A possible contribution of remote sensing data to control area based rural development measures

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Abstract

With the process of “greening the Common Agricultural Policy (CAP)”, more sophisticated control and evaluation methods are required especially in the field of area based rural development measures. These include measures for which aid is calculated on the basis of a spatial or linear unit, and which may be assessed with imagery and handled within a GIS. As remote sensing plays an important role in the control of arable crops, and forage lands, how far this role could be extended towards the control and evaluation of such rural development measures is discussed and whether the new very high resolution satellite generation will significantly improve the situation.

1 Introduction

The landscape of Europe, especially central Europe, is a result of the continual expansion of urban areas as well as an increase in land use intensity. The continuous destruction of habitats and biotopes in favour of an industrial agriculture and forestry and the continuous intensification of land use have led to extensive loss of habitats, biotopes, structural variety and to uniformity of site and living conditions along with water pollution, loss of soil fertility etc..

To thwart this ongoing development, several reforms concerning the integration of environmental issues into the CAP have taken place since 1992 when European agri-environmental policy defined the first specific regulations on agri-environment (Basic Council Regulation (EC) on agri-environmental measures [1, 2, 3], on nitrates [4], on organic foods [5]), and on afforestation [6].
In 2000, a new reform of the CAP took place. It confirmed the 1992 orientations but added a new pillar to the direct aid system - rural development (RD).

All Member States today have RD-plans, accepted by the (EC) STAR Committee, in accordance with the Rural Development Council Regulations (EC) n° 1257/1999 [7] and n° 445/2002 [8], where agri-environmental measures (AEMs) are compulsory and consolidated (but voluntarily for the farmer). These activities are co-financed by the European Agricultural Guidance and Guarantee Fund at various levels depending upon region categorisation. Budget share is set about 10% of the whole CAP budget for the period from 2000–2006. Looking at the CAP midterm review it is envisaged that rural development will increase in importance in the future and the share of the actual agricultural budget will increase [9].

<table>
<thead>
<tr>
<th>Productivity</th>
<th>Competitiveness</th>
<th>Sustainability</th>
</tr>
</thead>
<tbody>
<tr>
<td>the Early years</td>
<td>the Crisis years</td>
<td>the 1992 reform</td>
</tr>
<tr>
<td>Food security</td>
<td>Over production</td>
<td>Reduced surpluses</td>
</tr>
<tr>
<td>Improving productivity</td>
<td>Exploding expenditure</td>
<td>Environment</td>
</tr>
<tr>
<td>Market-stabilisation</td>
<td>International friction</td>
<td>Income stabilisation</td>
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<td>Income support</td>
<td>Structural measures</td>
<td>Budget stabilisation</td>
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<td></td>
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<td>Deepening the reform process</td>
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<td></td>
<td></td>
<td>Competitiveness</td>
</tr>
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<td></td>
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<td>Rural Development</td>
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</table>

Figure 1: The Common Agricultural Policy—an evolving policy? (ref EC DG Agriculture; G.1 - Scheele).

2 Design and budget of rural development programmes

The current regulation allows the Member States to design a rural development plan/programme widely tailored to their needs and with some definition-freedom. Maximum amounts for different measures are defined and a codification is given by the regulation/guidelines [8, 10], but specific obligations/requirements and the targeted geographical areas are defined under the responsibilities of the relevant authorities in the Member States. This results in a broad variety of differently designed rural development programmes. The 127 programmes with more than 2200 measures implemented under the 2078/92 regime have not decreased with the new rural development plans [11].
This heterogeneity is reflected in the EU/national expenditure for the second period from 2000 – 2006, and in the differing budget allocation by measure for each Member State (see figure 2).

A clear preference for agri-environmental measures, in our context the most important group of area based rural development measures, within the budget of the RD-plan is visible for Austria, Germany, Italy and Sweden covering a wide variety of different measures like extensive production, environmentally friendly production techniques and maintaining cultural landscapes.

3 Control requirements

In general rural-environment policy puts high demands on Member States' administrations, which are obliged to conduct different types of control to ensure that payments to the farmers are correctly managed. The subsidies are aimed both to compensate farmer's income loss and additional costs resulting from the measure (compensatory allowance), as well as monetary stimulus (support). This control needs to be carried out during the time of the commitment.

There is also the requirement on the Member State administration to carry out correct monitoring and evaluation of the measure(s) in order to ensure a positive outcome. Such an outcome (e.g. a specific impact on habitats and biodiversity or on landscape diversity) is therefore to be assessed after the commitment ends (≥ 5 years) [12].

Both the above control and evaluation issues require new quantitative indicators where remote sensing should play an important role. The introduction
of the area based measures (basically categories d, e, f, h, i, and possibly some of the Art 33-type measures eg. j, k, t [7, 8]) also require sophisticated management and information monitoring systems, which suitably introduces a geomatics GIS oriented approach.

The control procedure and the use of remote sensing within this context is defined by the Commission Regulation (EC) n° 2419/2001 [13], by the Common Technical Specifications describing the methodology applied for the remote sensing controls of arable and forage land [14] and specific guidelines for the area based rural development measures [15]. The latter outlines how to implement a system of management, checks, and penalties for the rural development measures.

As well as an administrative check covering one hundred percent of the beneficiaries, five percent have to be controlled by on-the-spot checks, where all commitments and obligations, which are possible to check at the time of the visit, should be checked [8].

Basically the Commission allows the use of remote sensing for control of the area based rural development measures according to a two samples approach, the size of which should be balanced and together amount to the above-mentioned five percent of the beneficiaries each year:

1. a first sample to be checked by physical inspections
2. a second sample to be checked by remote sensing for the ground cover and measurement of areas, and by physical complementary inspections for the other commitments and obligations [15]

Attention should be given to the fact that the more complex a scheme is, the higher the administration costs become. As the Court of Auditors pointed out in the United Kingdom, for the first year of the scheme implementation the control costs exceeded subsidy paid, and then reached a level of 46% after 5 years (1995–1996) [16].

3.1 Remote sensing control of arable and forage land

Concerning the control of arable aids, the remote sensing control technique is a method accepted by European Commission regulation [13]. The method includes the use of a series of satellite images and/or aerial photos together with ancillary information. If only one aerial photo is used, a rapid field visit (RFV) becomes obligatory to determine/confirm the land use. The control zones, circles of radius 25 km, and the selected aid-applications within these zones are defined by risk analysis and then controlled by means of computer-aided photo-interpretation (CAPI) [14]. The European Commission strongly recommends using a two-scale-approach: working with a very high resolution image, currently mainly airborne ortho-photos, in order to perform the necessary parcel measurements and using coarser, but multi-temporal and multi-spectral information from satellite data for crop-detection.

Even though new approaches are always being developed, it may be considered that above control method has reached a rather mature stage and is
successfully applied in 13 Member States (2002), sometimes even completely replacing the traditional on-the-spot control.

3.2 Remote sensing control of area based rural development measures

At present, also the area based rural development measure commitments in these control zones are partly checked by means of remote sensing, but this is restricted to area measurement and crop detection. So the majority of measures either require a complementary physical check, or are totally excluded from the controls with remote sensing and have to be controlled by a full physical inspection. It is envisaged by the authors of this paper that this will change so as to allow remote sensing to control not only area and crop type but also more requirements and a larger set of rural development categories.

For area based rural development measures there is therefore a need to define new image interpretation decision rules, classification, and indices, introduced mainly with the use of high or very high resolution (VHR) imagery. The authors thus consider that there are potentially controllable measures by remote sensing like heather burning, winter stubbles, green cover, extensive crop rotation, fruit orchards, hay cutting restrictions, hedgerows, tree rows, long term set aside, ponds, dykes, etc. that could be included under the controls with remote sensing and would reduce the expenditures for the controls.

Nevertheless, as mentioned, the measures are often only one requirement of a more complex measure or scheme (e.g. erosion control, extensive grassland management etc.). A measure is therefore in general only partly controllable with remote sensing whilst other parts have to be checked with a rapid field visit (RFV) or complementary physical check. If the new methods do not bridge this gap, or if measures cannot be defined differently, the remote sensing method may only be regarded as a tool to speed-up the physical on the spot check.

3.2.1 New satellite data—new control possibilities?

The first civil VHR satellite (Ikonos) has been in orbit for more than three years and collects images with a resolution of 1 m in the panchromatic mode. At present the family has increased to include Quickbird and Eros-1. In addition SPOT 5 is in place with its ‘super-mode’ acquisition giving a resolution of better than 3 m in panchromatic mode, covering an area of 60 km by 60 km with a single scene. The main satellite characteristics are listed in table 1.

As well as the above satellite sensors, digital airborne sensors with very high resolving power and discrete non-overlapping spectral bands are on the market e.g. ADS 40 [17]. The latter allowing for statistical and automatic classification which is difficult to perform on the basis of precision scanned aerial photography.

In general the VHR image suppliers explicitly address projects dealing with agricultural applications as their customers. They claim that the information value in the imagery and the acquisition possibilities (e.g. no flight restrictions etc.) are to be seen as complementary to traditional airborne photography.
Currently the pricing of the VHR data, especially for ortho-rectified products, is well above the pricing of orthophotography produced from traditional analogue airborne photography. It is however probable that this pricing will follow a comparable evolution to the traditional airborne products, and decrease substantially in the near future. This issue is certainly important but should not prevent us from evaluating the possible contribution of this type of data for control and evaluation purposes.

Table 1: Main VHR satellite characteristics.

<table>
<thead>
<tr>
<th>Satellite</th>
<th>Launched Date</th>
<th>Resolution</th>
<th>Sensor Type</th>
<th>URL</th>
</tr>
</thead>
<tbody>
<tr>
<td>IKONOS</td>
<td>24/09/1999</td>
<td>1 m</td>
<td>Panchromatic</td>
<td><a href="http://www.spaceimaging.com">http://www.spaceimaging.com</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Multi-spectral</td>
<td></td>
</tr>
<tr>
<td>EROS:A</td>
<td>05/12/2000</td>
<td>1.8 m</td>
<td>Panchromatic</td>
<td><a href="http://www.imagesatintl.com">http://www.imagesatintl.com</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>QUICKBIRD</td>
<td>18/10/2001</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>16.5 x 16.5 km</td>
<td></td>
<td><a href="http://www.eurimage.com">http://www.eurimage.com</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPOT:5</td>
<td>04/05/2002</td>
<td>2.5 (artificial) or 5 m</td>
<td>Panchromatic</td>
<td><a href="http://www.spotimage.com">http://www.spotimage.com</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Multi-spectral</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>60 km x 60 km</td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.5 m (SWIR 20 m)</td>
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If, in this context, emphasis is put on the imagery and information requirements needed to control area based rural development measures, two main categories may be distinguished:

1. The first group of measures could be controlled with remote sensing data currently used within the control of arable and forage land, e.g. ETM+, SPOT XI and IRS LISS. Here the multi-temporal and multi-spectral information is of high value to detect the appropriate measure e.g. crop rotation, autumn/winter green cover or mow cutting dates. A better spatial resolution would lead to a better parcel size measurement but is not crucial for detecting the measure itself. However, there are richly structured rural landscapes with very small agricultural
patterns within Europe where control and monitoring are difficult to perform with the current satellite data in use. The utilization of multi-spectral VHR satellite data at appropriate dates would be extremely supportive to detect the measures as the landscape pattern is better reflected.

Figure 3: Cultivation of arable crops, crop rotation measures. UL parcel limits (black) and area measurement in 1m PAN orthophotography. UR, LL, LR declared crop, barley, is a winter crop. The maximum biomass level is expected around April. The harvesting should be carried out in the period 1–15 July. The available images (SPOT XS March, May, and July) confirm the correctness of the declaration i.e. correct crop in crop rotation scheme.

The VHR imagery can be seen in this context as real valuable complementary information. But it should also be mentioned that this group of measures often requires data at several dates throughout the year (e.g. specific hay cutting dates, ploughing dates, crop rotation) and that currently no real VHR satellite families (3–4 Satellites) are in place to support the repetition rate and therefore the chance of a successful image capture. This is a crucial point for the Member States’
administrations, as they are obliged to perform the controls and put in place a reliable and operational control system.

2. The object of control of the second group are typically elements linked to landscape conservation, e.g. tree rows, hedgerows, walls, field margins, ponds, and dykes, only controllable with VHR data and the inherent geometric and radiometric resolution. For a successful control the object has to be definitively identified (e.g. via computer-aided photo interpretation or classification) and the area, length, or position measurable in order to be compared with the declared value. In fact, the area check in the present remote sensing controls for arable and forage land the methodology makes use of technical tolerances, applied at parcel level, which are defined depending on instruments/maps/imagery/shape of parcels etc. These are calculated based on the perimeter of the parcel. The difference between declared area and measured area is then tested against this tolerance. Similar tolerances are required for linear measurements (eg. length of walls, hedges, width of field margins etc.), and for location of landscape features.

Figure 4: Landscape Conservation—detection and measurement of linear features in Quickbird data.

A possible drawback for the VHR satellites is the current control site design for arable and forage land. Today these sites, as mentioned earlier, are defined by circles of 25 km radius with the demand for covering a minimum control area (10000–20000 ha), or a sufficient number of applications (500–1500) including all widespread parcels of a holding. This design is however re-definable, and
another type of acquisition may in future fit even better into the required risk analysis for choosing beneficiaries to be controlled.

4 Conclusions

Currently the use of remote sensing to control area based rural development measures is restricted to crop detection and area measurement, but the new VHR sensors might broaden the horizon if appropriate guidelines and technical tolerances are defined. Pilot projects are presently being carried out, financed by the European Commission, to define an appropriate control design for these measures [19].

Not only is the control design crucial for a meaningful role of remote sensing, but also to a great extent the measure definition itself. From a control point of view many area based rural development measures are "soft measures" or qualitative measures where a quantitative control is impossible. This does not only create problems for the physical inspection but also for the remote sensing control. A discussion is therefore needed on whether it is possible to define a measure as "controllable" as possible, taking into consideration existing geomatics and remote sensing methodology, but without neglecting the environmental target of the measure, which has to be the main driving force.

The Integrated Administrative and Control System (IACS) [13, 18, 20] is currently used by the Member States to manage direct area based subsidies of the CAP. This system needs to be used, not only for arable forage and livestock, but also for the area based rural development measures (compulsory compliance required by 1 Jan 2003). It defines the rules to be followed in terms of aid application, penalties, administrative and on-the-spot-checks. Also, there is within the IACS, a requirement for a Land Parcel Identification System (LPIS) where land referencing is made at the level of the agricultural parcel. All Member States are required to have a digital LPIS within a GIS by 1 Jan 2005, and also there is a recommendation to use aerial or spatial ortho-imagery.

![Figure 5: The area based rural development chain.](image)

This undoubtedly suits the area based rural development measures where detection of sub-parcel features is often necessary, and there is a real requirement for high spatial-, dynamic-, and possibly also spectral resolution. It is therefore
envisaged to have, in future, a GIS defined with layers and attributes fitting the needs of the area based rural development measures.

Moreover, and in order to decrease imagery costs, remote sensing should take part in the monitoring and evaluation process of the area based rural development measures. In this context landscape structure is, beside land use, an essential parameter to be evaluated with regards to ecological processes. As landscape structure is inherent in remote sensing data, landscape function can be correlated with visible structures in the data. Indicator derivation from remote sensing data that aims at area based rural development measures with influence on landscape structure should therefore be considered. This approach would enhance synergy effects within the area based rural development chain and a decrease of costs is to be expected.

References


[17] Leica Geosystems, ADS40 Airborne Digital Sensor, Product Description, 2002


