standard, part 2 "Sampling plans indexed by limiting quality (LQ) for isolated lot inspection".

3.4.7. Land cover and land use data in LPIS

The last point of the questionnaire was concerning the type of land cover / land use defined in the LPIS. Although this question is not directly linked to the strategy of the LPIS update, it might provide additional information on the content of the LPIS, as an important part of the National Spatial Data Infrastructure.

Most of the MS recorded the information of the land use in their LPIS. Some of them, like PL, CZ, SK, IE and DE, maintain quite

detailed information with various land use and crop classes defined. In most of the cases, the MS used similar nomenclature, however it will be interesting to further analyse if the definition or the meaning of the land cover/land use classes is the same in the different countries. This will be important, if the LPIS will be used as a base to generate a detailed land cover/land use database on EU level.

4. CONCLUSIONS

The aim of this study was to provide an overview of the status of the implementation of the LPIS in the EU MS with a focus on the currency of the reference parcels used. It should not be considered exhaustive and complete, but a dynamic document which will be revised and updated regularly with recent and more detailed information.

The data provided by the MS should be discussed and revised deeper in order to evaluate better how the strategies for the LPIS update in the MS are compliant with the EU regulations. Of course the opposite is also valid – some changes in the regulations might be recommended, taking into account the results obtained from the MS applying the existing rules and requirements.

A cross-correlation between the reference parcel and the applied methods of update should be performed. For this purpose, some additional questions should be asked to the MS.

The data given by the MS in the questionnaire is not yet enough to provide clear answers to the questions in point 1.2. However the following could be mentioned:

- The most common methods used by the MS to estimate the currency of the reference parcels are the results from the OTSC and the systematic checks based on new orthophotos, available usually over certain area of the country. Both are based on certain sample extraction from the whole database. The question, if this sample is unbiased and big enough to provide reliable statistical estimation of rule 75%/90%, still remains.
- Although, the results from the OTSC are broadly used to evaluate the currency of the LPIS, in very few cases the factors, related to the LPIS are included in the risk analysis. Is it then appropriate to use the results of the OTSC or should a separate sample be created based on specific LPIS-oriented risk analysis?
- If the rule 75%/90% aims to enable proper identification of the agriculture parcels using the reference parcels, and thus to facilitate the administrative cross-checks (with regards to the “over-declaration”), the results from the administrative cross-checks might be more relevant to estimate the compliance of the LPIS to the IACS procedures. As the administrative cross-checks comprise all applications, the statistics could be also more reliable, based on random sample from the total database. Some MS stated that they use the results from the administrative control, but it is not yet clear how they do it.
- The requirement to assess the Art 6 at MS level is not a very flexible tool for some countries. A stratified per region assessment might be more appropriate. Based on the statistical data from the declarations, the MS could try also to track geographically the reference parcels, which were under 90% utilised and thus focus the LPIS update on the worst areas.
- From the point of view of the administrative cross-checks (as a primary target of the LPIS), the check on the eligibility could be based on the claimed area only. It was evident from

the statistics, that there is a certain percentage of reference parcels (particularly valid for physical blocks or cadastral parcels) not claimed at all. However, the LPIS database is migrating already toward a multi-use and multi-purpose data pool. This might put additional requirements in favour to the estimation of the currency of the reference datasets, based on the total eligible area.

- In some MS, the LPIS is not more only a supporting tool for the IACS. It is becoming in fact a Land Management Information System, providing data to many domains. This probably will change the data model of the system itself, enabling the possibility to integrate other layers of information. This trend might be expected in all EU countries. It is already evident that the LPIS could be the basic source for NSDI in the EU, if proper tools for generalization and standardization on European level are created. All this, might require a revision on the way the accuracy and currency of the LPIS is evaluated.

5. REFERENCES AND SELECTED BIBLIOGRAPHY

Discussion document “*Implementation of IACS-GIS, Reg. 1782/03 and 796/2004*”, JRC IPSC/G03/P/SKA/skaD (2004)(2575)

Council Regulation 1782/03

Commission Regulation 796/04

Status of the orthoimage production and implementation of Web-LPIS in the EU Member States and Candidate Countries (up to Nov 2006), JRC IPSC/G03/P/PMI/pmi D(2007)(7140)

Results (raw data) from the LPIS questionnaire to the EU MS (Data updated up to Nov 2006, JRC IPSC/G03/P/PMI/pmi D(2007)(7152)

Reflection note on the 75%/90% rule

Milenov, P., Kay, S., *LPIS and ortho MS survey: analysis and review*, November 2006. (Accessible on line at http://agrifish.jrc.it/marspac/meetings/Toulouse2006/Parallel4/PMilenovSKay_LPIS75-90.pdf)

6. Acknowledgements

The authors would like to thank the Administrations of the EU MS for their kind support during the elaboration of this study.

IACS NEW GENERATION ARCHITECTURES

J. Garinet¹

¹CS – Communication & Systèmes – TOULOUSE, jean-yves.garinet@c-s.fr

KEY WORDS: IACS, LPIS , Interoperability, Light Client, N-Tier Architecture

ABSTRACT:

Existing IACS have been designed and deployed with old technologies: decentralized architectures, GIS functions weakly coupled with IACS kernel. The new technologies based on: High rate networks, GIS light clients, Open Source and Interoperability are now offering :

- a strong cost reduction in deployment and IACS exploitation
- bridges with other territorial data sources (Geo-portals)
- e-services components directly addressed to farmers

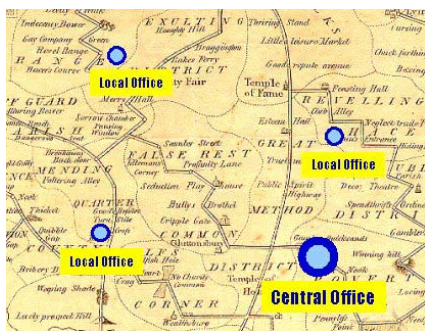
1. INTRODUCTION

1.1. Aim of the study

The aim of the study is to give some key architectural concepts for building or renovating existing IACS. It is not only technology-oriented but deal with data model and management problematic, especially concerning geographical data.

1.2. IACS/LPIS functional overview

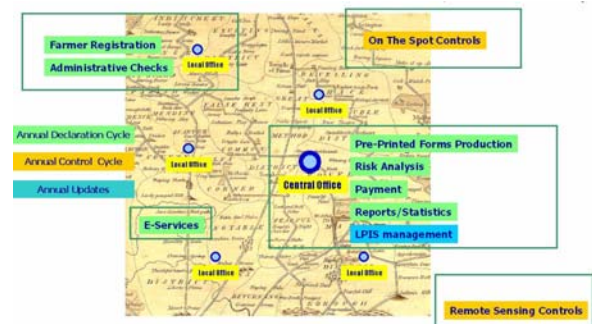
Any IT infrastructure is deployed for serving organisational, functional and processing objectives.



An IACS system is deployed on a regional or national scale with one Central Office and distributed Local Offices. Actors interacting with IACS/LPIS are :

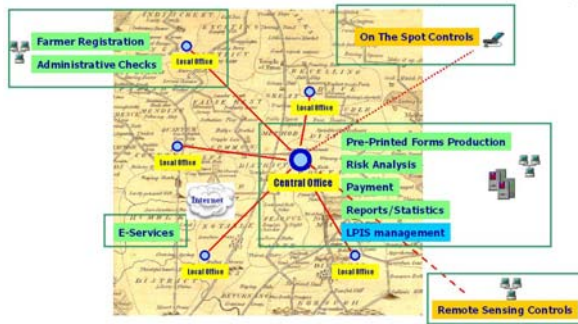
- Administrative agents in central and local offices
- Farmers with on-line capacities or not (paper)
- Control Unit agents (connected or nomad)
- External users (Control by Remote Sensing)

All these users, distributed on a generally wide territory (State or Region), need an access to the IACS and LPIS Information Systems.



The above scheme shows all the functional fields addressed by IACS/LPIS system. The activities of an IACS/LPIS system are structured around three cycle annual processes for declaration/checking/payment; control activities and LPIS management. We will discuss further about separation of LPIS and IACS according to the basis choice (block, ilot, parcel).

2. IT INFRASTRUCTURE



2.1. Network

Networking technology and associated costs allows the deployment of high-rate links between all administrative offices, local and central in an asymmetric way: the information flow from central to local is more important. The benefit of such centralized topology is very important because it cancels all problems linked with the management of territory continuity between two administrative regions. All local offices have a continuous vision of territory with update privileges on business data only on their administrative perimeter.

2.2. Hardware deployment

With a centralized architecture, local offices don't need strong server capacities, the management of business data integrity and security is centralized in one point. The benefits are important not only in the definition of hardware needs in local offices, but in the staff allocation for the system exploitation.

2.3. Software deployment

With a centralized approach, N-tier architectures are possible. Applications and data can be managed in one unique point (central office) and the deployment in local offices can be supported by light clients without any local installation.

Deployment for administration application can share components with e-services dedicated to farmers.

3. KEY ARCHITECTURE CONCEPTS

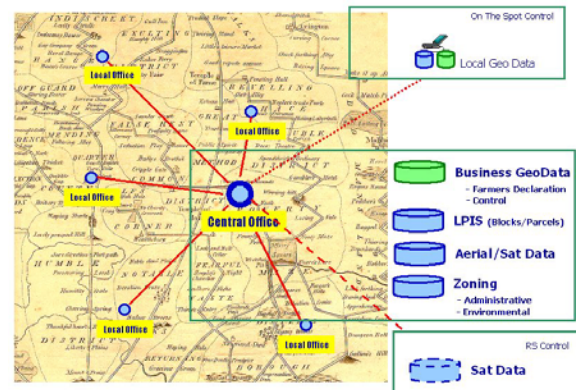
3.1. GeoData management

The management of geographical data is a crucial question and a bad infrastructure choice could lead to important costs in operations and maintenance.

The principal rule is to not separate geographical data and applications with non-geographical data and applications. IACS/LPIS must not be considered a priori as a GIS combined with alphanumeric business application. This disastrous point of view leads to inconsistencies needing a huge charge of management.

A good vision is to find a separation between **business** data and **reference** data. Business and reference data could have geometric and geographical attributes or not. For example :

- Geometric drawings coming from farmer graphical application form entries must be considered as business data.
- LPIS block limits (in a block based context) are **reference** data, not linked with farmer declaration.



In a *parcel-based* or *block-based* LPIS context, such separation is clear, LPIS and IACS can be considered as separate systems. In an *ilot* way, it is more difficult because LPIS segmentation comes from farmers' declarations.

IACS/LPIS systems are not GIS systems, but global Information System with a strong geographical connotation. The preliminary phase of information modelling take an important place and must not be missed. The choice of geographical software components (GIS desktop, middleware, DBMS) must be performed after this preliminary modelling phase.

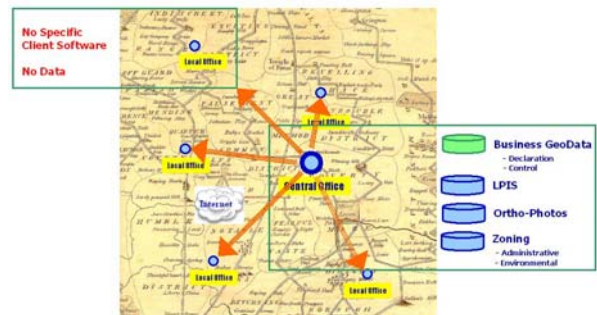
In this modelling phase, business objects must be identified and designed as a whole, including alphanumeric and geographic dimensions.

This kind of approach is adequate for identifying the three major components of a wide Information System :

- DBMS including the whole semantic of business objects and Reference data organisation.
- Global framework for Application Platform (.NET, Java, ...)
- Dedicated tools for specific tasks (GIS desktops).

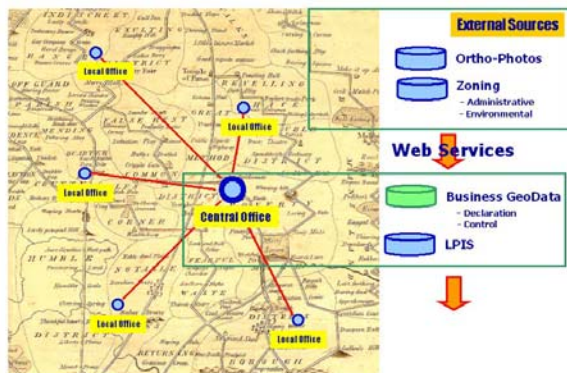
4. MAP SERVICES

As we have discussed before, network capacity and centralized software solutions can provide an architecture without any software and data distributed in local offices for administrative tasks (according to the IACS processes only, excluding other geographical analysis led by the agriculture administration).



So the needs of map manipulation (and parcel drawing) by local offices can be provide by web-mapping technology. This technology is based on unique central Map Services application. This Map Services Application is able to use tuning capabilities provided by the application framework (load-balancing, scalability).

4.1. External Services



The growing capacity of information interoperability, especially in geographical domain allows to design applications based on distributed services. It is now not necessary to own all reference data (orthophoto, zoning,...), technology is now opened for connecting with external sources through the notion of services. In this configuration, IACS administration could be a client for such of Web Services, and is not concerned with management of this kind of data.

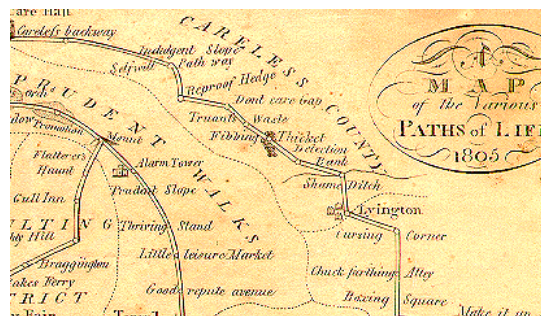
In an other way, IACS/LPIS administration could be a provider of Web Services because IACS/LPIS owns agricultural information which is useful in other country planning domains. This new organisation based on Web Information Services is a powerful spatial infrastructure for implementing INSPIRE directives.

4.2. Open Source Opportunities

We have seen that geographical components have to be defined and chosen for managing spatial data, providing web services, providing web-mapping and also providing desktop for analysis and solutions for on-the-spot activities. It is not necessary to be dependent upon a single GIS software provider. GeoData Management and Web Mapping are domains in which Open Source solutions are reliable and conceivable. IACS/LPIS organisation must have a critical point of view about GIS technology and their providers.

5. CONCLUSIONS

The Common Agricultural Policy is in perpetual change, territories and human activities are not in the same dynamic. IACS/LPIS systems have to be reactive face to European CAP and have to be opened to take into account the next stakes, particularly in the environment domain. So, data and applications architecture must be flexible; flexible architecture are possible with a sustainable infrastructure, based on data modelling, separation between business and reference data, separation between data management and applications and Services Oriented Architectures.



A Map of the Various Paths of Life, 1805
Map Collection, Yale University Library

iSIP – LPIS ON-LINE

R. Araújo¹, L. Nascimento¹, R. Roquette¹, A. Campos¹

¹IFADAP/INGA, Direcção de Inspeção e Controlo, Serviço de Identificação Parcelar, Lisboa, Portugal
rita.araujo@inga.min-agricultura.pt, lurdes.nascimento@inga.min-agricultura.pt

KEY WORDS: iSIP, LPIS, on-line, reengineering, GIS, information system, farmers.

ABSTRACT:

LPIS was implemented in Portugal in 1995. After 10 years the system was becoming obsolete, considering the improvements in the geographic information systems technologies, the changes in the European Regulations with the requirement to append new levels of information, and the increasing usage by other entities.

In October 2004 the Portuguese authorities decided to implement the iSIP project to reengineer the LPIS system. The main propose of this project was to develop an on-line access not only for users involved in the updating but also to other internal processes, such as the on-line claims and control procedures, to other public/private entities that uses its information and to the farmers itself.

The iSIP project was planned to finish in December 2007. In its first phase, the main features to ensure the on-line updating were developed, which is in production (on-line) since December 2005. At this moment the second phase is taking place in order to integrate other systems and to improve auditing procedures.

1. INTRODUCTION

1.1. LPIS implementation in 1995

The Land Parcel Identification System (LPIS) was created within the Reg. (CE) n°3887/92 and Reg. (CE) n° 3508/92. In this context, the creation of a Geographic Information System became essential to ensure regulatory compliance.

The implementation of IACS in Portugal identified as a first problem, the availability of a rustic cadastre to support the LPIS for only part of the country. This situation became an obstacle for Portuguese authorities. Thus, INGA decided to implement, using geographic information systems from the start, the Land Parcel Identification System (LPIS), with two essential aims:

1. To supply geographic information that supports the farmers in the correct fulfilment of aid applications.
2. To constitute an efficient instrument for control procedures in order to guarantee the correct attribution of the subsidies.

The INGA strategy, which was launched in 1995, involved a big identification and numeration project of the totality agricultural parcels declared in the Portuguese IACS. This identification also involved the determination of the respective areas and provided geo-reference elements with high precision to the farmers.

1.2. What changed in the last 10 years

Dimension and complexity

The LPIS system, initially based on the parcels limits identification by the producers using orthofotos, was gaining complexity in consequence of total or partial integration of new levels of information (OLI-GIS, environmental areas, slopes ...) and of the successive adjustments that the INGA

introduced annually motivated by European Commission (EC) regulation.

This system is actually, without any doubts, the most important GIS of the Portuguese Ministry of Agriculture, which has more than 383 000 farmers registered and 3.6 million of parcels identified totalizing 5.1 million of hectares. The number of trees geo-referenced go over 49 million.

Evolution of technology

LPIS is based on the Geographic Information Systems technology. Even though currently it can be considered as a particular case of the Data Base technology, GIS technology normally was not dominated by the IT Department.

In the implementation of the LPIS was necessary to create a new service called Parcel Identification Service (SIP) that fits the technical skills necessary for its development (information systems, agronomy, cartography).

The SIP service assumed until the beginning of the LPIS project an enormous set of responsibilities extended by the dimension that the LPIS has been taking since 1995.

The available GIS technologies in the market had itself a significant evolution throughout the last 10 years, not only at the level of the concepts and tools dedicated to topology resolution problems but also concerning the development of new functionalities to share information through web technologies.

In the following figures, we present an overview of the broad band evolution in Portugal and in the European Union, that supports the decision taken to advance for an on-line updating system only in 2004.

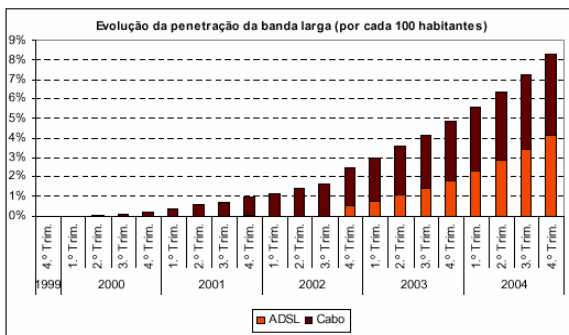


Figure 1. Evolution of the penetration of the broad band in Portugal

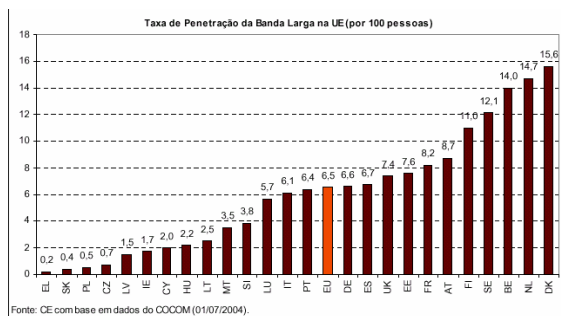


Figure 2. Penetration in EU (2004)

2. THE PROJECT – ISIP

2.1. Overview

The reengineering of the LPIS within the iSIP project constitutes an authentic technological shock at the level of security and geographic data management. The new architecture allowed the implementation of a central data and accesses management needed to provide on-line information to the users all over the year.

The iSIP Project scope can be enunciated as an informational redesign of the LPIS system, exceeding the weaknesses of the old system, in particular the model of archive, security and availability of the data and the way of updating the geographic information.

2.2. Main objectives

The “iSIP-LPIS on-line” project intends to create a new LPIS architecture in order to:

- Create an on-line access for LPIS.
- Reengineer LPIS management procedures.

For this project two phases were defined:

- 1st Phase – to develop the main features to ensure the on-line updating.
- 2nd Phase – To integrate other systems, improve auditing procedures.

The 1st phase conclusion was taken in December 2005 and allowed the following achievements:

- The updating can be made all over the year;
- The updating can be made in any regional service;
- The simplification of the current tasks for the system management in the central office;

- Improve the geographic/alphanumeric data security;
- Promote the data quality through the availability of several new geographic information layers.
- Simplify the integration process of new information layers.

In the 2nd phase (started in December 2005) the iSIP integrated a bigger system information project - iDIGITAL - which involves all IFADAP/INGA services and has its end foreseen for December 2008.

2.3. Team

The SIP service was responsible, until the beginning of the iSIP project, for the development and management of the LPIS, with an enormous set of responsibilities extended for the dimension that the LPIS started to take.

Although the several technical skills acquired by the SIP service (information systems, agronomy, cartography), these were considered insufficient considering the Information Systems development requirements and the EC regulations that advises an increasing interaction between different information systems only possible in a truly integrated system.

In this context, a partnership was established between the Information Systems Department (DSI) and the SIP with the purpose of developing the new LPIS system, transposing a data set and methods implemented over 10 years. The team responsible for the project implementation integrates 7 members from GIS department (DIC/SIP) and 7 members from IT department (DSI).

The GIS department team is responsible for the following tasks:

- Decision making
- Functional analysis;
- Software tests;
- Access profiles administration;
- Training and users support.

The team from the IT department is responsible for:

- Software development;
- Database administration;
- Network administration;
- IT Support

The project has a coordinator to follow its implementation and the schedule fulfilment.

2.4. Schedule

The following table represents the scheduling for 1st phase implementation:

October/2004	Previous Studies
December/2004	Team definition - Key-User's/Group (4) + IT Team (7)
January/2005	Choice of tools (Intergraph, Oracle Spatial 10G , .NET)
March/2005	End Functional Analysis
March/2005	Installation of VPN (ADSL) in regional offices
September/2005	End Development
November/2005	End Test
November/2005	Training (e-Learning)
December/2005	Production

Table 1. – iSIP schedule (1st phase)

Since December 2005 the team is working on the 2nd phase goals.

2.5. Technical Infra-Structure

In the Figure 3 is presented the implemented infrastructure with the following components: DB Oracle Spatial, Application servers, Web services, Firewall.

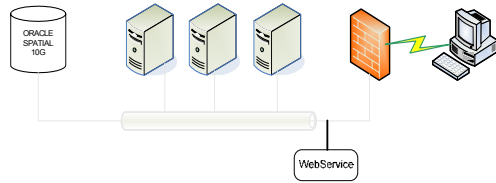


Figure 3. iSIP Infra-Structure

The web services level was developed to supply information to external systems and organizations.

The system development was carried out by using the following tools:

- Oracle Spatial – 10G
- C#
- ASP
- Adobe SVG
- Intergraph Geomedia Web map
- .NET

2.6. Main Functionalities

The main iSIP functionalities, developed in the iSIP 1st phase, are related with the following subjects:

	Administration – to define user’s profiles and access policies.
	Update – to view and update LPIS information. For example, modify parcels limits or identify trees.
	Maintenance – to define default values, symbology, import new information, etc.
	Farmer’s convocation – management tool in case of conflicts between farmers.
	Field visits – to register information about field visits (date, observations, inspector identification...)
	Control data – to view/integrate control information
	Reports – to order the production of output documents P1/P3
	Jobs – to execute tasks in order to produce information

Figure 4. iSIP main functionalities developed

3. OVERVIEW AFTER 1 YEAR IN PRODUCTION

3.1. Users

Between January 2006 and December 2006, LPIS was used by 270 remote users, located in 60 regional services. These users were trained and certified for the update information tasks.

3.2. Statistical data

In December 2006 LPIS had approximately:

- 3.6 million parcels
- 383.000 farmers
- 49 million olive trees

The total area identified was 5.1 million hectares. From January to June 2006 the regional services identified and updated 187.000 parcels, mostly because during this period the farmers with animals were constrained to identify their parcels.

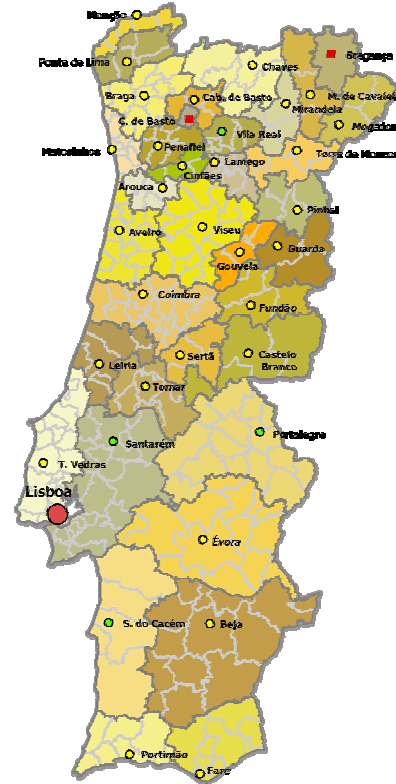


Figure 5. Distribution of the regional offices

The iDigital main goals are:

1. **Key support systems** – Reengineering of the horizontal information systems in order to create an integrated view of the farms and to supply default information to on-line aid applications.
2. **Subsidies management** – Reengineering of the subsidies and incentives management model, through the implementation of a single application model and the on-line aid applications, in order to deal with several aids in an integrated approach, to optimize the analysis processes, the aids payment and to allow the integration with the control system.
3. **Control (CwRS, OTS and Financial)** – Reengineering of the control model, in order to anticipate the control sample selection matching with the period of candidacies allowing the extension of the period for control execution and the implementation of integrated controls.
4. **Quality management** – Implementing processes in order to create a quality management culture, through the creation of an Internet portal as the privileged link between the Institution and the exterior, allowing the farmers access to its information. Through the creation of a Contact Centre, the valorisation of the

professional training while process of qualification of the human resources and through the certification of the organization with the ISO 9001:2000, as a clear signal of a new organisational culture.

3.3. iSIP – 2nd phase (within iDigital)

After the conclusion of its first phase, the iSIP 2nd phase was integrated in the context of the iDigital project, with the required development to integrate external systems and to improve auditing procedures in order to:

- Open the LPIS on-line access for aid applications and control procedures
- Open the LPIS on-line access to farmers
- Improve audit and quality controls procedures for the system maintenance.

4. CONCLUSIONS

The initial implementation of LPIS system was a successful project considering the short time period for implementation and the lack of a rustic cadastre system covering the country.

On the other hand, the constant changes in national and EC legislation promoted a continuous adaptation of the system with the consequent high costs in the effective LPIS model.

In this context, the administration concluded that the LPIS implemented in 1995 did not have a structure sufficiently adaptable to react to the dynamics of the agricultural politics.

The iSIP – LPIS on-line Project appeared as a natural result of the effort to modify the existing model, in order to increase its flexibility to the constant and necessary improvements and accessibility enlargements.

The implementation of the project had in consideration the following set of concerns:

- Construction of a scalable system;
- Standards usage;
- Integration with the aids applications and control systems;
- Interoperability with other external systems;
- Implementation of auditor ship and quality control of system;
- Easy access to the information for the internal human resources, for other external entities and for the farmers.

The system development only using internal resources of the institution was a decision that made possible the internal know-how enrichment which facilitates the continuous improvement of the system. The increased knowledge acquired by the DSI team concerning the geographic information tools implemented should be noted.

LPIS reengineering played an important role in the promotion of changes in IFADAP/INGA processes, with effective results on the increasing of the aid applications quality and the consequent decreasing of errors detected on the cross-checking and controls.

The importance of LPIS reengineering was proved by the iSIP first phase implementation success.

5. REFERENCES AND SELECTED BIBLIOGRAPHY

J. Miranda, J. Pinto, ICP – Autoridade Nacional de Comunicações, *O Mercado da Banda Larga em Portugal*, 2005, <http://www.anacom.pt/template20.jsp?categoryId=774&contentId=272626>

L'UTILISATION DES DONNÉES GÉOGRAPHIQUES EN FRANCE POUR LE SIGC, 2007

A. Petitjean¹, E. de Laroche¹

¹AUP, 12, rue Rol-Tanguy TSA10001 93555 Montreuil sous Bois Cedex
alain.petitjean@aup-agri.fr, emmanuel.de-laroche@aup-agri.fr

SYNTHESE

Le SIGC (IACS) repose majoritairement en France sur l'utilisation de données géographiques. Celles-ci sont largement utilisées aux différentes étapes du cycle de traitement des dossiers.

La déclaration graphique : Le SIPA (LPIS) est fondé sur des parcelles de référence de type " îlot " définies sur base déclarative des agriculteurs. Chaque année, ceux-ci confirment ou modifient graphiquement leurs îlots en fonction des mouvements fonciers sur les exploitations et ils localisent leurs parcelles culturales au sein de chaque îlot. Les déclarants peuvent aussi faire ces déclarations graphiques par internet.

L'instruction des demandes : Les agriculteurs remettent leur déclaration aux Directions Départementales de l'Agriculture et de la Forêt (DDAF), bureaux déconcentrés du Ministère de l'Agriculture et de la Pêche (MAP) dans les départements. L'administration vérifie qu'il n'y a pas de doublon entre les îlots voisins ou d'écart de surface et interroge les agriculteurs en cas d'anomalie. La notification des observations est accompagnée de documents graphiques.

Les contrôles sur place : La majeure partie des contrôles (80%) s'effectue par télédétection. Le logiciel de contrôle par télédétection centralisé est partagé par 17 services régionaux de l'Agence Unique de Paiement (AUP) et par des prestataires de service. Pour les contrôles sur le terrain, l'usage du GPS d'arpentage associé à un pocket PC est généralisé. Malgré un nombre croissant de dossiers refusés en liaison avec l'utilisation généralisée des images à très haute résolution (<= 1m), la télédétection garde tout son intérêt. Elle constitue notamment un outil complémentaire des vérifications terrain pour les BCAE et le RDR. Les données géographiques sont largement utilisées par le contrôleur et servent de support, lorsque cela s'avère nécessaire, au processus de mise à jour des parcelles de référence.

ABSTRACT

IACS in France is mainly based upon the use of geographical data. These data are used in various places in the aid application management cycle.

The "graphical declaration": the LPIS is based upon farmers' block reference parcels (*îlots*) defined on the basis of a declaration by farmers, who each year graphically confirm or modify their *îlots* depending upon the changes in boundaries; agricultural parcels are located inside each *îlot*. Aid applicants may also make applications via the internet. Administration of the applications: applicants put forward their applications at decentralised offices of the DDAF; the administration makes checks for double declarations of neighbouring *îlots* or differences in areas and checks for anomalies with farmers using the maps. On the spot controls: the majority (80%) of these use remote sensing and is split between 17 regional services of the AUP and contractors. GPS (pocket PC and survey software) is used for field visits; VHR remote sensing maintains its value in assisting checks for GAEC and RDP. Graphical data – maps – are used mostly by inspectors as a support to their activities, and when necessary in the updating of the reference parcels.

1. INTRODUCTION

Le SIGC (IACS) est fondé en France sur l'utilisation des données géographiques. La présentation décrit comment les données géographiques sont partagées et utilisées par les différents acteurs qui interviennent dans la gestion de la PAC : Agriculteurs, conseillers, agents instructeurs en DDAF et contrôleurs de l'AUP.

2. LA DECLARATION GRAPHIQUE (ILOTS, PARCELLES, ELEMENTS ENGAGES)

Le SIPA (LPIS) s'appuie en France sur des parcelles de référence de type " îlot " (farmer's block), unité de terrain exploité par un seul agriculteur mais pouvant contenir plusieurs cultures. Le LPIS comprend 6 200 000 îlots ce qui correspond à 12 000 000 de parcelles culturales et 27 000 000 ha cultivés par 400 000 agriculteurs.

Chaque année, des documents graphiques sont produits par l'AUP et transmis aux exploitants. A partir de 2007, ces documents font apparaître, en plus des limites d'îlots de l'exploitation concernée, les limites des îlots des autres exploitations et les terres inéligibles. Un document annexe permet d'indiquer aux déclarants la surface exacte des îlots (surface de référence) et la surface inéligible au sein de chaque

îlot. La surface de référence d'un îlot est déduite directement du dessin numérisé.

En cas d'échange de terres entre agriculteurs, ceux-ci peuvent initier eux-mêmes la mise à jour de leurs îlots en l'indiquant directement sur le document cartographique. La surface de l'îlot modifié sera arrêtée connue qu'après numérisation par l'Administration. Les agriculteurs sont incités à déclarer ces modifications en se coordonnant avec l'autre agriculteur concerné par la cession et en se basant sur les dessins existants et les surfaces de référence connues. Ceci permet d'éviter l'introduction d'erreurs de saisie ou de doublon et aussi d'établir par anticipation et de façon fiable les nouvelles surfaces de référence des îlots modifiés.

Une fois les mises à jour d'îlots effectuées, les agriculteurs localisent graphiquement les parcelles culturales à l'intérieur de chaque îlot et déclarent leurs surfaces. Les engagements agri-environnementaux, tant surfaciques que linéaires ou ponctuels sont également localisés graphiquement au sein de chaque îlot.



Exemple de déclaration graphique remplie

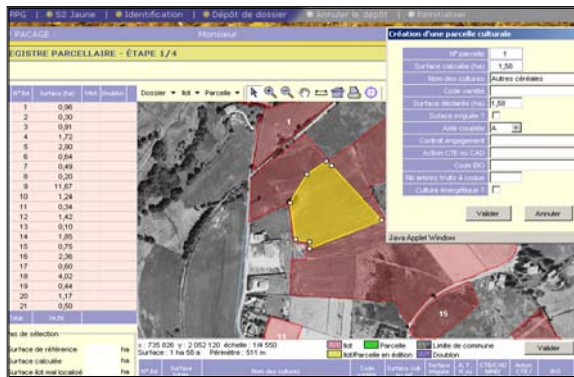
3. LA TELEDECLARATION ET LE PARTAGE DES DONNEES

Les déclarants ont également la possibilité de faire leur déclaration par internet grâce au service en ligne TelePac. Comparativement à la déclaration sur papier, ce service offre des avantages importants comme le calcul des surfaces, le partage des limites avec les îlots voisins et le calcul des incohérences en temps réel.

Les déclarations graphiques peuvent également être préparées sur des logiciels externes puis ensuite rechargées sur TelePac où elles subissent les mêmes contrôles après avoir été importées. A l'inverse, les données préparées sur TelePac, peuvent être chargées sur un système externe. Cette possibilité est largement utilisée par les organismes de conseil qui proposent toute une gamme de services et de conseils qui s'appuient sur la cartographie et les données géographiques (plan de fumure, plan d'épandage, conseil agricole, suivi des cultures par imagerie satellitaire, agriculture de précision, ...). Pour faciliter les échanges de données un dispositif d'échange par lots a été mis en place.

Pour rendre cohérent l'ensemble de ces travaux, les fonds cartographiques utilisés (orthophoto, cartographie 25 000, limites administratives) ont été fixés par l'AUP et le ministère de l'agriculture. Ainsi la même référence de localisation est utilisée et partagée par tous les acteurs de la sphère agricole.

Les échanges de données géographiques nécessitent également une coordination étroite entre les différents acteurs sur les autres sujets tels que : la précision des données géographiques, la définition des règles de gestion géographiques, les formats de données, ...



Exemple d'écran de saisie d'une déclaration sur TelePac

4. L'INSTRUCTION

Les agriculteurs remettent leur déclaration aux DDAF (bureaux déconcentrés du Ministère de l'agriculture dans les départements) qui sont les " guichets administratifs " uniques pour les agriculteurs en ce qui concerne la PAC. Toutes les données, qu'elles soient graphiques ou alphanumériques sont saisies dans un même système centralisé grâce auquel l'ensemble des contrôles administratifs sont effectués en temps réel. Plusieurs contrôles sur le registre parcellaire graphique utilisent des fonctions géographiques et permettent de vérifier d'une part la cohérence interne des déclarations et d'autre part la cohérence des déclarations entre elles. Les contrôles clés consistent notamment 1) à vérifier qu'il n'y a pas de double déclaration en s'assurant que deux îlots ne se chevauchent pas, 2) qu'il n'y a pas d'écart de surface entre la surface de référence de l'îlot et la somme des surfaces déclarées au sein de l'îlot 3) que les parcelles qui doivent être situées sur des terres éligibles (jachère et aide recouplée) sont bien localisées. En cas

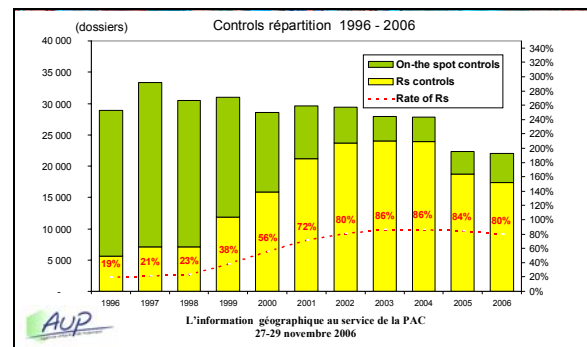
d'incohérence, l'observation est expertisée par la DDAF et les agriculteurs concernés sont interrogés par l'intermédiaire d'un courrier accompagné des documents graphiques correspondants.

D'autres contrôles sont effectués portant sur la cohérence entre formulaires, la complétude, la vraisemblance, etc...

5. LES CONTROLES SUR PLACE

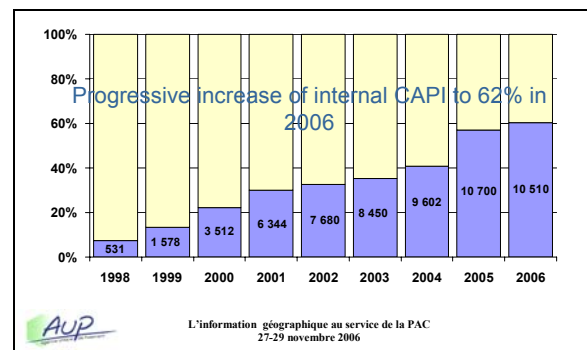
Sur les 410 000 dossiers de demandes d'aides déposés, le taux de contrôle d'objectif est de 5,5%, soit 22 500 contrôles surface des aides du 1er pilier, 6 500 contrôles des aides du 2ème pilier, et 4 000 contrôles des Bonnes Conditions Agricoles et Environnementales. La majeure partie des contrôles (80%) s'effectue par télédétection et concerne environ 18 000 exploitations. Le solde soit 20% des contrôles (4 500 exploitations) se fait par contrôle classique sur le terrain.

Evolution temporelle du nombre total de contrôles effectués par télédétection et sur le terrain :



La part de la télédétection dans les contrôles s'est progressivement accrue à partir de 1998 pour se stabiliser à 80% des contrôles depuis 2005.

Cette augmentation s'est appuyée sur une appropriation progressive de la photo-interprétation (PIAO) par les 16 Directions Régionales (DR) de l'AUP. Elles réalisent actuellement 62% de la photo-interprétation le solde étant effectué par deux prestataires de service (CS et SIRIS).



Les documents de référence pour le contrôle : Les opérations de contrôle sont encadrées par quatre documents de référence, deux instructions de contrôle (1er et 2ème pilier), un guide PIAO et un guide du contrôleur terrain. Ces documents sont mis à jour à chaque nouvelle campagne de contrôle.



Les moyens matériels mis en œuvre : Les contrôleurs terrain sont tous équipés de GPS d'arpentage associant un PDA Dell Axim au logiciel Arpengis et des antennes Holux ou GlobalSat. Les matériels disponibles permettent d'équiper 464 contrôleurs. Les mesurages de second rang sont effectués avec 42 systèmes GPS différentiels Leica GS 50 ou Trimble Pro XR. A partir de 2007 les contrôleurs disposeront d'un nouvel outil appelé NOMADE qui permettra de disposer sur le terrain, de SIG, de la PIAO, et de superposer en temps réel le résultat des mesurages GPS.



Les ressources humaines: Les opérations de contrôle reposent sur des équipes d'opérateurs PIAO contractants et AUP soit 130 personnes. Les opérations de terrain ont été menées en 2006 par 430 inspecteurs dont une soixantaine est également photo-interprète. Cette double compétence, assurant une meilleure cohérence des deux méthodes de contrôle PIAO et terrain, est encouragée par l'AUP. La formation initiale des contrôleurs est assurée par l'Institut National Agronomique de Paris-Grignon pour les aspects agronomiques et par l'AUP pour les aspects réglementaires et méthodologiques. L'AUP est également vigilante à former ses inspecteurs au relationnel avec les exploitants.

Les outils informatiques du contrôle: le logiciel de PIAO dénommé HORUS est un outil spécifiquement développé pour l'AUP. Il est conjointement utilisé par l'AUP et les deux prestataires. Cet outil repose sur une base de données Oracle

connectée aux logiciels d'instruction et de paiement des aides de l'AUP.

L'organisation des contrôles par télédétection: Le contrôle télédétection est réalisé sur 45 zones définies pour 25% de manière aléatoire et pour 75% sur la base d'une analyse de risque définie par l'AUP. Pour chaque zone sont utilisées 3 à 4 images haute résolution (HR) Spot ou Landsat destinées à l'identification des cultures et une image métrique aérienne (PVA) ou satellitaire (THR) Ikonos ou Quickbird soit 20 zones avec PVA et 25 zones avec THR.

6. L'OPTIMISATION DES CONTRÔLES

Par souci de simplification et d'acceptabilité du contrôle par les exploitants, l'AUP réalise les contrôles du second pilier et des BCAE sur le même échantillon d'exploitation que celui des contrôles 1er pilier. 50% des ces contrôles BCAE et 2ème pilier sont réalisés dans les zones de télédétection et 50% hors de ces zones.

Les taux de retour terrain après télédétection : Depuis 2002 le taux de dossiers refusés après télédétection s'est accru graduellement du fait de la suppression des «tolérances au groupe de culture» et de la réduction des incertitudes de mesurage liées à la généralisation de l'imagerie très haute résolution (THR). Ainsi le taux de dossiers refusés après télédétection est passé de 35% en 2002 à plus de 50% depuis 2004. Il y a de plus en plus de dossiers avec inspection terrain après télédétection non seulement sur les dossiers refusés ou incomplets mais aussi parmi les acceptés complets en raison des contrôles qualité après PIAO (200 dossiers), des contrôles BCAE (800 dossiers), des contrôles RDR (600 dossiers). De fait, 61% des exploitations contrôlées par en télédétection en 2006 ont fait l'objet d'une inspection terrain.

Un tel constat pourrait-il remettre en cause l'intérêt de la télédétection pour les contrôles ?

En fait, cette approche statistique en nombre de retours terrain ne doit pas masquer d'autres atouts majeurs de la télédétection. Grâce à cet outil :

- 80% minimum des surfaces sont mesurées ;
- les inspections terrain sont ciblées sur certaines parcelles ;
- la durée de l'inspection est raccourcie.

Le contrôle devient ainsi plus acceptable par l'exploitant et le travail du contrôleur est facilité. En fait, on se rend compte que les méthodes télédétection et terrain sont devenues parfaitement complémentaires. La préparation des contrôles par une phase de PIAO permet d'optimiser le contrôle poursuivi sur le terrain. Les préparations par PIAO des contrôles BCAE et RDR mises en œuvre par l'AUP illustrent tout à fait l'intérêt de cette méthode.

Les préparations par PIAO des contrôles BCAE et RDR:

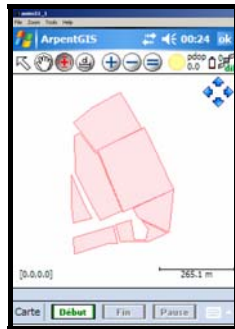
Le principe est que les inspections systématiques sur le terrain sont précédées d'une préparation des dossiers à l'aide de la PIAO. La PIAO allège et optimise le travail du contrôleur en le déchargeant de calcul fastidieux (vérification de la BCAE « diversité de l'assolement »), en allégeant les mesurages (BCAE « couvert environnemental » et « entretien des terres », mesures RDR) et en lui permettant de cibler son inspection terrain (BCAE « entretien des terres » et mesures RDR).

7. L'UTILISATION DU SIG DANS LE CONTRÔLE

Le SIG est la base du contrôle sur place que ce soit par télédétection ou par contrôle classique. Dans le cadre du contrôle classique il sert à la sélection d'au moins 50% des

«îlots» à inspecter en application des dispositions sur le contrôle. Il permet de s'assurer également de la bonne localisation des parcelles à inspecter en ayant sur le fond d'écran GPSA le contour des îlots (voir exemple ci.joint).

A l'aide de l'outil mobile «NOMADE» le contrôleur peut superposer ces contours avec les mesurages GPS, les résultats de la PIAO, des photos, et d'autres couches diverses.

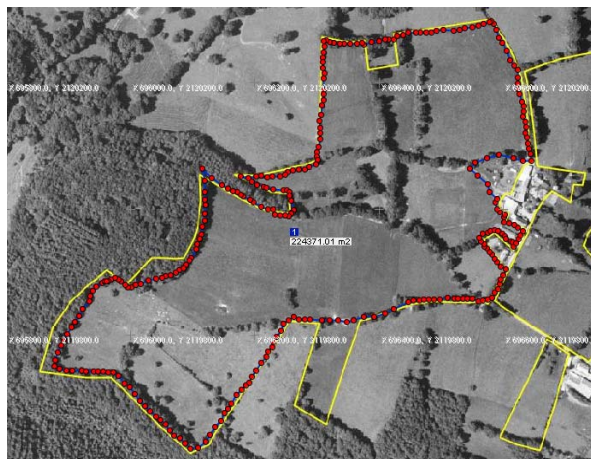


Exemple d'affiche d'îlots sur un écran de PDA.

La mise à jour du SIG lors d'opérations de contrôle : Le dispositif NOMADE permet également, lors du contrôle sur place, de proposer une mise à jour de l'îlot parcelle de référence et de préparer ainsi efficacement la déclaration de l'année suivante.



Îlot déclaré par l'exploitant (Contour en jaune)



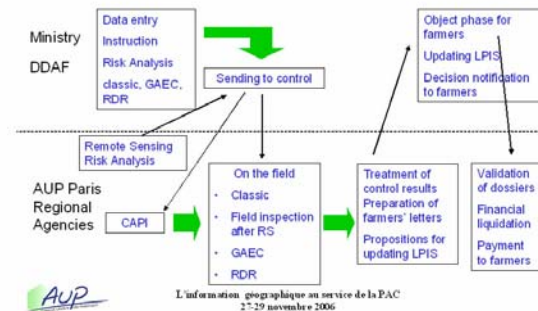
Îlot inspecté et mesuré GPS (contour en rouge)



Îlot déclaré par l'exploitant la campagne suivante. (Contour en jaune modifié)

8. LE SCHEMA D'ORGANISATION DES CONTROLES

L'organisation mise en place pour les contrôles fait intervenir à tour de rôle les services centraux ou déconcentrés (DDAF) du Ministère de l'Agriculture et de l'AUP. Les DDAF sont, par délégation de l'AUP, responsables de la saisie et de l'instruction des dossiers de demande d'aide. Elles sont également responsables des mises à contrôle.



L'AUP, quant à elle, est responsable de l'analyse de risque télédétection, de la réalisation des contrôles, PIAO, classiques, RDR et BCAE, du traitement des suites du contrôle et des propositions de mise à jour de la référence îlot. Sur ces bases les DDAF doivent conduire la phase contradictoire avec l'exploitant, lui notifier la décision préfectorale et mettre à jour le registre parcellaire graphique. L'AUP pourra ensuite procéder successivement à la validation des dossiers à la liquidation et au paiement des exploitants.

9. CONCLUSION

Tout au long du cycle de traitement des demandes d'aide surface, les données géographiques sont utilisées pour la constitution des formulaires, l'établissement de la déclaration, la saisie des données, l'instruction du dossier et enfin la réalisation des contrôles sur place.

L'AUP transmet aux agriculteurs des formulaires graphiques pré-remplis qui reposent sur une orthophoto et les déclarations de l'année précédente. Les agriculteurs se servent de ce document pour déclarer de façon graphique : Ils mettent à jour

leurs îlots, et localisent leurs parcelles et leurs engagements. Les DDAF saisissent les déclarations dans une base centrale qui inclut un SIG à part entière où les déclarations sont contrôlées grâce à des fonctions géographiques qui s'exécutent en temps réel. Les contrôles se font ensuite par télédétection ou, sur le terrain en utilisant des GPS. Les GPS et les dispositifs de contrôle « nomade » qui leur sont associés permettent d'embarquer sur le terrain l'ensemble des données graphiques relatives aux exploitations. Le cas échéant, les résultats de contrôle sont utilisés pour mettre à jour les parcelles de référence.

De cette façon, aux différentes étapes du cycle de traitement des dossiers, les données géographiques peuvent être partagées entre les acteurs concernés : agriculteurs, organismes de service et de conseil, agents instructeurs, contrôleurs et superviseurs.

Final Conference Programme

<p>Monday 27/11 10.00 – 14.00</p>	<p>Registration / Installation of posters and stands</p>	
<p>Monday 27/11 Afternoon</p>	<p>Plenary 1: Introductory session</p>	
<p>14.00 - 17.00 break (15h30-16h00)</p>	<ul style="list-style-type: none"> • Welcome addresses AUP - DG AGRI - DG JRC • Earth Observation in Toulouse/Midi Pyrénées Region (J-C. Cazaux) • Earth Observation: a historical perspective (G. Brachet) • IACS-GIS/SDI: review of MARS-PAC activities (J. Delincé) • Can Galileo improve the field collection for LPIS and Controls? (T. van der Wal) • The French IACS and graphical information (A Petitjean, E De Laroche) 	
<p>17.30-19.00</p>	<p>Pedestrian visit of Toulouse Centre</p>	
<p>19.00-22.00</p>	<p>Icebreaker</p>	
<p>Tuesday 28/11 Morning</p>	<p>Parallel session n°1: CwRS Review of 2006/preparation 2007 (J-C Graciette, S. Kay)</p>	<p>Parallel session n° 2: New services relying on agricultural graphical data (E. De Laroche, P. Loudjani)</p>
<p>9.00 - 13.00 break (10h30 - 11h00)</p>	<p><u>Restricted to National/Regional Administrations</u></p> <ol style="list-style-type: none"> 2. Summary statistics 2006 (H. Kerdules) 3. VHR image acquisition 2006 (M. Fotin) 4. HR Image acquisition 2006 (M. Erlandsson) 5. QC 2005 and transfer to MS of QC activity, 2006 (H. Kerdules, S. Kay) 6. Changes to CTS (methodology) (H. Kerdules, S. Kay) 7. BE: a revised strategy for CwRS (P. Nemry) 8. IT: revised strategy for 2007 (M. Pionponi) 9. Image allocation, 2007 - preliminary proposal (JRC) and debate/feedback (S. Kay) 10. Discussion 	<ol style="list-style-type: none"> 1. Development of agro-environmental indicators based on land use/land cover changes for assessment of rural landscape changes (L. Brodsky) 2. Geo-Traceability: a transversal tool for 5th and 6th framework research projects (M. Debord) 3. Protection of Permanent Pastures in selected Member States (A Gobin) 4. Integrated solutions for farmers, farm advisors and experts on a country scale - technological possibilities and organizational preconditions (W. Mayer) 5. RS innovative processing approach to built-up operational services for member states to apply european and national policies (H. Poilvé) 6. Monitoring of agricultural practice by joint analysis of VHR images and MODIS time series (D. Kristof) 7. Proposed Procedure of Validation and Certification of GNSS Instruments and Observers (S. Oszczak) 8. The Romanian Control With Remote Sensing Pilot Project 2006 (S. Gacichevici, O. Mihailescu) 9. Changes in consulting services and farmers decision making processes thanks to the new IACS graphical information policy (D. Lepoutre)

<p>Tuesday 28/11 Afternoon</p>	<p>Parallel session n° 3 benchmarking of satellites and airborne instruments, trials and studies (A. Rohrbach, G. Csornai , P. Åstrand) (CARAVELLE 1)</p>	<p>Parallel session n° 4 IACS: sharing data online (T. van der Wal, S. Kay) (CONCORDE 1)</p>
<p>14.00 - 18.00</p> <p>break (15h30 - 16h00)</p>	<ol style="list-style-type: none"> 11. The Leica ADS40 - 2nd Generation - New, unique features & benefits for environmental & resource monitoring (A. Rohrbach) 12. Implementation of the Digital Mapping Camera in the CwRS (R. Stein) 13. EROS B - New very high resolution satellite in space (R. Hellerman) 14. Formosat 2 performance in the Control with Remote Sensing Campaign 2006, and future (M. Mangolini) 15. Agricultural Control Applications of the Disaster Monitoring Constellation: Experiences of Europe's Control with Remote Sensing (CwRS) Programme (D. Hodgson) 16. Impact of using DMC on CAPI in two sites in France (I. Muquet) 17. EO data access for science and application/The ESA data portfolio now and in future (B. Hoersch) 18. Creation of the Digital Orthophotomap on the base of VHR satellite images for the Bulgarian LPIS (V. Vassilev) 19. Automatic geo-registration of satellite imagery (T. Westin) 20. Improving CAPI through Spectral Characteristics Preserving Image Fusion (S. Klonus) 21. Cloud cover evaluation of imagery of the VHR Campaign 2006 – is it possible to define a common approach? (P. Milenov, P. Åstrand) 22. An intuitive data exploitation tool for detailed information extraction (G. Banchini) 	<ol style="list-style-type: none"> 10. LPIS and ortho MS survey: analysis and review (P Milenov, S Kay) 11. IACS New Generation Architectures (J-Y Garinet) 12. iSIP - LPIS on-line (R. Araújo) 13. Sharing IACS-GIS Information for the OTS Checks – GPS Measurement in the Area of C-C and HRDP. (L. Savelkova) 14. The concept of the UAID online processing (G. Durrstein) 15. Single application in the NL 2006 online (A. van der Greft) 16. IACS-GIS Land Parcel Identification System – in Turkey (H. Erden) 17. TELEPAC France (J. Leroy) 18. LPIS in Bulgaria (G. Toshev)
<p>19.00-24.00</p>	<p style="text-align: center;">Gala Dinner</p>	

Wednesday 29/11 Morning	Plenary session n° 2 (M. Ricker, S. Kay, J-C Graciette) (CONCORDE 1)
9.00 - 10.45	<p>Round table: Synergy between CwRS and OTS Checks</p> <ul style="list-style-type: none"> • A portable data acquisition system for field inspections (L. Pasi) • Presentation of Nomade (A. Petitjean) • Speech recognition for common agricultural policy subsidies management and control (R. Herin) • GIS in the field work in Hungary (M. Lelkes) • Discussion, orientation for the 2007 campaign
break (10h30 - 11h00)	Coffee
Wednesday 29/11 Morning	Plenary session n° 3 (E. De Laroche, M. Erlandsson) (CONCORDE 1)
11.15 - 13.00	<p>Round table: Regulatory issues related to information dissemination.</p> <ul style="list-style-type: none"> • Regulatory issues related to information dissemination (A. Norman Palmer) • SRS data (Satellite Remote Sensing data) purchased - what can/should be made available and to whom? (P. Astrand) • Dissemination of CAP geographical data (M. Wurtz) • Development of the INSPIRE draft Implementing Rules (F. Bertrand)
13.00-14.00	Lunch break
Wednesday 29/11 Afternoon	Plenary session n° 4 (J-C Graciette, J. Delincé) (CONCORDE 1)
14.00 - 17.00 break (15h30 - 16h00)	<ul style="list-style-type: none"> • Assessment of the round tables (J. J. Jaffrelot, J. Delincé, P. Germain) • Discussion • Review of technical sessions: selection of JRC special publication shortlist (F. Sevilla) • Future prospects for Earth Observation (H. Jeanjean) • MARS-PAC Workplan, 2007 (S. Kay) • Conclusions (J. Delincé)

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

<http://agrifish.jrc.it/marspac/meetings/Toulouse2006/programme.htm>

The mission of the JRC is to provide customer-driven scientific and technical support for the conception, development, implementation and monitoring of EU policies. As a service of the European Commission, the JRC functions as a reference centre of science and technology for the Union. Close to the policy-making process, it serves the common interest of the Member States, while being independent of special interests, whether private or national.

EUR 22160 EN
JRC 40462

