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O Applications à l'environnement
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EUROPEAN COLLABORATION ON DEVELOPMENT OF NEW ENVIRONMENTAL THEMATIC MAPS-TYPES FROM REMOTELY SENSED DATA

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Abstract

The Collaborative Programme on European Marginal Areas – Remote Sensing in Land Use and Environmental Protection – is an organization of 25-30 institutions. The objectives of the Programme are aimed at classification and quantification of the rural less favoured areas ans their properties, and at management, environmental protection and development. The Programme is organized in working groups on either thematic or regional applications of remotely sensed data.

Most of the work carried out during the first phase (1986-89) of the Programme was concentrated on various smaller pilot projects. One of the main conclusions from these projects was that integration of Remote Sensing data with other, ground-based, cartographic data was the only way in which the remotely sensed data could be used in scales required by local management. This resulted in strong support on development of PC-based Remote Sensing/Geographical Information Systems and demonstration projects on the application of these.

Another problem encountered was the difficulty of transferring typology from various parts of Europe to other parts: The definition of surface cover types varies from country to country. It was therefore necessary to start work on definitions of land use categories relevant for management of especially non-agricultural less favoured areas. As a first step in this direction two actions have been taken: The first concerns forested areas; a general typology is required in order to assess the European production and in order to integrate this renewable ressource into general marginal area management. The second concerns Mediterranean areas from which general thematic maps are needed – but especially maps relevant for environmental protection purposes and land use development. Also a strong need for development of a landscape-ecological map of Europe has been expressed; a map that is based on land-units, their ecological properties, and first of all their mapability from Remote Sensing imagery could be used in environmental management – especially soil-erosion and land-degradation control.

The paper will concentrate on some of the results from the first phase of the CollaborativeProgramme which is presently reporting and will present some of the major actions defined for the second phase which is now launched.

◆ Introduction

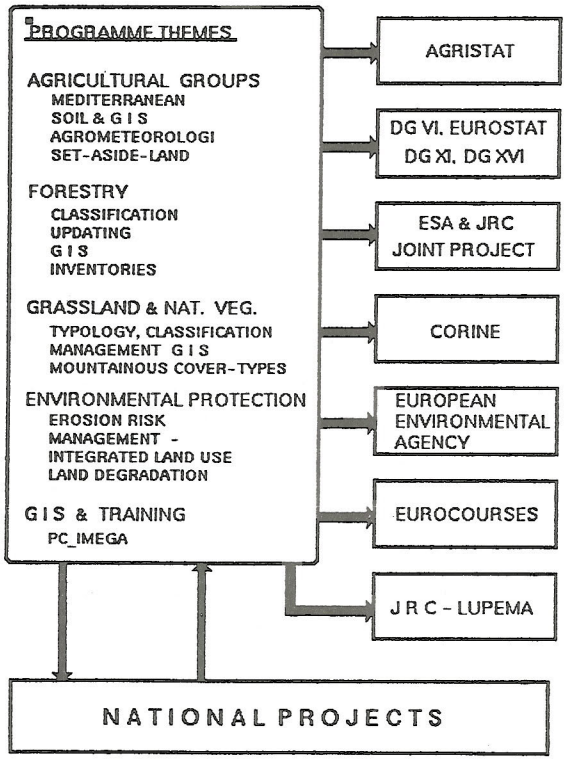
The administrative needs and the political necessity of the European administration have created a demand for new European maps. In principle there are two ways of meeting this demand, one is to issue directives to be followed by national mapping agencies in order to create comparable maps of somewhat equal standard, the other way is to initialize maps or map-series that from the time of planning are meant to be made by compilation of national material as for instance the European Soil Map, 1: 1.000.000, published by the European Community, Directorate General for Agriculture, 1975; or the Vegetation Map of the Council of Europe Member States; 1: 3.000.000, Council of Europe, 1979. Another – much more complicated – approach is to take into consideration from the very beginning both the common objective needs and the national specific interests (and natural diversities); the so-called CORINE Land Cover map, 1:100.000, can be considered an example of this very difficult task.

For years people engaged in remote sensing have been claiming that their source of data and the computerized treatment of these remotely sensed data would provide fast – automatic or semi-automatic – updating; we have even been claiming that we could provide dynamic maps. When it comes to reality we have hardly yet provided maps that could or would be used in management. There are many good reasons for this. One could be the difficulty of arriving at satisfying classification and generalization results from remotely sensed data by automatic methods; and that cartographers perhaps have had little interest in helping to define and develop methods that could be used in computerized automatic and semi-automatic maping from satellite imagery. The reason why direct, geometrically and radiometrically corrected, printed images are not used is probably due to the fact that the amount of information in these tends to confuse users.

Considerations like these are the background for the choise of topic for this paper. We have chosen to present parts of the Collaborative Programme of the Institute for Remote Sensing Applications dealing with environmental mapping. The Programme is just now being restructured ans redefined into its second phase. Starting from a few of the results from the first phase which we consider of special interest for this occasion some of the integrated projects now initialized are described.

◆ European Collaborative Programme

The Collaborative Programme was originally set up because the Joint Research Centre of the European Community needed support groups at a European level to cooperate with its remote sensing projects. It was felt that there existed a lack of concensus on methodologies, approaches, techniques etc. to be applied to land use and terrestriall environmental problems. It was also necessary to have a network of laboratories and institutes capables of rapidly responding to european needs for environmental assessments which could also be extended to include institutions outside the EEC.



The Collaborative Programme is divided into various themes which are more or less tied to support for various other entities and to national projects.

Originally the general objectives of the programme were defined as:

• Need to develop and define remote sensing related tools and models capable of:

- Classifying the rural less favoured areas ands marginal land by identifying and quantifying their properties.
- Defining, for any selected area, criteria by which management decisions and/or actions may be taken to protect its environment and/or stimulate its development.

• Need to analyse and define fields where remote sensing could supply new and constructive insight into environmental processes.

These objectives have been extended towards incorporation of various aspects concerning the natural conditions of growth within agricultural areas as well – among other things in order to build a bridge between pure statistical purposes and general mapping purposes of application of remote sensing. In this paper, however, we shall only be dealing with the so-called less favoured areas of the EEC.

The emphasis has been put on definition and development of tools and models that could be used on both European, regional and local level, however biased towards the local level in order to ensure a high degree of usefulness and interest in the results – and because we are dealing only with high resolution satellite images.

Within the next working period it has been agreed to concentrate on the following issues:

- The development of geographic information systems in forestry assessment and forestry management.
- Development of classification and mapping criteria for grassland, natural vegetation and mountainous land-cover.
- Ecological and morphological classification and mapping of selected european landscapes with special reference to degradation assessment.
- Environmental protection related mapping.

This is by no means a difinitive list, as the emphasis may be changed towards other subjects if so wished by the participants and for the time being there seems to be considerable interest in workshops on selected relevant topics within the themes.

◆ Some results from the first phase

• Tourist map

As mentioned an important aspect of the Collaborative Programme has been to demonstrate use of second generation Earth observation satellite (SGEOS) data in development of less favoured areas. Within the frame of the working group on evaluation of SGEOS data as a source in information for integrated resource management in the uplands ERA Ltd, Dublin has produced a tourist satellite map. The map covers a rura less favoured area, lieve Bloom Mountains, in central Ireland, with an average farm income of less than IRpounds 2000 per year.

The tourism potential of the Slieve Bloom Mountains has been the object of much attention during the past years, but the lack of adequate infrastructure has meant that this attention has not resulted in any significant contribution by tourism to local economy. Another major drawback has been the lack of detailed guide material of high quality for visitors.

The first objective of the project was to produce a color printed map at a scale of 1:50.000 of the Slieve Bloom area. The map should consist of satellite imagery with access and tourist information overlaid on it. The map aims at showing the sites of special interest and accommodation, catering facilities and activities in a novel and clear format.

The second objective was to have the map used in a carefully focused marketing campaign aimed at special interest groups in the European market.

Ground data collection and compilation of the following information was carried out:

- access routes into the area
- local historical and heritage features
- recreation and sport facilities
- accommodation and refreshment facilities
- long distance working tracks
- nature reserves.

The data was entered into a PC-ARC/INFO GIS together with line data representing road and track network according to the Ordnance Survey.

The satellite data (Landsat TM, 7th. Aug. 1988 and SPOT, 14th. Oct. 1988) has been used to provide the color image map part and was processed in the following way:

- geometric correction and 10 m pixels resampling
- production of true color composite from TM bands 1,2 and 3
- conversion of TM color composite into intensity, hue and saturation images
- adjustment of contrast in SPOT pancromatic image to match intensity image from TM composite
- reconversion to red, green and blue images using hue and saturation from TM, but replacing the intensity with SPOT pancromatic image
- final color balancing and edge-enhancement.

In summary the production of the final map involved the following stages:

- Digitizing the line and point information through tthe PC ARC/INFO system.
- Conversion of precessed satellite imagery and perspective views to cyan, yellow, magenta and black images followed by conversion to ascii hexadecimal files and transfer from a VAX to a Macintosh computer.
- Design of template, text and legend using Freehand software on the Macintosh.
- Conversion of map template (with legend, text and symbols) into Postscript separates (cyan, magenta, yellow and black).
- Merging of satellite imagery with Postscript template file.
- Downloading of completed Postscript to a Lintronic 300 imagesetter to produce film separates.
- Production of plates from film separates.
- Printing of final map on the reverse of the Ordnance Survey 1: 50.000 topographic map.

• PC-based GIS - PC-IMega & IM-X.

It was realised at a very early stage ot the Programme that there was a very strong need for an inexpensive, easy to handle geographic information system with possibilities of integrating remotely sensed data and performing elementary image processing. A software package was developed by the Department of Theoretical Physics, University College Dublin, which could be of use where facilities were at a premium and which could be used for training and creating interest in, and an acquaintance with, the use of RS and GIS in local management.

All the software programs are supplied with full color graphics on-line help and can be configured for the given installation. The on-line help contains text paragraphs, boxed items for fast reference, and graphics inserts showing the effects of software functions.

The main PC-IMega software is menu driven, under either keyboard or mouse control. The software can accept four images of up to 3072 8-bit data bytes wide. The IM-X series of software are pop-down menu driven, under mouse control, with pop-up options windows. They can accept single images, again up to 3072 8-bit data bytes wide.

All software can accept images where the data is encoded in either 1, 2, 4, 6, 8, 10, 12, 14, 16, or 32-bits per pixel. Such images are treated as generic (of unknown source) where header information lengths can be defined but the actual information ignored. Images can be converted from one bit format to another and image sections can be extracted. Images stored in the 16 or 32-bit integer entity format can be converted to byte stream format used by PC IMega for all bit format image storage. The images are displayed in EGA or VGA color or grey shade modes, but the VGA 320x200 256 color mode can be accessed as a transient display and the IBM PS/2 8514/A graphics Adaptor and 8514 Color Display can be accessed as a second display. All modes operate with palettes read from disk palette files which are user defined from within the main software. Pixel assignment to screen color in the 16 color modes is achieved through color look up tables using either linear, logarithmic or exponential assignment. Alternatively, range assignments can be defined for the simplest form of image classification.

Processing functions include predefined 3x3 image smoothing and edge detection including scalar laplacian filters and vector gradient filters. Filtering can also be achieved through user defined 3x3 and 5x5 convolution masks. Single image and two image combination arithmetic operators are provided. Histograms of pixel intensity distributions and standard statistical measures of such distributions can be displayed. Linear density slices or transects can be displayed in histogram or profile form. Individual pixel values can be verified or set, and contours of equal pixel intensities can be plotted.

Annotation functions include text labelling, geometric shape marking, icon symbol overlaying, and views can be stored and recalled.

GIS functions are provided for display and editing of overlays. Vectors can be linked to form logical boundaries for which attribute information can be recalled. Vector data can be overlayed onto any image given that both sets of data are registered to the same grid system. Attribute information can be recalled in the form of boundary fills, mnemonics placed within boundaries, or pop-up window tables of attribute lists. The software can be configured for different attribute applications where the user directs the software to different sets of user defined attribute definition and translation files.

The dot matrix and Postscript printer drivers allow for screen printing, providing hard copy with, typically, eight gray shades. Screens can be stored in image files for subsequent, fast recall or presentation.

Although this software development may seem a little out of touch with traditional cartographical approaches to the use of remotely sensed data, the interest in the product and the number of copies distributed very clearly underline both the understanding and the need for new approaches. Perhaps it needs to be stressed that the PC-IMega and IM-X software packages by no means are meant to be competitive with commercially available cartographic

systems, but, it does help educational institutions and makes it possible for most European local administrative entities to use modern remote sensing integrating cartography in their day to day management of land use and environment.

◆ The second phase of the collaborative programme

From the enlarged range of activities of the second phase a few have been selected here in order to show the breadth and the complexity of the studies. First a mapping and management project in a mountainous national park will be presented, next the forest classification and updating pilot project is dealt with and finally the plans for the expanded activity on land degradation is presented.

Parc National de Mercantour has been selected for an integrated study. The park is approx. 70.000 ha and is situated in the very southern part of the French Alps. The climate is unique, mountainous and Mediterranean. The area is very well mapped both topographically and in many themes describing nature and environment. Most maps are directly derived from or serve as input into data bases which for some part are included in geographic information systems.

The study is carried out by the Parc National De Mercantour authorities, INERM, Grenoble, and Université de Nice. The aim is to integrate remote sensing data – incl. air-photos – into the data bases and via integration to improve the mapping of the various geophysical and geographical variables of the landscape. The study will also try to redefine the traditional mapping of ecological types and transitions between these, – both the static and those being in progression. The GIS is to be used in the daily planning and control work of the park authorities and the aim is to make it possible to monitor the whole area to a degree where the small local ecosystem transition processes can be frozen, so to speak. The idea is among other things to examine whether remote sensing integrating GIS will help in keeping the landscape in a dynamic process where a maximum of landscape ecological diversity can be preserved by intensive use of up-to-date maps.

The data base and the continous updating via remotely sensed data will be used for production of scientific information and for publication of popular and educational material.

Together with the above-mentioned perspectives the tool should be used and tested in relation to tourism – both accidental and «professional»; – the question is primarily, if the ecological diversity in the park can exist when the landscape is heavily used for recreation. And one of the tools for solving the problem could be the ability to produce new tourist information material which could actively be used to protect areas if changes could be detected at an early stage.

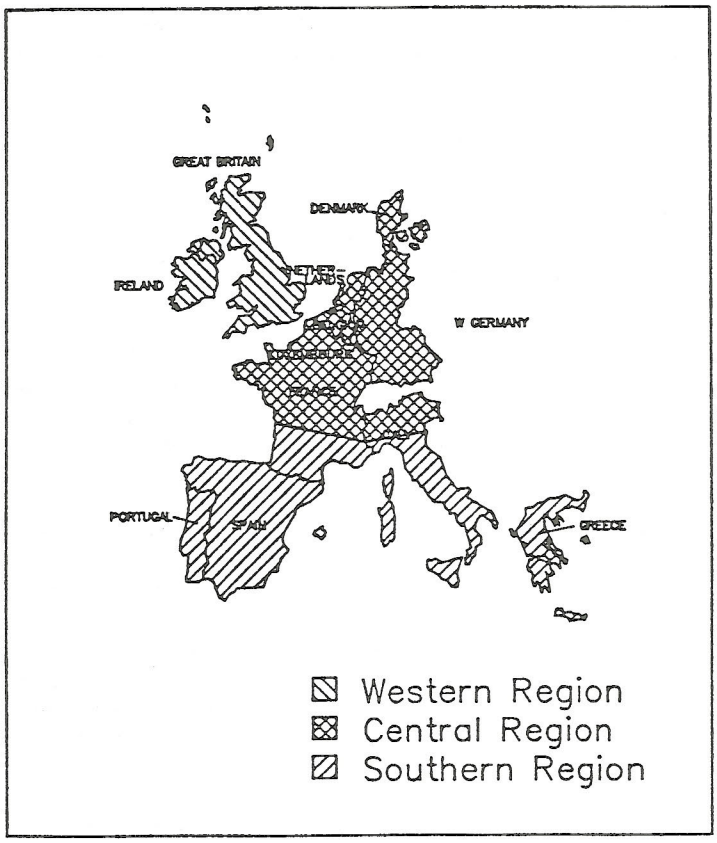
The forestry theme of the Collaborative Programme was given high priority by the steering Plenary Meeting, correspondingly several study-projects have been contracted. This theme is a typical example of the difficulties which exist when an European forest map is needed. So far only one map exists; it shows only the boundaries of forested areas without regard to type of vegetation (Forests of the European Community, 1:4.000.000, 1987). The forest classes given by the CORINE land cover map have to a certain degree solved this problem. But it does not constitute a real forest map. It is based on national mapping which, even if the legends and classes are common, do not always give comparable results – and the number of forest classes are too small.

The intention of the working group on forestry was to define a thematic forest map fo Europe with a legend able to characterize and distinguish the various types of forestry in a way that would be meaningful for forestry management at regional level. Furthermore the map covering Europe was to be defined so that it would be possible to relate it to local and regional management directly, in a sort of hierarchical management structure. And, of course, the map-information was intended to be based on high resolution satellite data.

The first step has been carried out; three different regions within the EEC have been identified via characteristic differences in management. We distinguish between a western, a central and a southern region. Preliminary studies on the use of SGEOS data for regional management were carried out in Ireland, Germany, Italy and Greece. Local studies took place in central Ireland, Denmark and southern Italy.

On the basis of the conclusions from the first step it was decided to continue the work, but to concentrate on local to regional levels rather than national to European levels. It also been decided to put more emphasis on semi-automatic GIS related studies. This probably means that the result will be more an «electronic map» than a traditional analog product. The idea is to link local mapping to regional and national data bases from which maps for general purposes can be extracted.

The working group is presently concentrating on: 1, Classification and automatic updating – key-study in Denmark; 2, forest inventory by use of SGEOS data integrated into forest management GIS – key-study in Ireland; 3, forest classification and degradation evaluation – key-study in Greece; 4, classification and mapping of high altitude forest types – key-study in France.



◆ Conclusive remarks

It is evident that there is a strong need for cartographic approaches to handle the enormous amount of data coming from both remote sensing and from geographical information systems. But, it is also evident that so far we are hardly able to handle, either very «small», local geographical information systems, or «large» systems of very low resolution for national and supra national levels.

The requirement for precise environmental information, including general land use information, is steadily growing and it is now becoming very urgent to be able to combine data in order to extract specific information on environmental parameters or environmental systems. The traditional way (if we can talk of tradition) of handling this problem is to compare analog maps and compile «new» information, or to make enquiries in GIS. These two methods are generally accepted, of course, but, there is no guarantee that we get the optimum solutions – answers – to our questions.

We have tried to incorporate studies of this sort of problem into the Collaborative Programme while we continuously aim at models and methods that cover both local and regional to national scales. There exists various ways in which to approach the problem. Advanced methods for classification of the satellite data, either by direct classification of the satellite data themselves, or by including auxiliary data in expert systems have been developed during the last couple of years (see Wilkinson 1990). Even if these methods are very promising, they will probably only be useful at local scales – at least for the near furure – and for the present they will only cover land usage.

The data contained in the local, sub-regional data bases are from very inhomogeneous sources and are derived by many different methods emphasizing various characteristics, they are therefore very often not comparable. The national and multinational data bases tend to be so general that they hardly can be used in a meaningful way in scales larger than one to one million (-an exception is the CORINE land cover map).

If we want to produce fast updated information for the whole EEC covering environmental parameters we need some method for linking SGEOS data to the dynamic, ecological system in the landscape, which inevitably leads to some sort of approach which takes into consideration the transformation of satellite data into cartographic knowledge. So far no method for this sort of approach has been developed. The forestry working group fo the Programme has started to move in this direction especially because it seems a useful way in which to be able to select and delineate potential afforestation areas.

The European Collaborative programme is very interested in cooperation on methodological studies, which eventually based on the photo interpretation related land unit mapping tradition, could be tested in GIS environment on remotely sensed data in various European landscapes.

Aknowlegments

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