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Controlling area based subsidies with RS and GIS in the EU

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ABSTRACT: The European Union's common agricultural policy (CAP) was changed in 1992; the subsidies of production were replaced by area-based subsidies. As part of this reform a control of the applications for subsidy was introduced concerning at least 5% of all the applications for area based subsidy. The European Union found that remote sensing was an efficient tool to perform part of the control. In ten years the European Union has set up the yearly technical specification and recommendations for the controls with remote sensing. This control is now acting as the primarily control of the applications for subsidy in most of the member states, which shows one of the largest benefits from the remote sensing data. This paper introduces the state-of-the-art of these controls seen from a Danish viewpoint.

1 BACKGROUND

In 1992 the European Union changed its common agricultural policy (CAP); the production subsidy was replaced by an area-based subsidy. The area-based subsidy varies from crop type to crop type, so that different crop classes are defined. The crop types that are subsidised vary throughout the European Union, but the subsidy per ha is at similar level.

As part of the Integrated Administration Control System (IACS) implementation of a national parcel register and a digital field block map was required. The member states choose different approaches to this. As part of the new policy it was decided to control at least 5% of all applications for subsidy.

To obtain a subsidy farmers are required to submit their annual subsidy applications in a prescribed form and by dates set in line with the Commission Regulation No 3508/92, in general between the end of March and 15 May depending on Member States. According to Article 8 § 4 of the same regulation, the control of these applications can, as an option, be based on satellite or aerial remote sensing and call in external contractors.

Remote sensing allows correct applications to be picked out so that inspection on the spot can be directed to the others and to problem parcels and the inspection number and cost are reduced accordingly.

The remote sensing contractor participates only in the stages related to this photo-interpretation, as the previous and final processing of dossiers is reserved for the National Administrations. Also, this arrangement is assumed to be "invisible" to the farmer, since no third party appears between him and the National Administration. The penalty calculations, sanctions or financial consequences for the farmer are not the responsibility of the contractor.

2 DANISH IACS SYSTEM

In Denmark this reform led to the construction of a control system based on a national register of agricultural information (GAR/CHR) and a digital field block map, both managed by the Danish Ministry of Food, Agriculture and Fisheries. This register stores now among other things the yearly claims for subsidy from more than 60.000 farmers, information on husbandry and fertilization etc.

The Agricultural register (GAR) was built from farmer applications for subsidies. The farmers' applications contain information about the producer, the farm and a map of the fields, for which a subsidy is requested.

The farmers' request for subsidy is sent to the DFFE (The Directorate for Food, Fisheries and Agro Business) in the spring. All the data concerning the applications are keyed into a database, which is then stored at LEC (Agricultural EDP-centre) in the CHR/GAR database, a database that is successively updated during the administrative controls at the

DFFE (Fig. 1). In 1996 the digital block map was taken into use for the first time and has to some extent revolutionised the controls.

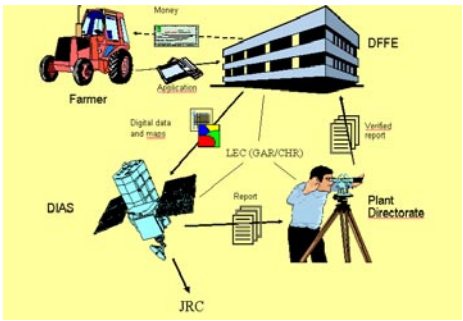

Figure 1. Data flow in Danish IACS system

The maps the farmers drew for the applications were done on T0-maps provided by the DFFE with an overlay block theme. T0-maps were based on aerial photographs at 1:10,000 scale and showed buildings, roads and other permanent features (Fig.2). These maps were totally replaced in 1999 by a print out of a colour ortho-photography (Fig. 3).

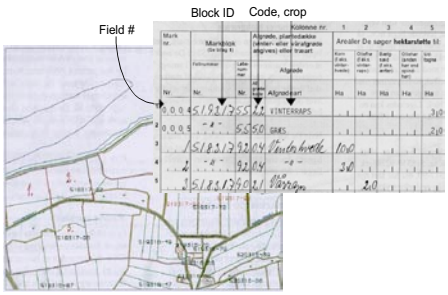

Figure 2. Farmer application 1997

Figure 3. Farmer application 1999

The field block maps are based on aerial photography from June 1995 and since then revised after each control season. A block of 1 to 10 fields is defined as a coherent group of fields surrounded by permanent boundaries. The average number of fields per block is 3.5. Each block has a unique id, comprised of the centre UTM co-ordinate down to 100m. Approximately 300,000 blocks cover Denmark. The blocks cover on average 10.5ha.

The area of a block is fixed in the current year, which means that it is possible for the DFFE to crosscheck the declared applications at block level. All areas declared within a block are added together and compared with the fixed area. If any over-declarations are found the farmers involved are contacted for possible corrections of the declared areas so that the fixed area is no longer exceeded. If the problem cannot be solved the Plant Directorate is measuring the areas on the spot. It is no longer possible to declare an area greater than is physically available as it was before the block system was introduced.

The main purpose of the national agricultural register is subsidy control and payments. The arable subsidy is given to producers of grain crops; oil seeds, pulses, oil flaxseed, fallow land and crops used for developing non-food products. The subsidy in 2002 varies from 330 Euro to 380 Euro pr. ha.In 2002 DFFE expect to pay over 5 billion DKK (Approx. 700 Mio Euro) to 51,000 farmers applying for subsidy or nearly 15,000 Euro per farmer.

It is possible to declare up to 17.6 ha without obligation to set aside. With a larger farm area the farmer is obliged to set aside at least 10% of the area applied for.

One of the major problems with the application system was the possibility of making erroneous data entry and wrong drawings on the maps. Errors made first by the farmer filling in the forms and maps and then by the personnel at DFFE keying in the information into the database. Several check routines are developed in the database to minimise and eliminate the errors.

With the implementation of the block system in 1996 some of the errors were eliminated especially those related to the position of the parcels. In 1997 a data entry program was made available by the administration for the farmers and the advisory services. From 1998 it was possible via the Internet to download this program and in 1999 a test was made with 500 farmers keying in directly into the database using digital signatures (Fig. 4).

The test in 1999 showed that there are some benefits from using the directly keying in into the database, since one link prone to errors is thus erased from the procedures. The program includes test of the data, so it is not possible to type incorrect combinations of crop type and crop group, both are selected from a list directly from a Microsoft Access database. If the data entry doesn't pass the test, the farmer will be asked to revise his application. And he will already know this if he uses the check button.

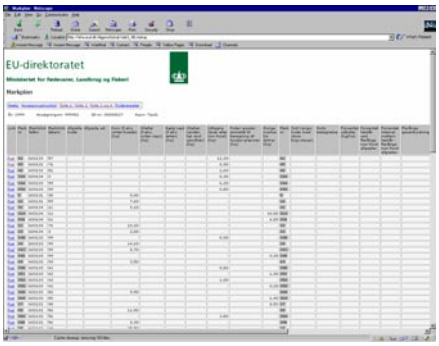

Figure 4. Web-based application

Due to problems with the digital signatures it was not possible to use this program in 2000, but a new law has been established and will allow the use of direct keying in of data in the future. This year it was possible to use the program on the Internet directly or copy the forms and send them in to DFFE. 13700 of 51300 farmers used the Internet programme, but only 1800 or 3.5% of the applicants used their pin codes/digital signatures in 2002.

Besides the data entry program a Web based digitising program has been developed in 2000. Now it is possible for the farmers and the advisory services to digitise the field in the correct blocks, measure the areas and use these areas in the application forms. All the drawings will be assessable for the DFFE, Plant Directorate and DIAS in the controls from 2003, so it should be easy for example to compare the application and see whether two farmers are declaring the same area (Fig. 5).

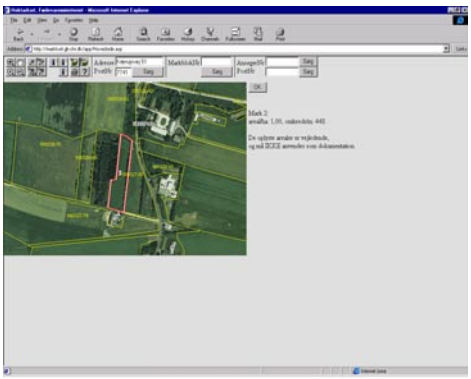

Figure 5. Internet farmer digitising

The Ministry hopes that the opportunity to deliver all the applications directly on the web will increase the number of applications sent in digitally from 2003.

3 REMOTE SENSING CONTROL AT DIAS

Besides the administrative control at the DFFE, the Plant Directorate performs a physical control on the spot of a number of applications. To fulfil the requirements of controlling at least 5% of the applications more than 4% of the applications are selected for area and crop verification in four control zones for control by remote sensing. The Remote Sensing Unit at DIAS since 1992 has performed part of the control of the area based subsidies by remote sensing.

2002 is then the tenth year that the Department of Agricultural Systems, DIAS, has carried out by remote sensing the verification of the Danish farmers' applications for subsidy of their arable land. The Plant Directorate reviews all the applications rejected in the remote sensing controls for control on the spot.

The principal stages in the remote sensing controls have been the same throughout the ten years and are as follows:

1. Selection of control zones
2. Selection and computerisation of dossiers
3. Acquisition and processing of satellite data
4. Digitisation of the limits of declared cultivated parcels
5. Selection of ground reference data
6. Automatic classification and photo-interpretation of the parcels on the images
7. Categorisation of the applications
8. Ground checks of a part of the applications, and validation of the interpretation

The task in the remote sensing controls is to verify the areas and crops that the applying farmers are declaring. To benefit from remote sensing data the applications that are subject for controls are selected in sites lightly smaller than Spot-scenes (radius 25km). The controlled applications are classified rejected or accepted. The rejected applications are subject to further controls on the spot. There can be several reasons to rejection of applications. One of the major problems in the controls is due the farmers' application forms and maps.

As described above the initial forms needed a lot of typing first by the farmer and then by the administration and the maps were first made from all sources of paper and with very limited accuracy. Now after several improvements the control system is much more efficient and accurate than in 1992. The LPIS changed the Controls with Remote Sensing dramatically. DIAS built a system CABS that are totally based on the use of the LPIS. Farmer drawings and applications directly using the Internet will in the near future ease the controls, since the digital lines from the drawings can be used directly in the remote sensing controls and the number of typing errors are reduced. The techniques are still being improved.

DIAS retrieves the application data via an online connection to the agricultural register at LEC and keeps this in a local database, which is used by the digitising staff. The maps are sent directly from the DFFE.

When DIAS receives the maps from the applications as well as the database with the crops and the areas declared, the fields are digitised in CABS on a raster data background such as ortho-photographs, SPOT XS, SPOT P, Landsat TM images. Vector data showing topological data like roads, buildings, lakes, forests etc. are also used as background themes for the digitising. The program CABS (Control of Area Based Subsidies) is a system based on ArcView and Microsoft Access initiated in the department in 1997 and has been used for the controls by remote sensing since then.

Some of the applications are rejected in the area and some in the crop verification process. Any positive difference between the area declared and the area observed leads to rejection of the application in the area of verification. In the crop classification an application is rejected, if at least one of the fields involved is categorised as containing a crop from a different subsidy category than the one declared by the farmer.

The digitising in CABS (fig. 6) is based on the block system. When the user starts the application, he enters his initials and which area to work on. The system then provides a list of the dossiers and blocks within that area. When starting a block, all the information from the database on fields in this particular block is retrieved from the database and shown to the user. Next the block is subdivided into the fields drawn in the applications and given a dossier and field number. In many cases, the block contains exactly one field and it can be completed with no further digitising. As soon as a field is digitised, CABS calculates the area and compares it to the area declared by the farmer.

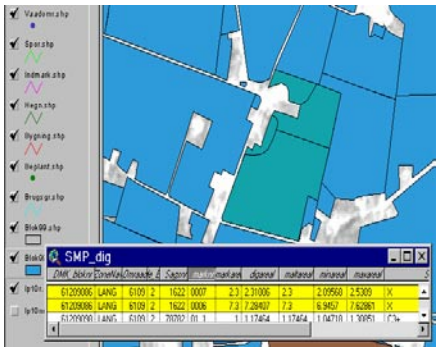

Figure 6. The CABS digitising programme.

After the area verification a crop classification is carried out. As the separate crops develop differently during the growing season, they can be distinguished on multi-spectral satellite imagery. By comparing three or more satellite images recorded at different times during the growth season, it is possible to determine which crop is on each field. The material for the crop classification is created using supervised Maximum Likelihood classification, using a priori probabilities for the various crop types (fig. 7-10)

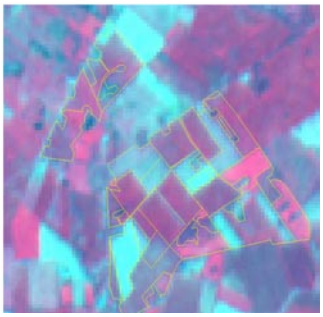

Figure 7. Spot image from May 1999, CNES ®

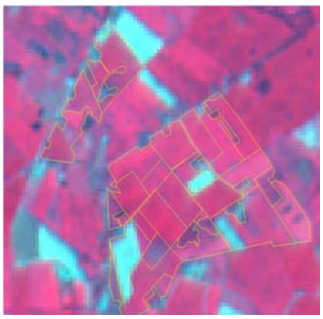

Figure 8. Spot image from June 1999, CNES ®

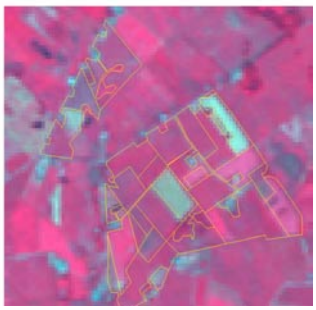

Figure 9. Spot image from July 1999, CNES ®

The a priori values are calculated from all applications treated in each control site. Statistics from the individual classes are based on SPOT XS images from autumn the year before and from May, June and July the year of classification. To find out which colour is representing which crops a sample of ground truth reference data is used. There are at least three ways of finding these data:

1. measurement of fields with the crops on the spot
2. use maps of digitised fields with the declared crops in different colours and verify it on the spot
3. use all declared information and classify automatically

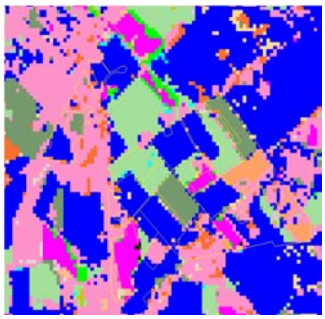

Figure 10. Resulting classification

The first one is the traditional way, when the field limits and crop are not known beforehand. This was used before 1996 and was very time consuming (8 man weeks). The second is the method used today, which is less time consuming and uses existing information. The last one is under consideration after a feasibility study has clarified obvious benefits available using the farmer declared data from the agricultural register (The FARMAP approach). Statistics tell that approx. 50% of the well-defined blocks contains only one crop type. Further research will be done to take advantage of the information of the agricultural register. For instance, could a preliminary classification based on the autumn and first spring image be used to ease the digitisation?

After collecting the set of ground truth data (300-400 field per site), crop classified satellite images are created based on three or four aforementioned satellite images and the crop classification of the individual fields can be carried out. This is done in two steps. First, the fields that can be classified automatically are found. This requires no user interaction. Second, the personnel for the remaining fields do photo-interpretation.

When developing CABS, one of the main goals was to reduce the percentage of fields that had to be manually photo-interpreted. Earlier, if the dominant crop type occupied less than 80% of the field, or if the crop had been classified differently from that declared, the crop type would be visually evaluated by photo-interpretation. This meant that in 1997, only 30-40% of all fields could be classified automatically. In 1998 and 1999, this percentage increased substantially by using CABS. Now it stabilises at 80%, but more than 90% of the winter crops are automatically classified.

After 1996, when the new digital topographic information became available, the techniques used were changed and improved. The uniquely georeferenced field blocks can now be used to ease the classification of the arable land together with remotely sensed imagery and will both be used for monitoring and mapping the land cover and to support decision makers in natural resources management

Most farmers (98%) are applying for subsidies and the application data for the previous year remains in the database. This makes it possible to derive from the register a unique distribution of crops by blocks, by grids or whatever geographical unit you may need. About 16% of the blocks contain only one field (and crop type). The information from the register can also be used to classify the remaining blocks nearly without fieldwork, but only with the use of remote sensing.

The farmer drawings are not yet available for DIAS as vectors, but could be useful in the controls by remote sensing. In CABS the most time consuming task is the digitising of 30,000 parcels. As figure 3 and 6 show the main task in the controls is to transfer the farmer drawings into the GIS. If the farmer or the advisory services did this drawing the control job would be much easier.

With the crop types, crop group and parcels limits directly given by the farmers, the crop classification would be easier than it is today. In the first years only a minimum of the farmers will use the new opportunities, but it will nevertheless make the controls easier and the possibilities of using the data in the national resources management will be increased.

4 CONCLUSIONS

During the last five years CABS has proved itself a very useful system for managing the area verification of the subsidy applications and performing the crop classification. The ability to automatically generate maps of all rejected applications and maps needed for ground truth collecting made the work much easier. The CABS program is now the only software needed by the subsidy controlling personnel at DIAS. This has reduced the costs for education and for software licenses substantially. Because the digitising staff consist of new people every year, it is crucial to the learning process that the same graphical interface is used for all functions.

In improving the crop classification and that way further bring the percentage of applications having to be manually photo-interpreted down, several actions are under consideration at DIAS.

The recently developed Web based GIS when fully implemented will make the controls easier and the errors will decrease further. This will also make the use of the data more useful in national resources management.

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DFFE Guidelines for the subsidy application 2002 are available in Danish:
http://www.dffe.dk/stoetteordninger/index.htm

EU Technical Specifications for the controls with Remote Sensing are available:
http://mars.jrc.it/control/#specifications

CABS description is available from the DIAS homepage:
http://www.agrsci.dk/jbs/cabs