

Mapping Europe's Environment
From CORINE Land Cover to European Spatial Analysis
Michel Cornaert

Abstract

CORINE Land Cover is a truly European information base at the service of sustainable development policies in the European Union.

The presentation puts the CORINE Land Cover project in perspective, describes its main characteristics, illustrates typical uses of the information and identifies some lessons of importance for Land Cover as well as for European information in general.

Thanks are due to Chris Steenmans and Ronan Uhel for their contributions to the paper.

The presentation is dedicated to Gunter Schneider whose vision and energy enabled the early development of environmental information for European Community policies.

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Let me first express my thanks to the Agency for inviting me to give a presentation on CORINE Land Cover. Having been involved in its development for quite some years, I am always pleased to talk about the Land Cover project. But it is a special pleasure and honour to do this at the 10th Anniversary of the European Environment Agency and in front of such a large audience of experts and personalities, all dedicated to the improvement of environmental information in Europe.

CORINE Land Cover provides comparable information across the whole European territory on what covers land: urban areas, crops, meadows, forests and natural vegetation, wetlands and water. This information allows comparisons between countries and between regions, while at the same time emphasising the extraordinary diversity of European landscapes: natural areas, complex coastal landscapes, densely urbanised metropolitan areas (see Figure 1). CORINE Land Cover is of considerable importance for environment, agriculture and spatial planning policies in Europe. It thus constitutes a vital element of the Information System of the European Environment Agency and of its Member Countries. Moreover it offers solid experience on the difficulties facing the production of European information and on ways to overcome these.

1. The development of environmental information in Europe

1.1. 10-year stages?

10 years ago, the European Environment Agency was established in Copenhagen.

20 years ago, at the end of 1984, the CORINE Programme was launched.

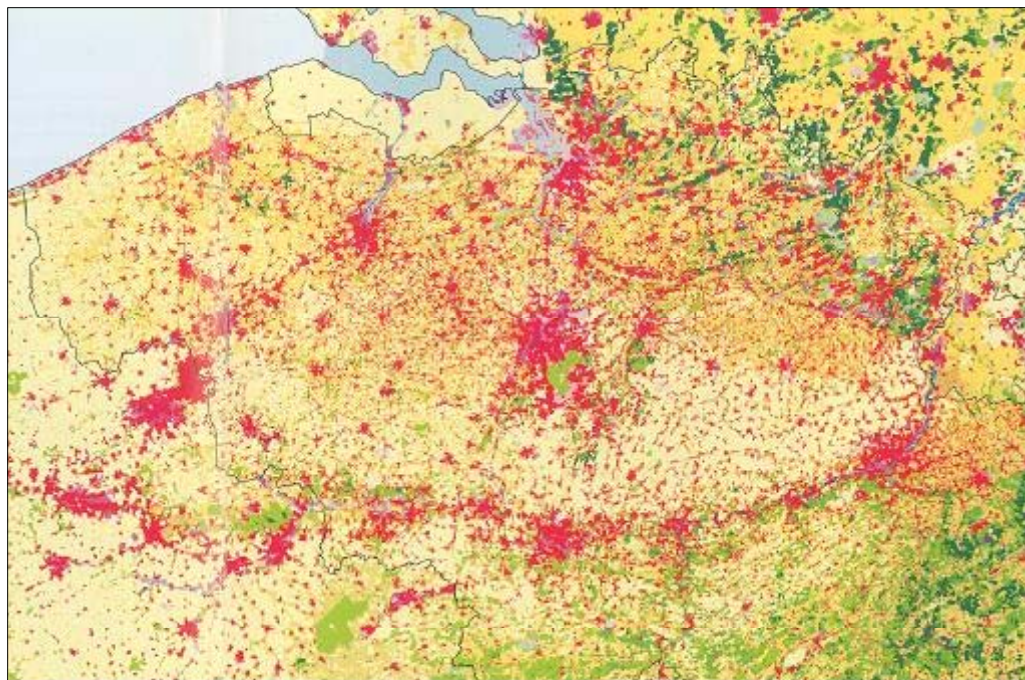


Figure 1: Land Cover of the North-West Metropolis of Europe.

30 years ago, in November 1974, the European Council asked the Commission to work on environmental information.

Important steps in this domain seem to occur at 10 years intervals! The 10th Anniversary of the Agency is therefore a good point to take stock on progress.

1.2. 1974-1984. The "Ecological Mapping" of the European Community

The first Programme of the European Environment policy was adopted in 1973¹. Barely one year later, the Council was prompted to discuss an Italian Memorandum stressing that environmental policy has to be based on sound information. This discussion led the Council to request the Commission "to start work on a classification of the Community territory on the basis of its environmental characteristics, so that individual objectives and measures could be crystallised and laid down"². The policy demand was clearly formulated: priorities have to be set and these priorities have to be based on good information.

Following the Council's request the European Commission reviewed the state of the art in environmental information in the then 9 Member States. Experience as well as availability of data and of methods were analysed. A method for "classifying the European territory on the basis of its environmental characteristics" was developed and tested in 9 regions. This allowed to identify the issues linked to the Council request, among which:

- the availability of data and of methods was poor but thought to be sufficient to make a start and allow rough assessments for a number of environmental areas of concern,
- with the emergence of environment policies, methods and nomenclatures to describe the environment were rapidly proliferating, stimulated by academic research and administrative regulations. As a result virtually no data sets were comparable at national level, let alone at European level,

- the policy demand ("classify the territory of the European Community") appeared to be ahead of what scientists could or would be prepared to offer. Many experts were reluctant to work on European classifications, claiming that scientific knowledge would not be advanced enough to allow for such integrated assessments and classifications to be developed at European level,

- new technologies - remote sensing from satellites and Geographical Information Systems – were becoming operational and should be put at use in this project. In particular a study in 1979 had demonstrated that mapping European Land Cover was feasible.

These initial steps led to the following results:

- By early 1980 a System of Environmental Indicators for the European Community had been designed and tested. It combined indicators of vulnerability, of pressure and of state to provide assessments in five areas of concern: Air, Water, Soil, Landscape, Natural Hazards.

- In 1983 the European Commission adopted a proposal³ for a programme selecting a few priority topics from the System of Indicators. The focus had been put on policy priorities of the Environment programme: Nature protection, Acidification, Natural resources in the Mediterranean area.

- By the end of 1984, following a positive opinion of the European Parliament, the Council had agreed on an Experimental Programme for the Collection, the Coordination and the Consistency of Information on Environment and natural resources in the European Community⁴ : the CORINE Programme.

1.3. The CORINE Programme

The CORINE Programme developed from 1985 to 1990, produced a decisive breakthrough in environmental information: i) an operational Information System; ii) agreements at national and international levels to ensure complementarity with related initiatives; iii) European nomenclatures and methodologies, shared know-how and expert networks.

In particular a Geographical Information System had been assembled which contained a series of data layers of relevance to European environmental policies:

- an inventory of Biotopes of major interest for nature protection, which helped in many ways the compilation of data on the Natura 2000 sites;
- a data base on the atmospheric emissions of pollutants (Corinair);
- maps of soil quality and soil erosion risk in the Mediterranean regions of the European Community,
- a Coastal erosion data base,
- and a Land Cover data base (see below).

Pending a decision on the location of the European Environment Agency, the CORINE Information System was maintained from 1991 to 1994 and extended to Central and Eastern Europe. During this period, the CORINE results, know-how and expert networks helped preparing the first multi-annual programme of the European Environment Agency. Since then they have been maintained and further developed as part of the successive EEA programmes.

2. CORINE Land Cover

2.1. The methodological approach and its implementation.

A methodological approach was developed and tested in 1985-86 in 10 regions of the European Community, which demonstrated the feasibility of the approach.

In summary, the principles of the method, (which proved to work and continue to be applied) include the following main step:

- Satellite images are acquired, corrected geometrically and radiometrically, then the mosaics are produced. These operations are conducted centrally.
- The satellite scenes are then used in combination with other data sources to identify homogeneous classes of Land Cover and to map these at 1/100.000 scale according to the 44 class CORINE nomenclature and guidebook. This is performed by national or regional teams, totalling some 100 teams of interpreters trained to the common method.
- The validity of the results is then checked and validated by a European central team and incorporated in the CORINE Land Cover information system.

Having proved the methodological feasibility, the next step was to check the practicability of mapping Europe's territory in a short period of time and for an affordable budget. With this aim in mind the territory of Portugal (90.000 km²) was mapped in 1987 in less than a year. The success of the real-size test encouraged Spain, South of France and South of Italy to embark in the project, soon followed by the Netherlands, Greece, Ireland, Denmark and the Eastern part of Germany. By the mid-90s, nearly the whole Community territory and 6 countries of Central and Eastern Europe, as well as coastal regions in North Africa, had been completed or were close to finish.

The project had been making intensive use of most advanced developments in GIS and analysis of data from satellite Earth Observation. Highly skilled teams at central and national level were able to master the still-evolving techniques and solve the problems as they arose. The real issue however was not one of technical nature but one of management and of funding.

Mapping large territories across borders in a consistent way at 1/100.000 scale had never been done before. The challenge was ensure the production of comparable data by some 100 working teams distributed all over Europe. Strict procedures for training the teams to the common method prior to the start, controls during the execution of the work and validation of the results proved indispensable to the success of the project.

Furthermore the cost of the project by far exceeded the budget allocated to the CORINE programme and complementary funds had to be raised from potential users. In fact the CORINE budget has been used mainly for methodological developments, tests and validation as well as for "pump-priming". The largest part of the costs has been met by budgets of user services, in particular the EC Regional Fund and the PHARE programme, and by national contributions. In addition, the LIFE programme co-funded the realisation of CORINE Land Cover outside of the European Union, e.g. in Tunisia, Morocco or Croatia.

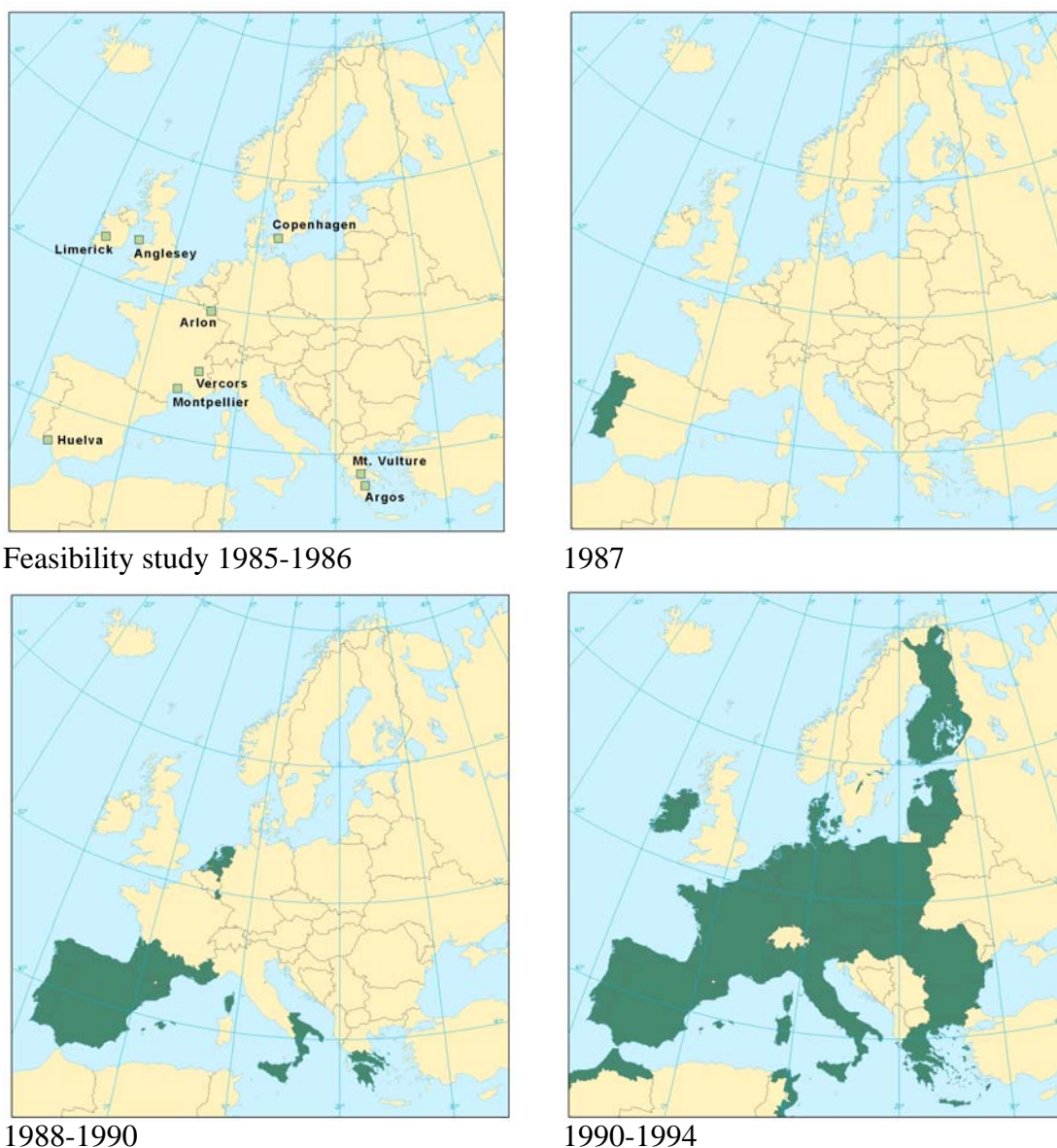


Figure 2. The realisation of the first CORINE Land Cover mapping.

Based on the experience acquired, the CLC inventory has been updated for the year 2000 in a much shorter period of time (2001-2004).

2.2. Using CORINE Land Cover data

Since the first sets of Land Cover data have become available, thousands of requests for data have been registered and met. Examples of use typically include environmental and territorial planning, nature conservation, agriculture and forestry, water and land management. However potential uses are not always predictable: for example one of the very first requests for CLC data in 1990 came from a mobile telephone company wanting to optimise the positioning of their antennas.

The examples below illustrate typical uses of CORINE Land Cover data. Whilst the range of topics addressed is fairly broad, it is important to bear in mind that CLC is not an all-purpose instrument. At the outset it has been developed to serve European environment and territorial policies, which are concerned with either the whole territory of the European Union (see Figure 3) or transfrontier regions, such as catchment areas. In addition the tool is also used at national and regional level for analyses of large areas (see Figure 4). Clearly however it has not been designed to support local policies and others, although at that level it can provide an element of broader spatial context.

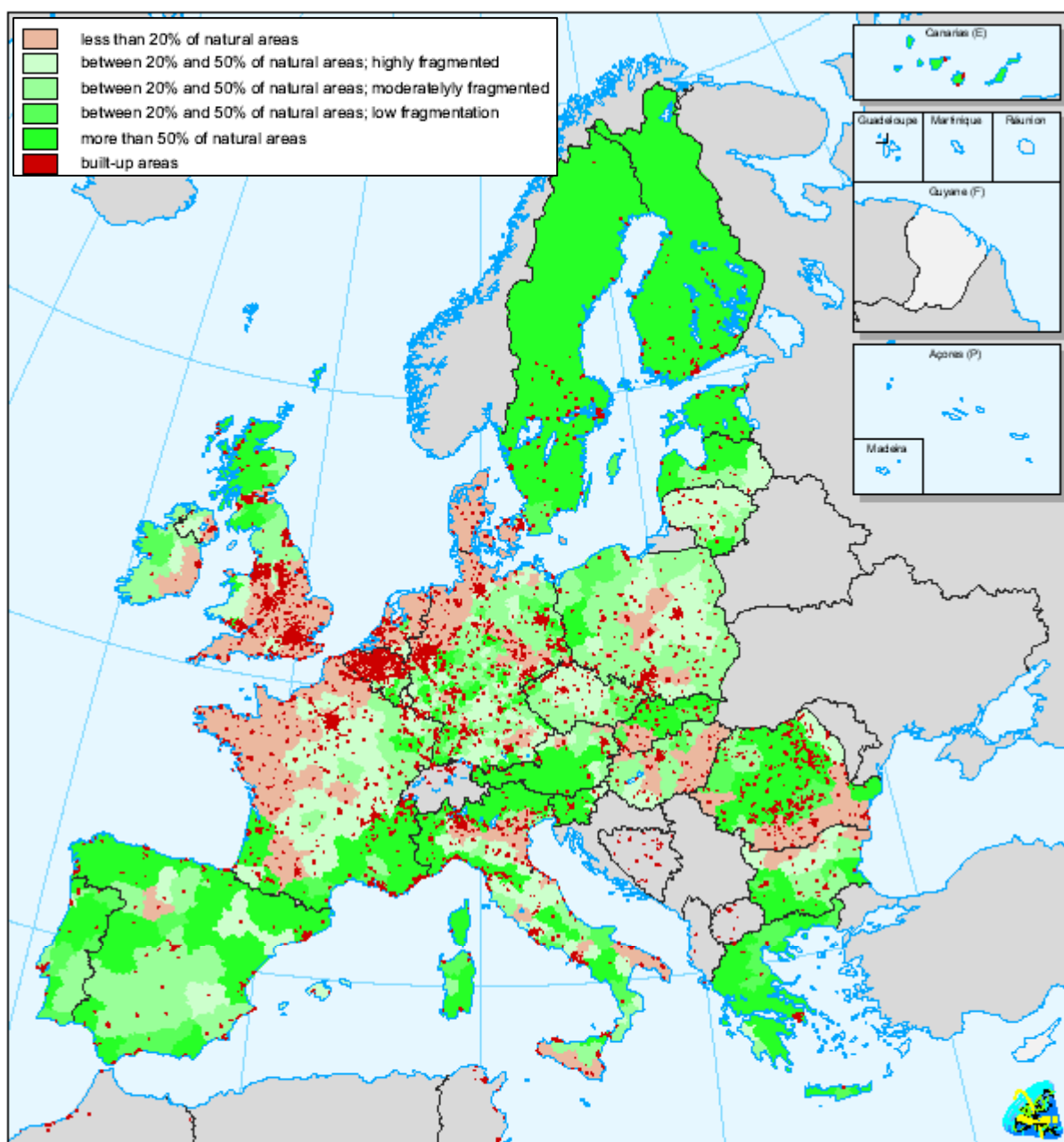


Figure 3: Territorial diversity – degree of fragmentation of natural areas. Source: Third report on economic and social cohesion. European Commission. February 2004.

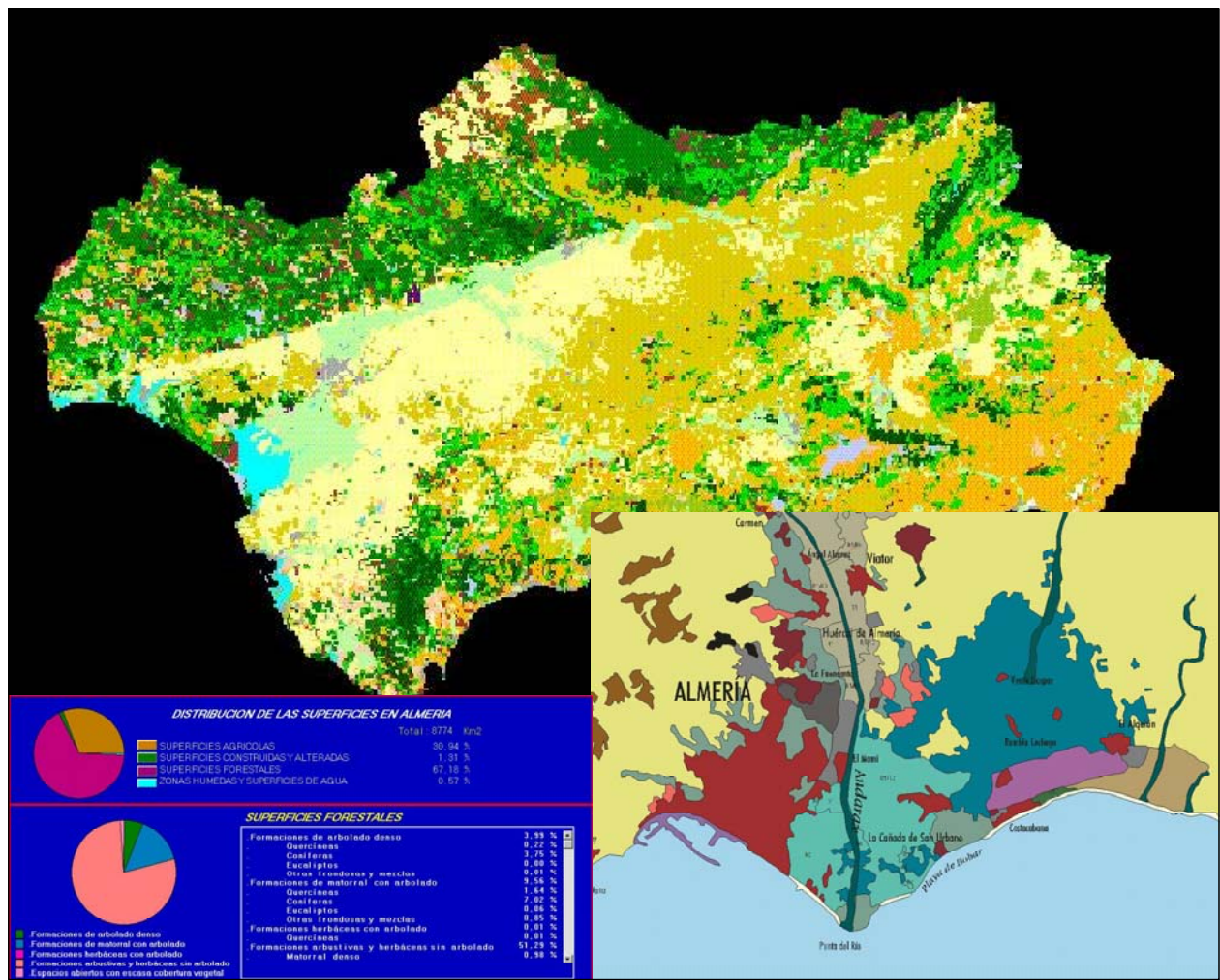


Figure 4: CORINE Land Cover is an important element of the Environmental Information System of Andalusia.

Land Cover is used in two main ways:

- i. as only data input, to provide statistics of Land Cover by administrative or natural unit and of Land Cover change over time; as such it provides a central input to environmental accounts;
- ii. as one among many data inputs to integrated assessments; it often also provides an adequate geographic frame for modelling work, adding value to socio-economic statistics.

Land Cover statistics show differences between geographic areas (natural or administrative) reflecting different pressures on the environment.

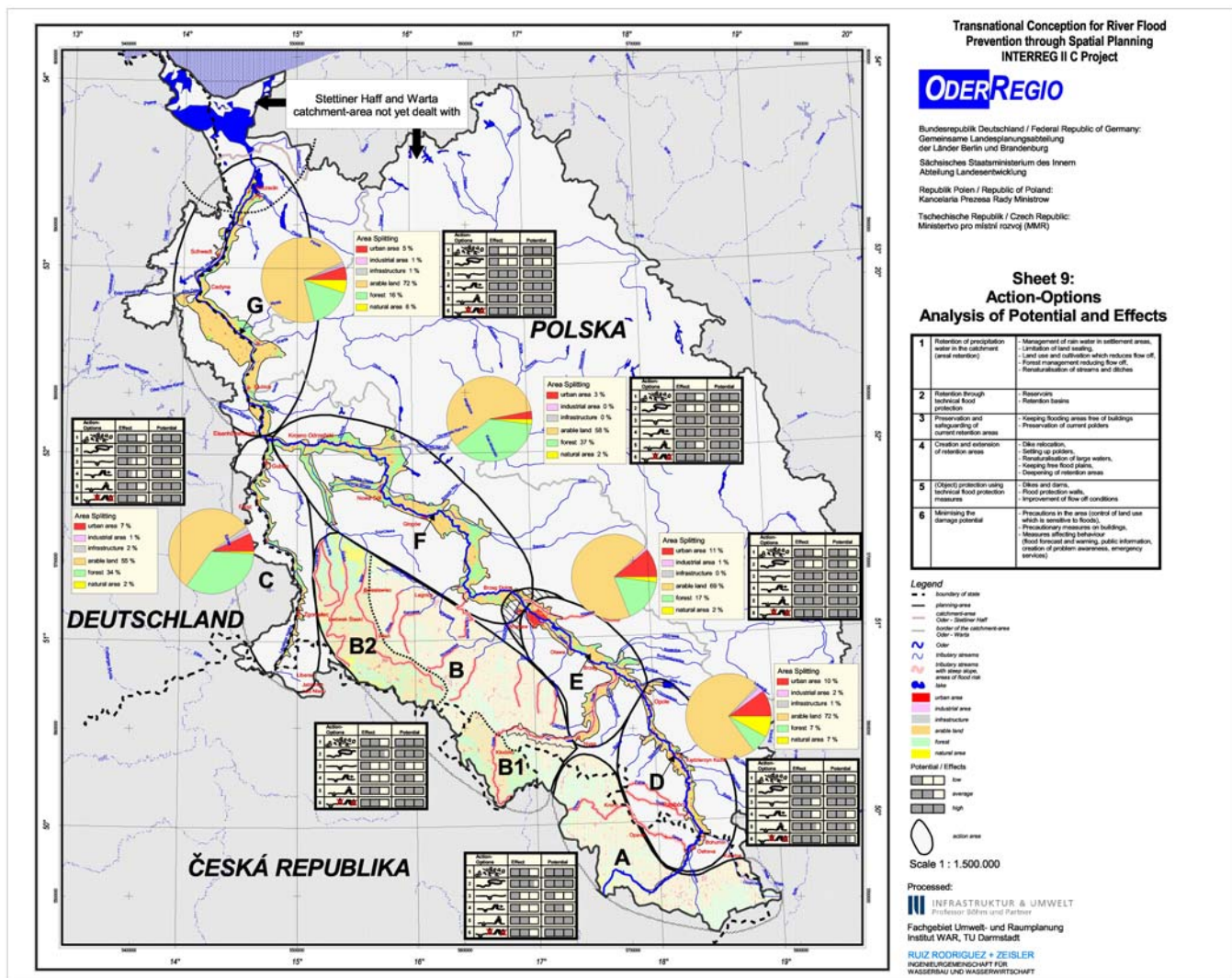


Figure 5: *ODER Regio Transnational Cooperation for river flood prevention through spatial planning*

Land Cover change is an interesting response indicator. For example, the Lacoast project⁵ showed that in many countries policies in place did not prevent further urbanisation of the coastline.

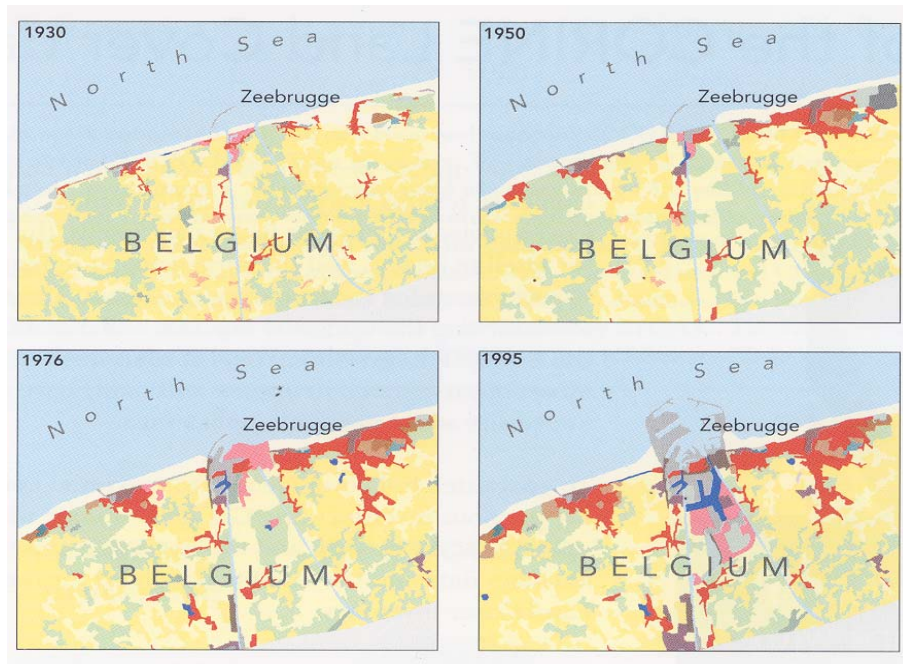


Figure 6: Land cover changes in the Zeebrugge area (Belgium)

Landscape change scenarios have been generated combining Land Cover, digital elevation model and pictures of landscape elements.

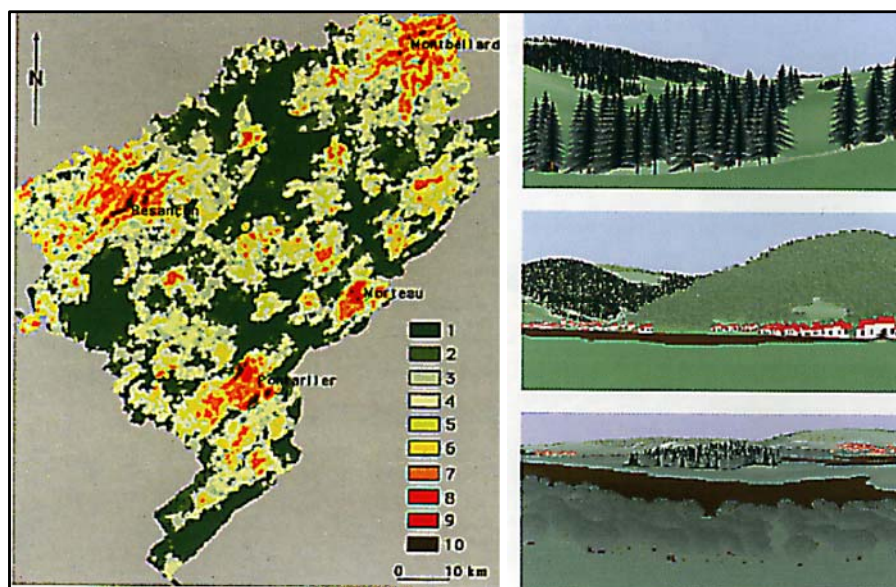
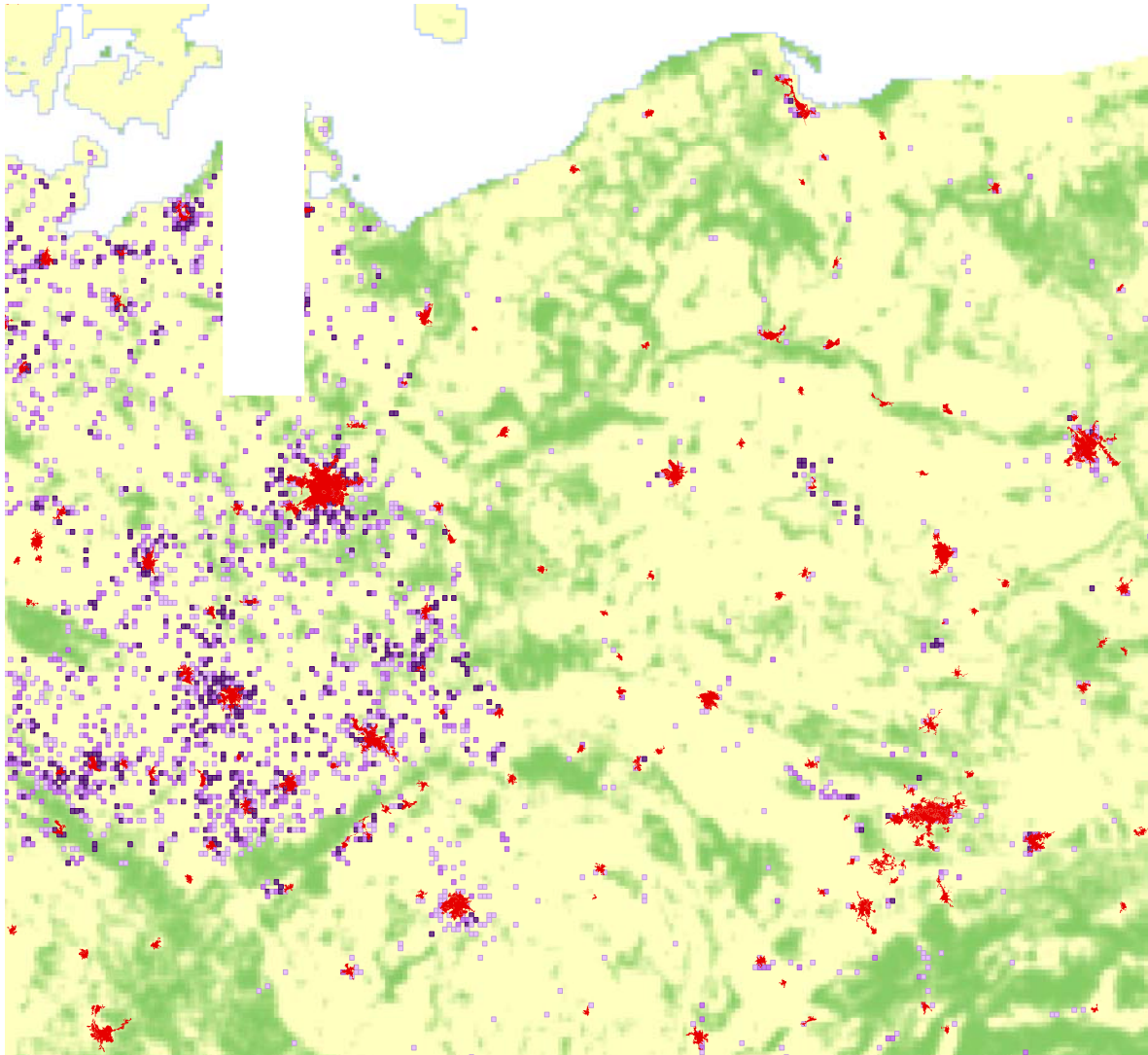


Figure 7: Analysis of landscape evolution in Franche-Comté region.







Land Cover data has been used to assess the degree of fragmentation of natural areas as a contribution to the Commission's 3rd report on social and economic cohesion in the EU (see Figure 3) and the same data plus the 2000 update is being used to analyse the related urban sprawl (see Figure 8).

Figure 8. East Germany / Poland/ North Czech Republic Urban sprawl (1990-2000)



Legend

Total urban sprawl

-  2% - 5%
-  5% - 10%
-  more than 10%
-  Urban morphological zones, pop. > 50000
-  High natural potential: 100
-  Low natural potential: 0

In combination with agricultural and socio-economic statistics, Land Cover has been used to assess nitrogen surpluses at the water catchment level under various policy scenarios.

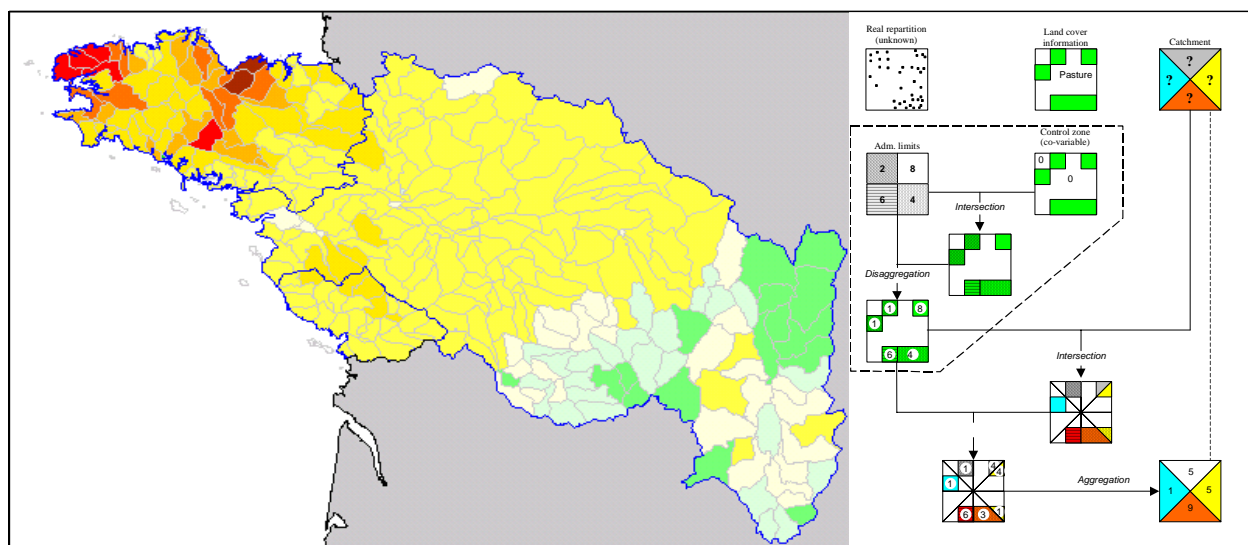


Figure 9: Nitrogen surpluses in the Loire river catchment areas. (Source EEA- IFEN 2000)

3. Mapping European Land Cover : some lessons learned

3.1. Problems: not always where expected.

In the course of the realisation of CORINE Land Cover, many problems were met and solved. Some had been anticipated thanks to the feasibility studies, but others came rather as a surprise, such as the following two:

- i. The technologically and economically most advanced EC countries had been expected to take the lead and spearhead the realisation of the project. In reality what happened is that the countries which had most recently joined the European Community (Portugal, Spain) as well as the countries of Central and Eastern Europe were faster to start and complete the work and that they performed remarkably well both in terms of quality of the product and of compliance to planning.
- ii. One had expected the academic world to support enthusiastically such a challenging European project, but the response was rather soft when not cold. Some researchers would question the users choice of a medium resolution map or of some classes of the nomenclature. Others would advise to wait until better resolution satellites would become available. Many would insist that automatic classifications of satellite data were nearly ready and one should not proceed with visual interpretation. In short, the disappointing message sounded like: "it is urgent to wait."

3.2. Sharing work and costs

One of the lead principles of the European Union – the subsidiarity principle - establishes that action should be taken at the level where it is most efficient (European, national, regional, local) and that the respective levels of competence should cooperate. The realisation of CORINE Land Cover is a good example of implementation of the subsidiarity principle.

- i. The task of the European level was to guarantee the quality and comparability of the results. The development and testing of one European method and nomenclature was a joint task of all levels concerned, together with the users. The European level was responsible to ensure consistent implementation in all parts of Europe and over time. This implied the formalisation of the method and the existence of a permanent small central team in charge of training the regional teams, controlling the images, monitoring progress and validating the results. Mapping was performed in some 100 national and regional teams.

An interesting aspect of subsidiarity is illustrated by the modular character of the legend. The European Land Cover nomenclature has 44 classes, and applies without modification to the whole of Europe. However any of these classes can be split at a lower level of nomenclature to reflect regional diversity or local needs. "Peat bogs", for example fall under one class (4.1.2), which is sufficient for European land cover information. But an Irish land cover mapping may well justify half a dozen sub-classes of peat bogs.

- ii. Funding was shared between the European and the national levels. For the European contribution, user services would take over the largest share of the costs (see point 2.1). This set up is essential since it commits responsibility of all partners involved. Although it may sometimes complicate the administration of the project, shared funding has thus been continued for the realisation of CLC 2000.

3.3. Know-how and networks

Two very important products of CORINE Land Cover are the know-how shared between the central and the national teams as well as the networks of responsible persons and of experts set up to manage and to realise the project. Indeed, although this may not be directly perceptible, know-how and networks are indispensable for the successful production of Land Cover data and of environmental information in general. Since these are very long and costly to assemble it is essential to keep them alive. Right from the beginning, the EEA regulation recognised the importance of the human dimension in specifying a key role of EIONET in the development of the EEA.

3.4. Final consideration: data policy and continuity

Finally it must be stressed that, successful as they may be, all these efforts will be in vain unless:

- i. resulting data are made widely available and their use is proactively encouraged. This approach to data policy has been adopted by the European Environment Agency since its beginning 10 years ago and by some of its Member countries and should be actively pursued.
- ii. continuity of the inventories and comparability over time are secured. The first two inventories (1990 and 2000) have been realised on a "voluntary basis". However continuity needs a firmer basis. The current proposal for a directive on establishing an infrastructure for spatial information in the Community (INSPIRE)⁶ rightly includes Land Cover as an essential data set. However it misses to explicitly specify the need for continuity with the previous two CORINE inventories. The discussion of the proposal in the Council and European Parliament will offer the possibility to consider this point.

References:

¹ Council Resolution of 22 November 1973. OJ C 112 of 20.12.1973

² Conclusions of the Council meeting 7 November 1974.

³ COM(83)528.

⁴ Council Decision 85/338/EEC of 27.05.1985. OJ L176 of 06.07.1985

⁵ Lacoast. Land Cover changes in coastal areas. JRC 1999.

⁶ COM(2004)516 of 23.7.2004