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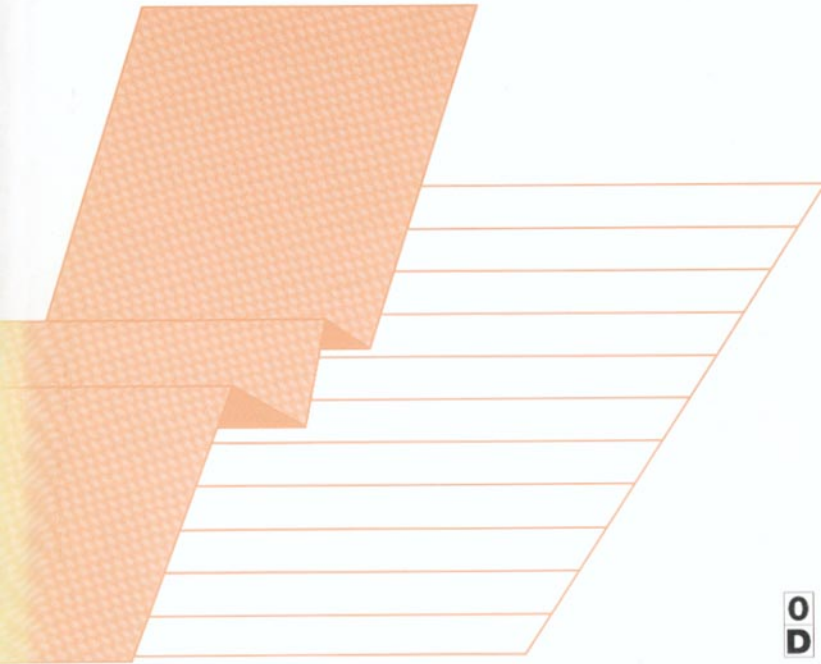
THE IMPACT OF REMOTE SENSING ON THE EUROPEAN STATISTICAL INFORMATION SYSTEM

Proceedings of the seminar
Esquilino, Rome, 27 to 29 November 1995



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TRANSFRONTIER PILOT PROJECT NORD-PAS DE CALAIS / BELGIUM

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Summary

The increasing use of Geographical Information Systems by regional authorities bears witness to their determination to develop the tools that will enable them to keep a closer eye on the urban and environmental components of the territory for which they are responsible. Remote sensing data processing techniques make a specific contribution to this monitoring process via the systematic typology of the areas observed, the dynamic analysis of chronological series of images and the adoption of a global approach to areas in transition in general and transfrontier zones in particular. They can be used for tackling the problems of definition of the perimeters of agglomerations, their dynamic analysis and the study of the interaction of major development projects with the natural environment. These wide-ranging applications are attempted in the Nord-Pas de Calais / Belgium project launched by the Observatoire Régional de l'Habitat (ORHA) at the beginning of 1995, in the framework of a partnership between the Direction Régionale de l'Equipement (the Public Works Directorate of the Nord-Pas de Calais region), the "Conseil Régional", the "Agence de Développement et d'Urbanisme de la Métropole Lilloise" and its transfrontier counterparts in Belgium, and Eurostat. The two sites selected of this project were the metropolitan area of "Lille-Roubaix-Tourcoing", with its transfrontier extensions towards Tournai and Courtrai, and the coastal zone encompassing Boulogne and the Calais area ("le Calaisis"). The aim is to work out an updated spatial definition of the urban agglomerations which is based on a common methodological approach to enable critical analysis and comparison with other urban areas elsewhere in Europe.

The project focussing on *the use of remote sensing tools for the delimitation of agglomerations and for analysing the impact of major regional development projects* was launched at the beginning of 1995 in the framework of a Franco-Belgian "partenariat" and in co-operation with Eurostat. Two areas were selected for study. The first covered a large zone on the Nord-Pas de Calais coast, extending from Boulogne to Calais. The second covered the "métropole" of Lille-Roubaix-Tourcoing and the adjacent areas of Courtrai and Tournai in Belgium. The aim of the present paper is not to anticipate the scientific results but simply to describe the general context into which the project fits.

1. The project

1.1. Context

In recent years, the actors in the realm of regional planning have seen the appearance and development of *decision-making tools* exploiting the numerous resources available in the domain of informatics. Geographical Information Systems have obviously led the way in this context: their usefulness as tools for tackling both urban and environmental problems has already been more than amply demonstrated: the technical departments of the "Communauté Urbaine de Lille" have over ten years experience of the operation of a GIS with a wealth of information at the level of blocks of houses in the urban agglomeration known as the "Métropole Lille-Roubaix-Tourcoing"; and more recently, the "Conseil Régional Nord-Pas de Calais" has mounted a project for the development of "SIGALE", a GIS encompassing the whole of the regional territory.

In this context in which not only the decision-makers but also the technical departments of the regional authorities (the term "*regional*" refers, here, to the entire territory covered by this project, i.e. the Nord-Pas de Calais and the area in Belgium adjacent to the Métropole Lille-Roubaix-Tourcoing) were already well aware of the potential of these tools, it was very soon realized that remote sensing was destined to play a vital role in the data collection process.

Without entering into a detailed description of the Nord-Pas de Calais / Belgium transfrontier area, it seems pertinent to describe a few of its characteristic features, which can *all* be thrown into much clearer relief by the specific contribution of remote sensing:

- *it is a densely populated region*, even in comparison with the French national average; it also has a *dense network of medium-sized towns*, and it is essential to know more about, their morphology, their components and their dynamics;
- *it is an important European communication crossroads*, an area characterized in recent years by the adoption in Nord-Pas de Calais of a regional development policy involving a number of major projects including the Channel Tunnel (the construction site of the century) and the "Rocade littoral" (the motorway linking the region's three major ports of Boulogne, Calais and Dunkerque). It is of course essential to measure the impact of these projects on a fragile environment in a region in which ecological factors are a major preoccupation;
- *it is a traditionally industrial region*, which is currently undergoing a profound transformation, a region which still bears the scars of its past, particularly in the form of industrial waste land which needs to be reconverted while at the same time preserving the environment;
- it is also a *continuous transfrontier area* in which the Métropole centred on Lille naturally extends, for example, beyond the Franco-Belgian frontier, and that means, of course, that its observation needs to extend beyond the limits set by administrative boundaries.

The creation of a homogeneous updated geographical data base obviously required the application of remote sensing techniques (as indicated, indeed, in the first conclusions of the programme published by Eurostat under the title of "Remote sensing and urban statistics", in which their use was recommended for "the study of transfrontier zones, the analysis of areas in transition - e.g. suburban zones and coastal zones - and for large-scale environmental applications"[1].

1.2. Objectives

The project was launched with the following three objectives:

- *the operational objective* in the context of a transformation of regional development policy, of meeting the need to monitor and map the development of the territory with the help of appropriate tools involving, in particular, an updated system of definition of the boundaries of agglomerations, their structural analysis based on land-use maps and their dynamic analysis based on the comparison of images;
- *the methodological objective* of validating the remote sensing methods employed in this context, with particular emphasis on the approach to urban and suburban areas;
- *the organisational objective* of developing a common set of tools to be used by all the partners in the project on a scale which meets their need to tackle their own specific problems while at the same time ensuring the coherence and compatibility of the technical means employed (with regard to basic maps, land use nomenclatures, chronological and spatial references, data processing tools, etc.).

It was clear from the start that the aims of this project extended beyond the limits of a simple one-off study to encompass the development of a fully-fledged process of exchange and cooperation between the technical and institutional partners with a view to mounting future projects on a more systematic basis, *in particular by promoting the adoption of standards for the definition of agglomerations and the application of land use nomenclatures* without which it would be futile to envisage the adoption (either at a national level or at a European level) of the comparative methods which are now indispensable although they are sometimes difficult to apply in the absence of genuine cooperation between the actors.

With these objectives in mind, two sites with rather different problems were chosen for inclusion in the project:

[1] *Pilot project. Delimitation of European Agglomerations by remote sensing - Results and Conclusions, Eurostat 1995.* Report on the "Remote Sensing and Urban Statistics Project".

- the Boulogne-Calaisis site comprising the coastal zone with its two urban agglomerations and the abovementioned transport infrastructures, in the heart of a particularly rich and sensitive natural environment. The decision not to extend the perimeter of the observation site to include Dunkirk was deliberate, because it had already been selected as a remote sensing study site in the framework of the Programme of research on urban ecosystems mounted by the French Ministry of the Environment[2];
- *the Metropolitan zone of Lille-Roubaix-Tourcoing*, constituting an agglomeration of approximately 1 million inhabitants.

These two sites were observed at five-year intervals (1990-1995 in the case of the coastal zone and 1990-1993 in that of the metropolitan zone). The apparent shortness of this delta t for the analysis of the data collected by remote sensing methods was justified by the phasing of the various large-scale projects, i.e. the Channel/Tunnel, the coastal motorway, the TGV lines and (in the metropolitan zone) the major urban development programme known as the "EURALILLE" project.

These analyses enabled the partners in the project to carry out the morphological definition of the various urban zones and agglomerations and to improve their Geographical Information Systems by the addition of land cover maps in raster format and land use maps in vector format on a scale of reference of 1/25 000.

2. Partnership

In spite of the inherent complexity of any project involving too many actors, *the idea of planning the project on the basis of an open partnership was adopted at a very early stage.*

There were two main reasons for this choice: the first pragmatic reason was the far from negligible cost of processing satellite images. The cost had to be shared in accordance with the principle (which must not be misapplied, however) that budgetary restrictions at least oblige the various actors to work together in a spirit of complementarity rather than competition: in other words, it is quite inconceivable that the costly development of tools of interest to several institutional partners should be set in train in the absence of any formal structure for cooperation and exchange.

The second reason was the multiplicity of actors in the domain of regional planning. France is frequently described as a highly centralised country, but it also has a large number of number of decisionmaking bodies at the various levels of the territorial hierarchy including "Conseils Régionaux" at the regional level, "Conseils Généraux" at the departmental level, Government services at both the regional and departmental levels, "Communes" (36.000 in all, including 1.500 in Nord-Pas de Calais), and groups of communes of the type exemplified by the "Communauté Urbaine de Lille" which has more than 80 Communes and covers the agglomeration of Lille-Roubaix-Tourcoing. And the complexity of the study was compounded by the inclusion of the trans-frontier metropolitan area and the involvement of the Belgian territorial structures.

The partnership arrangements for this project have resulted in the cooperation of several of these actors: the organization mounting the project, the "Observatoire Régional de l'Habitat Nord-Pas de Calais" (ORHA), is itself composed of several actors including the State and the "Conseil Régional", the "Agence de Développement et d'Urbanisme de la Métropole Lilloise" and its Belgian counterpart, the COPIT, together with the Statistical Office of the European Union (Eurostat).

It should also be noted that the technical departments of the organisations commissioning the study are represented on the Technical Committee appointed to coordinate and participate in the work. They include the "Direction Régional de l'Equipement Nord-Pas Calais", the "Direction du Plan et de la Statistique" (on behalf of the "Conseil Régional") and the CESD-Communautaire (on behalf of Eurostat). The other bodies providing expertise include the "INSEE" (Institut National de la Statistique et des Etudes Economiques - France), the "Direction Régionale de l'Environnement", the IGN (Institut Géographique National -equivalent to the Ordnance Survey), the "Centre Technique de l'Équipement" (the CETE Nord-Picardie), the "Directions Départementales d'Équipement" (the DDEs of the Nord and Pas de Calais departments) and the University of Liège.

[2] Officials responsible for this Programme participated in the activities of the Technical Committee of the present project.

3. Realisation

3.1 Plan of action

The plan of action is divided into three phases to be tackled on completion of the preliminary studies and project planning work (started in 1994) which resulted in the commissioning of two joint contractors (one in France and the other in Belgium) to collect and collate the cartographical data produced by remote sensing and to ensure the technical application of the protocols for their validation.

Each phase covers a period of approximately 18 months:

- phase I was when the project really got off the ground in the first half of 1995 and consisted essentially in the elaboration of the land use nomenclature based on Eurostat's standard known as CLUSTERS[3];
- phase II was launched in mid-1995 and consisted in the collection and collation of the data by the joint contractors;
- phase III was launched at the beginning of 1996 and consists in a first exploitation of the data collected by the experts of the Technical Committee in phase 2 and the presentation of the full results of the project at a seminar to be held in the first quarter of 1996.

3.2 A few questions put to the Technical Committee

At the present stage of the project, i.e. the commencement of phase III at the beginning of January 1996, and without going so far to talk of a first set of results, it seems appropriate to draw attention to a few of the main questions to which the Technical committee has had to deliver pertinent responses:

- *definition of the land use nomenclature:* although we have many years' experience of the use of remote sensing to deal with environmental problems, its application to man-made urban environments began only recently. It requires the definition of an appropriate land use nomenclature; and that confronts us with a certain number of methodological problems: the distinction between cover and use, which is perfectly clear in natural environments, can be much less clear in a man-made environment, so that a given man-made surface may require a multiple coding. The CLUSTERS nomenclature, developed to its most finely-drawn level to ensure its adaptation to the specific characteristics of the regional territory, appeared to be the most appropriate nomenclature for this study although very careful attention had to be paid to the conversion systems enabling compatibility with CORINE LAND COVER at different levels of aggregation;
- *definition of minimum observation units:* precise rules (which will not be spelled out here) were formulated for the purpose of defining the size limits of the spatial elements, particularly in an urban environment in which a far lower threshold than a hectare was to be applied;
- *map validation procedure:* this aspect was prioritized right from the start, when the technical specifications were being worked out, especially as the objectives of the project included an evaluation of the reliability of remote sensing methods of observation of land use in an urban environment. The areas selected for this study were particularly interesting because the sources available to the partners included not only satellite images but also various auxiliary data sources (e.g. aerial photographs);
- *definition of agglomerations:* finally, it is well known that when we get beyond the limits of the few elementary rules with regard to the continuity of built-up zones, the make-up of the agglomeration concept is not precisely the same for the different users. The definition proposed by Eurostat was adopted after consultations with the INSEE.

[3] See the land occupation and use nomenclatures in annex

4. Concluding remarks: the benefits to be gained

In the age of the new media and telecommunication networks for the circulation of information, it is more than ever necessary to ensure the adoption, at a technical level, of the standards and common concepts that will obviate the risk of a "Tower of Babylon" situation with regard to the definition of land use nomenclatures, the agglomeration concept, the systematisation of the application of visual photo-interpretation techniques to major urban agglomerations, etc.

This cooperation must continue at both the national and European levels.

ANNEXES

Annex 1: Headings in the nomenclature of land-use maps

- dense urban
- discontinuous urban
- crops
- deciduous
- coniferous
- pastures and meadows
- waters
- bare soils

Annex 2: Land use nomenclature based on CLUSTERS

Residential areas and Public services

- A111 Continuous and dense residential areas
- A112 Continuous residential areas of moderate density
- A113 Discontinuous residential areas of moderate density
- A114 Isolated residential areas
- A115 Collective residential areas
- A121 Campus and university areas
- A122 Health center and buildings
- A123 Militaries areas
- A124 Collectivities & publics services - others

Industrial or commercial activities

- A201 Heavy industry
- A202 Manufacturing industrial activities
- A203 Commercial and financial activities and services
- A204 Agricultural holdings

Technical and transport infrastructures

- A311 Technical networks, protective structures
- A312 Water and waste treatment
- A321 Road transport
- A322 Rail networks
- A323 Airport and aerodromes
- A324 River and maritime transport

Extractive industries, building sites, tips and wasteland

- A411 Managed Coal tips
- A412 Managed Quarries
- A413 Other industries (extractives)
- A421 Building sites
- A422 Tips
- A423 Wasteland

Land developed for recreational purposes

- A501 Cultivar sites
- A502 Sport facilities
- A503 Green or leisure areas

Utilised agricultural areas

- B1 Tilled and fallowed land
- B2 Areas under grass used for agricultural purposes
- B3 Permanent crops

Forests

- C11 Deciduous trees
- C13 Conifers
- C14 Intensively managed plantations
- C21 Clear-cut zones

Bush or herbaceous areas

- D1 Bushes
- D2 Herbaceous vegetation

Surface with little or no vegetation

- E011 Rocks and scree
- E012 Dunes and beaches

Wet surfaces and surfaces under water

- F1 Wet surfaces
- F2 Inland water
- F3 Coastal water

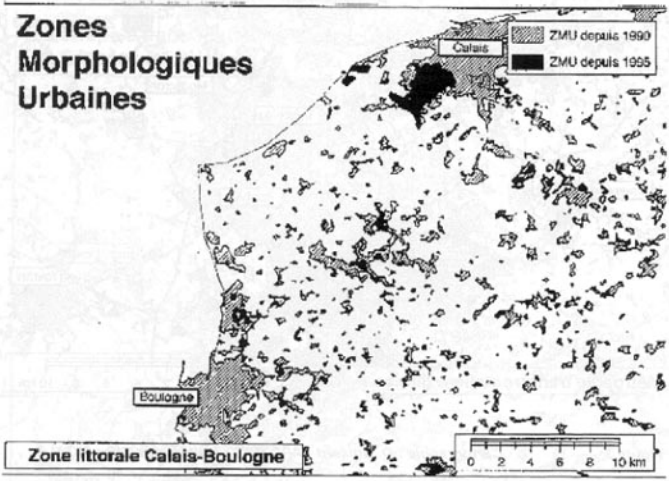

Figure 2 *Cartographie : O. Boisard - ARD-DPS / Traitements SIG : SIGALE*

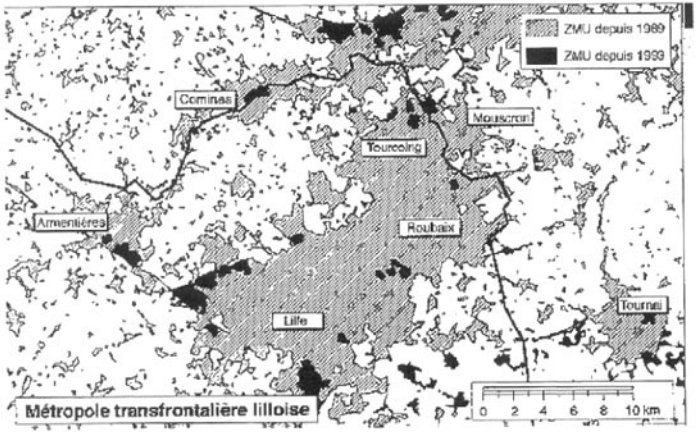

Figure 3 *Cartographie : O. Boisard - ARD-DPS / Traitements SIG : SIGALE*

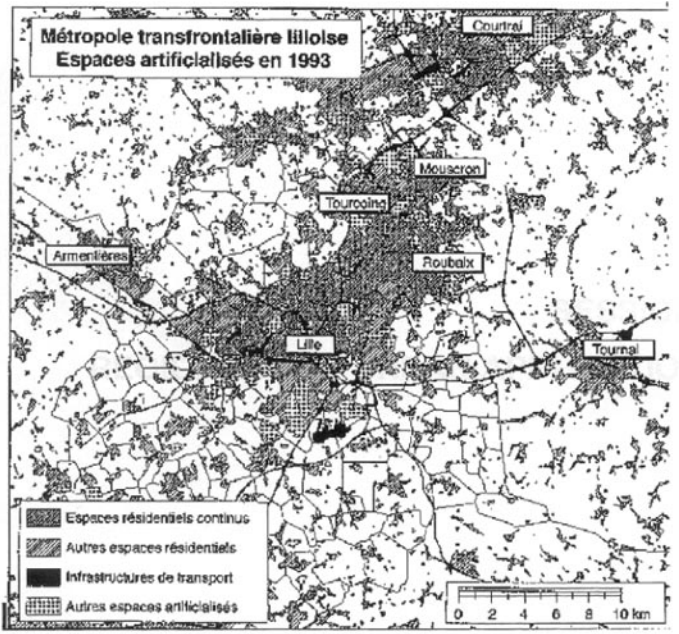

Figure 4 *Cartographie : O. Boisard - ARD-DPS / Traitements SIG : SIGALE*