Topic report No 4/2001

# Land cover
# Annual topic update 2000

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A great deal of additional information on the European Union is available on the Internet.
It can be accessed through the Europa server (http://europa.eu.int).



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# Contents

# 1. The European Topic Centre on Land Cover

## 1.1. Background

The European Topic Centre on Land Cover (ETC/LC) is organised as a consortium of 16 partners as listed in Table 1. The ETC/LC is led by Satellus AB which is based in Sweden. The Joint Research Centre co-leads the topic centre. During 2000, the Joint Research Centre coordinated the IMAGE2000 project. The Phare Topic Link on Land Cover (PTL/LC, financed by the Phare programme of the Directorate-General for Enlargement) is the extension of the topic centre towards central and eastern Europe. The PTL/LC was established in 1997 and has worked closely with the ETC/LC following an integrated work programme with common deliverables for several tasks. Besides the information provided in this report for the year 2000, specific information on products and progress of work can be found on the web sites http://ptl.gisat.cz/ptl/ and http://etc-lc.eionet.eu.int/.

**Table 1: Composition of the ETC/LC consortium**

| Organisation | Acronym | Country |
|---|---|---|
| Satellus AB | Satellus | Sweden |
| Geospace | Geospace | Austria |
| Geographic Information Management | GIM | Belgium |
| National Environmental Research Institute | NERI | Denmark |
| Finnish Environment Institute | FEI | Finland |
| Institut Français de l'Environnement | IFEN | France |
| Federal Statistics Office | StBA | Germany |
| Hellenic Mapping and Cadastral Organisation | HEMCO | Greece |
| Natural Resources Development Centre | NRDC | Ireland |
| EU Joint Research Centre/Space Applications Institute | JRC/SAI | Italy |
| Centro Interregionale | CI | Italy |
| Centre de Recherche Publique — Henri Tudor | CRP-HT | Luxembourg |
| Centro Nacional de Informação Geográfica | CNIG | Portugal |
| Instituto Geográfico Nacional | IGN | Spain |
| Winand Staring Centre for Integrated Land, Soil and Water Research | SC-DLO | Netherlands |
| Institute of Terrestrial Ecology[1] | ITE | United Kingdom |

The leader of the ETC/LC during the year 2000 was Martin Krynitz of Satellus AB.

[1] As of April 2000 ITE became part of CEH (Centre for Ecology and Hydrology)

## 1.2. EIONET primary contact points for land cover (in EEA member countries)

**Table 2: Overview of the EIONET primary contact points for land cover**

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NRC — National Reference Centre,
NFP — National Focal Point,
PCP — Primary Contact Point

**Table 3: Overview of the Phare EIONET primary contact points for land cover**

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NRC — National Reference Centre,
NFP — National Focal Point,
PCP — Primary Contact Point

## 1.3. Work plan for 2000

The main emphasis of the work plan of the ETC/LC and PTL/LC in 2000 was on:

— technical coordination of the Corine land cover update which started in 2000;
— organising the annual EIONET land cover workshop in Prague where the emerging needs for land cover information and the implementation of CLC2000 were discussed;
— maintaining the Corine land cover database as a key dataset for spatial analysis, integrated assessment and geographic information system (GIS) support to the EEA and its topic centres as well as support to environmental indicator reporting;
— providing an assessment report on carbon sinks based on Corine land cover data and other geographical data (e.g. soil map of Europe);
— integrating land cover with other georeferenced data to provide statistics and information for different environmental reporting units (e.g. biogeographic regions, watersheds).

The ETC/LC uses the EEA web site and its own web site to provide access to products relevant to the general public. Documents regarding the CLC2000 update are available to EIONET partners on the web site of the Circle interest group on spatial analysis (http://eea.eionet.eu.int:8980/public/irc/eionet-circle/home/main).

# 2. State of play on the Corine land cover database

## 2.1. Objectives of land cover update 2000

From 1985 to 1990, the European Commission carried out the Corine (coordination of information on the environment in Europe) programme. During this period, an information system on the state of the environment and also nomenclatures and methodologies were developed. The Council of Ministers decided in 1990 to set up the European Environment Agency (EEA) and to establish the European Environment Information and Observation Network (EIONET). At the Dob íš conference in 1991, the Corine programme was also extended to Phare partner countries.

Today, Corine land cover (CLC) is recognised by decision-makers as a key reference dataset for spatial and territorial analysis for different regional and natural reporting units. Within the Commission services, such as the Directorates-General for Regional Policy, Environment, and Agriculture, as well as the EEA and its topic centres, a growing need for spatial and territorial analysis exists. These demands represent both a justification and an obligation for ensuring the update of the CLC database.

The objective of the I&CLC2000 project is to update the Corine land cover database. Although initially only EU Member States were foreseen to take part in this update, the Phare countries have already submitted official requests to the EEA to extend the project to their area. The I&CLC2000 project aims to provide a satellite image snapshot of Europe (IMAGE2000), an up-to-date land cover map for the year 2000 (CLC2000) and information on main land cover changes in Europe during the period 1990–2000. The project was estimated at EUR 10 million for the EU Member States and will be co-funded by the participating countries and the European Community. The estimated duration of the project is three years (2001–03).

To reach this goal, the EEA and the Joint Research Centre (JRC) in Ispra have agreed on a joint management in which the JRC has the responsibility for the IMAGE2000 component (including purchasing and processing of satellite images) and the EEA is responsible for the CLC2000 part. In April 2000, the project was officially launched for Member States with a kick-off meeting.

The key tasks of the I&CLC2000 project are as follows:

— purchase and correction of satellite images;
— interpretation of land cover changes;
— data validation, integration into a seamless European land cover database and data dissemination;
— quality assurance and quality control.

A number of countries have already indicated their readiness to start the I&CLC2000 project in 2000 and 2001. The European data integration and quality control will be performed by the land cover support team and validated data will be made available for wide dissemination.

The dissemination and use of the I&CLC2000 products is defined in an agreement between the EEA and Member States in order to ensure the widest possible use of the

land cover databases (status and changes) as well as the satellite images. A wide range of environmental applications benefit from the new European geometric reference layer based on IMAGE2000. This layer provides a unique Europe-wide geometric reference of high geometric accuracy (25 m) and will also be made available to other applications outside the I&CLC2000 project.

The main outputs at European level of the I&CLC2000 project will be as follows:

— a geometric reference layer based on satellite images for the year 2000;
— an updated national and European CLC inventory for 2000;
— a database of land cover changes between 1990 and 2000 at national and European levels.

## 2.2. IMAGE2000

The IMAGE2000 project represents the first phase of the I&CLC2000 project where a geometric reference database is produced by ortho-correcting a satellite image of Europe with a digital elevation model. The resulting image database will be used for mapping changes comparing 1990 with 2000 information.

To ensure a consistent basis for the Corine update (CLC2000), a full cloud-free coverage of ortho-corrected satellite imagery over the 15 EU Member States has to be provided.

Compared with the earlier Corine project, where each country was responsible for the processing of satellite imagery, a centralised approach will lead to a more homogeneous coverage of ortho-corrected cloud-free satellite scenes. The basic concept is to use Landsat-7 imagery, with all eight spectral bands, including a panchromatic band providing up to 15 m ground resolution.

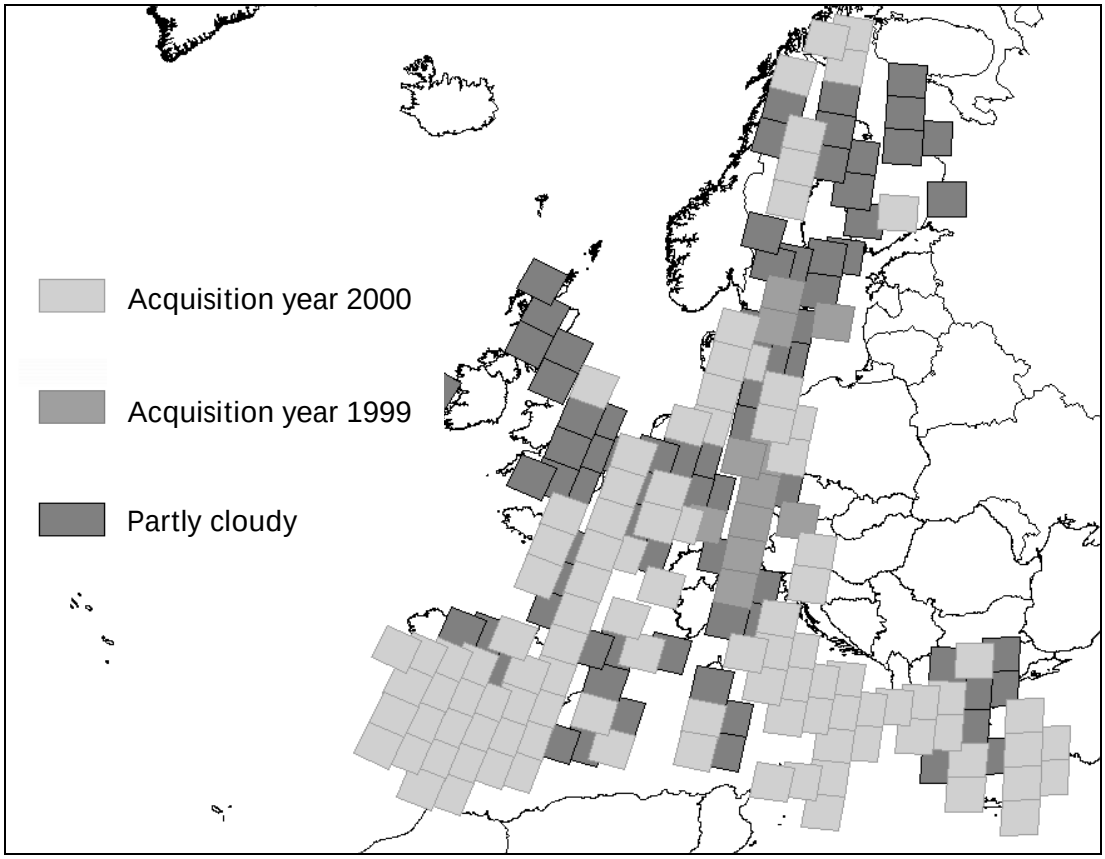
The coverage will mainly consist of Landsat-7 images from the summer of 2000 and, where necessary, it will be complemented with images from 1999 and 2001. As can be seen from Figure 1, the available coverage with imagery from 1999 and 2000 for a majority of countries is good. A campaign is planned for 2001 to fill the gaps in the coverage.

The national authority responsible for CLC2000 in each country defined an optimal time period for imagery acquisition to be used in the CLC2000 project. The figure shows the satellite scenes available for an acceptable time acquisition period (mainly summer images).

A web-based project management tool is used throughout the IMAGE2000 project. This tool allows ‘quicklooks’ of available images to be shown and downloaded and the progress of ortho-correction to be monitored.

The expected output of the IMAGE2000 project will be a national mosaic for each country using a national projection, as well as a European database in a European projection. These products will be available in different geometric resolutions. All results will be helpful for a large variety of other European and national projects and a prerequisite for updating the existing CLC database.

**Figure 1: IMAGE2000 coverage, 1999 and 2000 — Status, October 2000**




## 2.3. CLC2000 — Implementing the update of the present CLC database

CLC2000 aims at the creation of an up-to-date land cover map for the year 2000 based upon the satellite image snapshot for Europe provided by IMAGE2000. The implementation of the CLC2000 project started in a number of EU Member States during 2000. For this objective, the EEA and Member States carried out bilateral discussions addressing both the technical execution and the financial arrangements of the project.

This commitment was followed by a national kick-off meeting in which the EEA and Member States discussed and agreed upon:

— national planning (tendering process, start of work, training, results);
— national particularities (e.g. use of a different methodology);
— national results and contribution to the European database;
— designation of national authorities in charge of the I&CLC2000 project.

In order to ensure a harmonised start to the project in all participating countries, the EEA initiated several activities as follows.

— A technical coordinator was nominated to support the EEA in regular contacts with the Member States.
— Centralised image interpretation training will be organised by the land cover support team in the Member States. Experts from the CLC1990 inventory will train the new teams in order to ensure backward compatibility of the new data.
— A draft data quality handbook was prepared laying down the quality assurance guidelines for the implementation of the European CLC database. These

guidelines serve as minimum requirements to which the final product must comply in order to ensure harmonised European products. Specific criteria include geometric and thematic accuracy, common methods for measuring data quality and a proposal for data documentation. The data quality handbook will be finalised in 2001.

— A set of reference documents for a comprehensive and harmonised project execution have been provided to Member States (see Table 4). A central online access point to the digital documents has been created on the ETC/LC web site (http://etc.satellus.se/I&CLC2000/) and the EEA Circle interest group on spatial analysis web site (http://eea.eionet.eu.int:8980/public/irc/eionet-circle/home/main).

**Table 4: Reference documents for the I&CLC2000 project**

- *Corine land cover — Technical guide, 1994*
  This gives the basic principles and the methodology used for Corine land cover. The second part gives detailed illustrations of the Corine nomenclature.

- *Corine land cover technical guide — Addendum 2000*
  Guide providing a description of new methodological developments and enhancement of the description of the CLC nomenclature based on experiences from the extension of the CLC database to the central and east European countries.

- *Technical and methodological guide for updating the Corine land cover database, 1997*
  Guide for the technical and methodological update of the CLC database by computer-aided photo interpretation.

- *Addendum: Technical and methodological guide for updating the Corine land cover database, 2000*
  Document summarising the necessary additional information on the methodology for the introduction of criteria for land cover change mapping.

- *I&CLC2000 technical reference document, 2000*
  Reference document for the I&CLC2000 project, including output product specifications, task descriptions and the organisational set-up of the project.

- *I&CLC2000 questionnaire for NFPs and list of contacts, 2000*
  A questionnaire has been developed and sent to all Member States in order to collect information on national projection parameters, preferred time windows for the image acquisition phase and contact information.

- *Terms of reference for I&CLC2000 project participation at the national level, 2000*
  The document contains the terms of reference of the I&CLC2000 project that are used for the project participation at national level. The document aims to ensure the compatibility of the project output by supplying guidelines for the implementation at national level.

- *Agreement on I&CLC2000 products dissemination, 2000*
  Agreement on the use of I&CLC2000 products.

## 2.4. Maintenance of the CLC topic database

During 2000, the CLC inventory of Finland was completed as one of the last national inventories in the European Union. As a result, 14 EU Member States are now covered by the CLC inventory, integrated into a seamless GIS database. The remaining exception is Sweden, which will start full production in the framework of CLC2000 project.

Data collection in the Phare countries was also finalised. The database is now available for all 13 countries. The outstanding datasets from Albania, Bosnia and Herzegovina and the Former Yugoslav Republic of Macedonia were integrated into the seamless European CLC database in 2000.

Switzerland provided the conversion of the national Swiss land-use statistics (SLUS) data to CLC level 2 data in 1998. This information is available as a separate dataset from the EEA and the Topic Centre on Land Cover. Consequently, the CLC database represents a unique database of land cover information at a consistent scale (1:100 000), following a comparable methodology in 28 European countries, as well as parts of Tunisia and Morocco.

The CLC database is available for downloading from the EEA web site (http://natlan.eea.eu.int/datasets.htm).

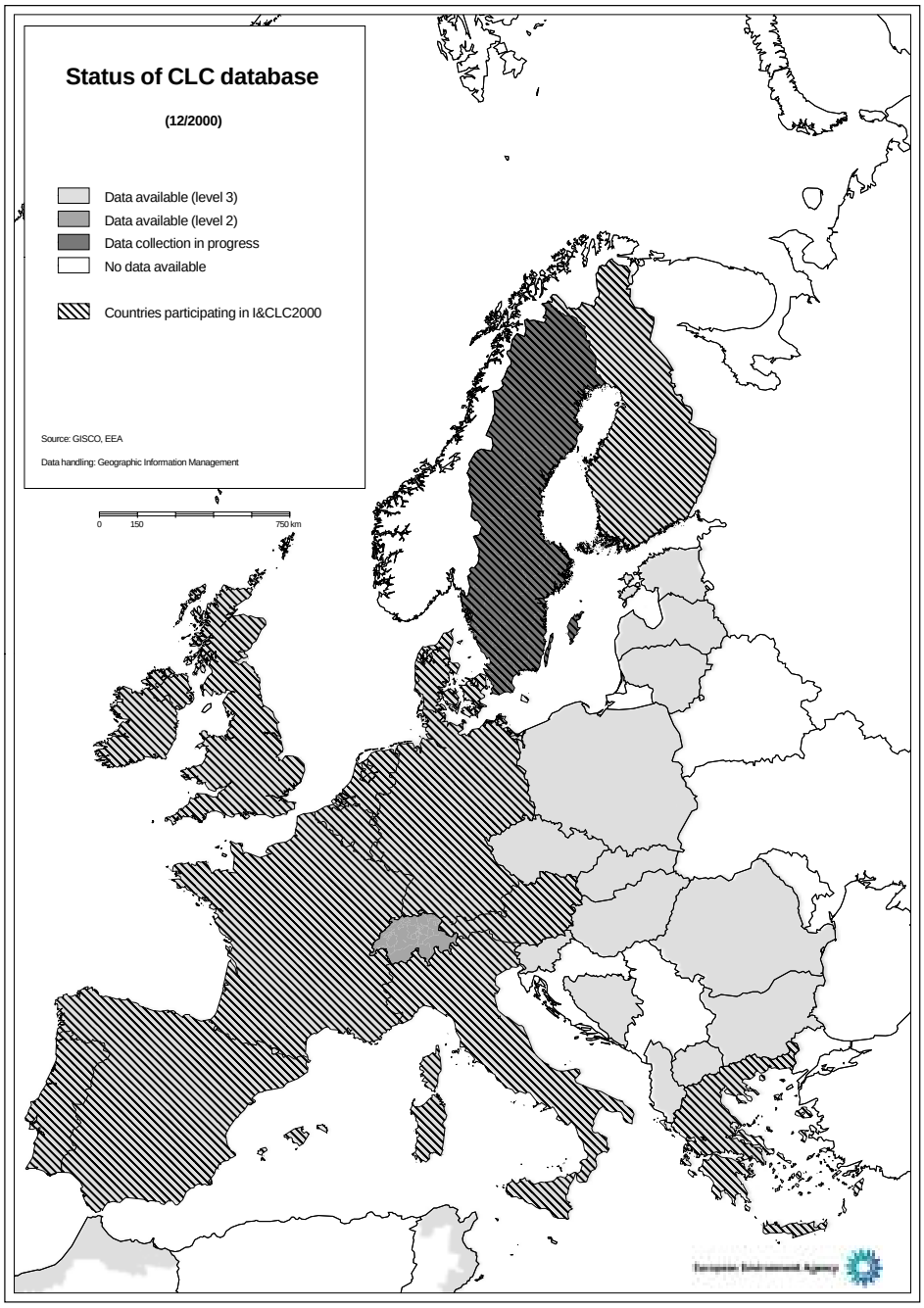
Database management and integration has been done by the ETC/LC, which holds overall responsibility for this task, and the PTL/LC for the Phare countries. The CLC database is a unique source of information for a range of spatial applications and indicators used by the EEA and the European Commission to assess the implementation of European environmental policies. By using the results of the CLC2000 project, an assessment of land cover changes taking place within the period 1990–2000 will be produced.

In 2000, the CLC database has not only been completed, but also improved for a number of countries. For the Czech Republic, France, Hungary, Romania and Slovakia, corrected land cover information has been received from the national reference centres (NRCs) and integrated into the European database. Additional minor corrections have been performed for different Phare countries during the quality assessment of the database.

In the framework of a data quality assessment of the European CLC database, all Phare countries have been subject to a critical review of their database content. The ETC/LC and PTL/LC have jointly developed the quality control procedures which were applied by the PTL/LC to the Phare CLC database. A report on the PTL/LC work on this issue is available from its web site (http://ptl.gisat.cz/home.shtml).

A description of the CLC database following the European Committee for Standardisation's (CEN) meta-data standard has been started. The activity was carried out in parallel by the ETC/LC and PTL/LC. The national meta-information was sent to the land cover primary contact points (PCPs) for verification and completion of the information provided. The objective of this documentation is to provide to the potential user of the database information about the dataset itself (e.g. national particularities) and point-of-contact information for further reference or purchase of national data in case of commercial use.

**Figure 2: Status of the CLC database, December 2000**




## 2.5. CLC data in the context of 'Global land cover 2000'

The I&CLC2000 project will produce a homogeneous land cover database for a large part of Europe. In addition to being used for policy-making and monitoring at the European level, the derived information will also be of interest for the implementation/enforcement of the following international agreements:

— Framework Convention on Climate Change (FCCC);
— International Agreement on Forest Management and Conservation;
— Convention on Biological Diversity (CBD);
— Convention to Combat Desertification (CCD).

The implementation of these international agreements is based on accurate contributions for global land cover mapping and monitoring initiatives. In this context, the I&CLC2000 data are used as input for 'Global land cover 2000' and for evaluating and validating global land-use and land cover change at regional level.

Collaborating with initiatives like 'Global land cover 2000' (GLC2000), the I&CLC2000 project contributes to a harmonisation of methodologies while avoiding a duplication of efforts. The 'Global land cover 2000' project is an initiative of the Global Vegetation Monitoring Unit (GVM) of the Joint Research Centre's Institute for Space Applications. The objective of the project is to produce a global land cover map at a 1 km resolution using SPOT Vegetation data. The GLC2000 proposal has been accepted within the framework of the VEGA 2000 initiative contributing to the objectives of the 'Millennium ecosystem assessment' initiative.

The target completion date for GLC2000 is set for early 2002.

Additional information is available on the following web sites:

— Summaries and papers, Vegetation 2000 Conference, Italy, 3 to 6 April 2000 (http://vegetation.cnes.fr:8080/);
— Minutes of the workshop on 'Global land cover 2000', Italy, 17 May 2000 (http://www.gvm.sai.jrc.it);
— Notes of LUCC 'Meeting in the middle', JRC, Italy, 17 to 21 October 2000 (http://www.indiana.edu/~act/focus1/mnm/);
— FAO Africover (http://www.africover.org/LCCS.htm);
— The 'Millennium ecosystem assessment' (http://www.ma-secretariat.org);
— Framework Convention on Climate Change (http://www.unfccc.de);
— Convention to Combat Desertification (http://www.unccd.ch);
— Convention on Biological Diversity (http://www.biodiv.org).

# 3. New land-cover-based information

The Corine land cover database has been further exploited during 2000 for the development of new applications and environmental indicators in support of the assessment of European policies on the environment. Consequently, the ETC/LC has provided GIS support, spatial analysis and regional assessments to the EEA. The service provided by the ETC/LC and PTL/LC included the analysis of various input data sources and their aggregation to specific reporting units different from those on which the data have been collected, and with a higher environmental significance.

## 3.1. Population density reallocated to land cover

During 2000, the Joint Research Centre in Ispra carried out a remapping exercise of population density data to land cover units. Traditional population statistics are gathered by administrative units, but the drawback of such statistics is that they only provide an average figure per region without indicating where in the administrative unit the population is distributed.

The approach taken was to use the traditional population statistics based on administrative units and to reallocate them to the land cover classes within the administrative unit according to a predefined distribution formula. The basic assumption of this reallocation is that the majority of the population will live in urban areas while agricultural areas will receive a lower percentage of the total population. Some areas such as high-altitude zones, wetlands, etc., are considered to be without inhabitants.

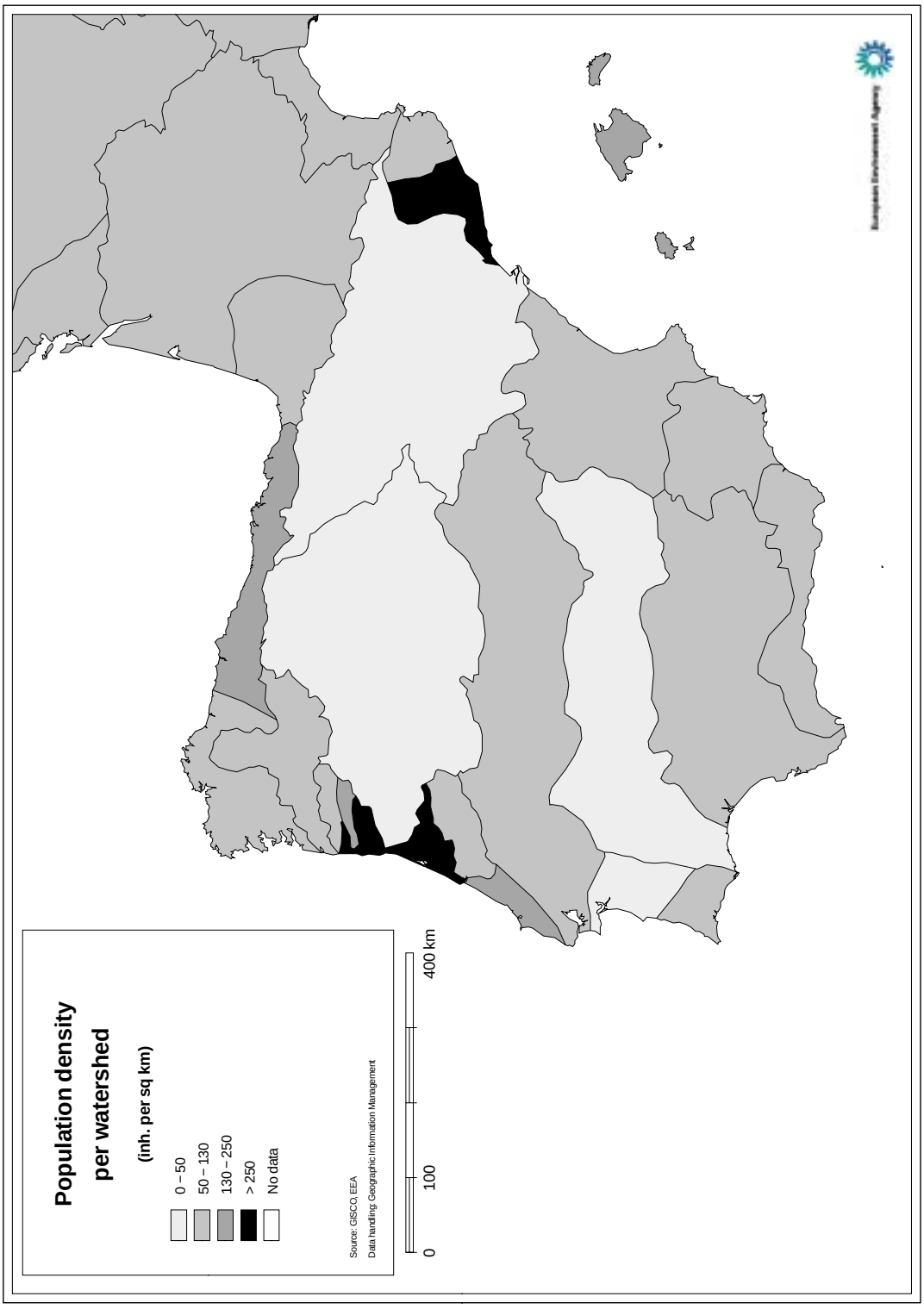
In practice, the total number of population per administrative unit is set in relation to the area of the different land cover classes within the region. According to the distribution key, the population is attributed to land cover units while ensuring that the actual population number in the administrative unit remains the same after the reallocation process.

The output file is a raster dataset with 100 m grid size (1 ha). Each grid cell is attributed with the population density of this cell resulting in a dataset representing the number of inhabitants per hectare. In order to obtain the actual population figure for a given area (e.g. watershed), the populations of the individual grid cells in the region need to be summed up. Potential applications of this data are assessments of the number of population living within a certain distance of protected areas (pressure indicators), population subject to noise from traffic infrastructure (impact indicators) or population affected by natural hazards (%). This dataset enables the user to create additional environmental indicators based on human pressures or assess the impacts on the human population.

The population density remapped to CLC classes (per administrative region) has been integrated by the ETC/LC in 2000 into a European database. The database contains information for Denmark, France, Ireland, Italy, Portugal, Spain, and parts of western Germany. Figure 3 shows the population density remapped to drainage basins on the Iberian peninsula.

Based on the results obtained, the JRC was requested by Eurostat/GISCO to revise and extend the population density database to other EU Member States. Consequently, a second version will be produced. The present database is currently available upon request from the EEA.

**Figure 3: Population density, 1991, by watershed**




## 3.2. Statistics for the EEA report on Europe's biodiversity

The contribution of the ETC/LC to the biodiversity report is the provision of statistics based on different environmental reporting units (biogeographic regions, watersheds, etc.) through spatial analysis of basic geographical information. These

statistics are used to define the characteristics of different regions (reporting units) providing region profiles. The EC habitats directive uses the biogeographic regions as the main reporting unit.

The ETC/LC analysed different geographical data sources in order to report information on habitats and population density on biogeographic regions, watersheds and countries. Land cover information from Pelcom ('Pan-European land cover map', 1999) and Corine land cover were combined to produce a pan-European land cover dataset reaching to the Ural Mountains. This dataset was used to describe the habitat distribution according to EUNIS nomenclature.

## 3.3. Carbon estimates in Europe derived from land cover data

In 2000, the ETC/LC produced a preliminary map for 13 of the 15 EU Member States (Sweden and Finland missing) showing the amount of carbon sequestration in vegetation and soils. The interest in assessing land cover carbon sinks is linked to the United Nations Framework Convention on Climate Change (UNFCCC, 1992), more precisely with the targets established in 1998 in the Kyoto Protocol. According to the protocol, the EU is committed to reducing emissions to 8 % below the 1990 level. The protocol introduces the idea that changes in carbon sinks in vegetation and soils may be accounted against the countries' commitments to reduce their greenhouse gas emissions in the future. Land cover changes can be considered as important information on carbon balance change assessments considering that an accurate assessment will be important for the total carbon balance accounting in Europe.

The ETC/LC has undertaken a preliminary assessment of carbon stocks and area estimates of EU Member States. The vegetation information is based on Corine land cover data, the agriculture statistics on data from Eurostat and the soil data on the 'World inventory of soil emission potentials' (ISRIC-WISE) global dataset of derived soil properties. The aim of the study was to present a new approach to mapping and assessing carbon stocks across Europe based on spatial information. The Centro Nacional de Informação Geográfica (CNIG) from Portugal conducted the study.

The methodology used for the assessment was developed by Cruickshank et al. (2000)[2] for the case of Ireland, where carbon density values have been attributed to CLC classes, agriculture crops and soil types. Although the Irish conditions are specific, they have been applied in this preliminary assessment for the whole of Europe. Hence, the results of the study must be seen as indicative. For classes that are not present in Ireland (e.g. vineyards), the carbon density estimations have been based on agriculture statistics or matched to the closest (nearest corresponding) class with a value applied for the Irish case; for example, the carbon density for olive groves was considered to be similar to that of fruit trees. For the class 'non-irrigated arable land', a composite value has been calculated for each EU country based on agriculture statistics on the five major crops grown in each country. The yields have been used as the critical input to derive the correspondent carbon densities.

Using this methodology, it was possible to map the distribution and calculate the amount of carbon stocks and area estimates by CLC class; for example, forests represent 79 % of the carbon stock in vegetation while only covering 22 % of the area. Arable land classes ('non-irrigated arable land', 'permanently irrigated arable

[2] Cruickshank M. M., Tomlinson R.W., Trew S. (2000), Application of CORINE land cover mapping to estimate carbon stored in the vegetation of Ireland, Journal of Environment Management 58, pp. 269-287

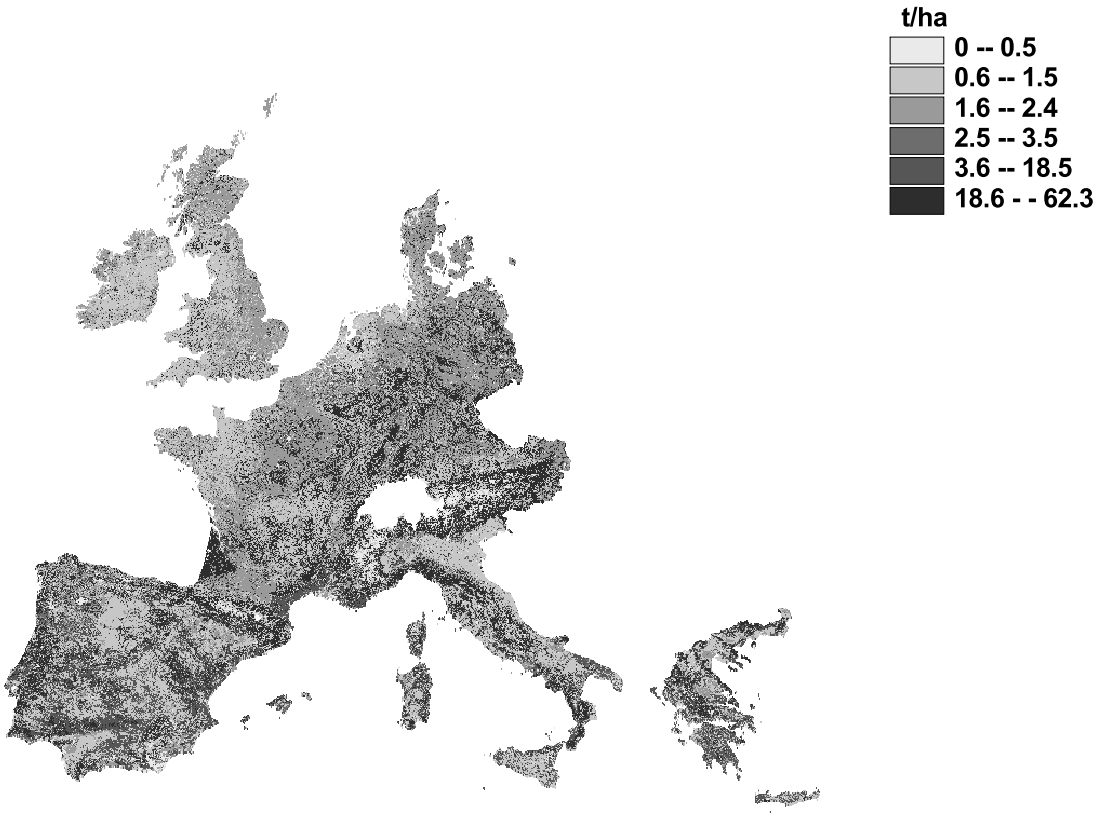
land', 'rice fields'), which represent 27 % of the total area, account for only 4 % of the total carbon sink.

**Table 5: Preliminary data on carbon stocks in vegetation and soils, 1990**

| | Total land area mapped (ha) | Total organic carbon stock estimate (Mt of C) (1) |
|---|---|---|
| Belgium | 3 062 575 | 369 |
| Denmark | 4 372 713 | 706 |
| Germany | 35 658 375 | 5 245 |
| Greece | 11 894 194 | 768 |
| Spain | 49 809 769 | 4 518 |
| France | 54 748 131 | 6 293 |
| Ireland | 6 905 913 | 1 015 |
| Italy | 30 018 613 | 722 |
| Luxembourg | 260 862 | 32 |
| Netherlands | 3 511 325 | 668 |
| Portugal | 8 880 044 | 1 077 |
| United Kingdom | 24 250 019 | 3 671 |
| Austria | 8 389 025 | 1 115 |
| **Total, 13 countries** | **241 761 558** | **26 199** |

([1]) Based on CLC 1990, ISRIC-WISE soil database, and Eurostat agriculture statistics.

**Figure 4: Indicative estimate of the amount of carbon stored in vegetation in 1990**



The conclusion of the study is that the CLC 1990 data used in this pilot exercise have demonstrated good potential for assessing both the stock and location of vegetation carbon sinks. Regarding the carbon stock estimate in soils, it is recommended to use a higher-resolution European soil database which includes more precise information instead of the ISRIC-WISE data which only provides coarse resolution data at 0.5 by 0.5 degree in raster format.

A comparison with preliminary data provided by Member States in November 2000 at the sixth Conference of the Parties (COP 6) to the 1992 UN Framework Convention on Climate Change on carbon stocks and area estimates related to Article 3(3) and (4) of the Kyoto Protocol shows that some estimates based on the CLC assessments correspond fairly well to the estimates provided by the countries (e.g. Austria reported 1 126 Mt compared with 1 115 Mt estimated in this study; Germany 4 765 Mt compared with 5 245 Mt estimated). On the other hand, a number of anomalies are present. Some estimates provided by countries differ significantly from the estimates based on European CLC and soil databases (e.g. France reported 3 952 Mt compared with 6 293 Mt estimated; UK reported 10 342 Mt compared with 3 671 Mt estimated).

The main reasons for the difference between the estimates based on European CLC and soil data and the estimates provided by the countries are:

— a number of assumptions and uncertainties, for example applied carbon density rates in soil and vegetation (t/ha). This study was based on carbon density rates used in a study of Ireland, broadened to other EU countries. This has introduced approximations probably making significant errors in the absolute values of estimated carbon sequestration especially for estimating soil carbon pools. Therefore, in future studies, regional specific parameters should be used for improving estimates of carbon density rates;
— inconsistencies in definition of land categories applied by countries (e.g. forest lands and other wooded lands);
— coarse resolution of the soil database used for this study.

Once CLC2000 data are available, it will be possible to show the difference between the vegetation carbon deposits between 1990 and 2000. This will allow the calculation of change and precise trend estimates, providing valuable information for carbon accounting.

# 4. Support to EEA indicator-based reporting

Over the last few years, the EEA has produced a series of comprehensive reports (including *Europe's environment: The second assessment* and *Environment in the European Union at the turn of the century*) with detailed information to support the development of strategic, long-term environmental policies and to provide relevant environmental information to the general public. The next 'state and outlook' report is planned for 2004.

The EEA is also publishing regular state of environment reports containing trend information. These series provide 'signals' on the progress of implementing environmental policies in EEA member countries and other regions of Europe.

During 2000, the EEA and ETC/LC continued to elaborate a set of spatial indicators based on Corine land cover information. The objective of the work is to create, develop and test spatial indicators. While in 1999 the focus was on wetlands, for 2000 it was on forests as well as on the extension of the indicators to the accession countries. In the long term, the EEA also aims to create and maintain a set of core indicators that can be used for the assessment of the integration of the environment concerns into sectoral policies.

In 2000, the ETC/LC and PTL/LC actively collaborated in the definition and elaboration of relevant environmental indicator categories/groups. The idea of a family of indicators is based on the fact that an environmental issue, for example forest fragmentation, can be addressed from different perspectives, for example natural fragmentation or fragmentation by (planned) transport networks.

**Table 6: List of indicators developed by the ETC/LC**

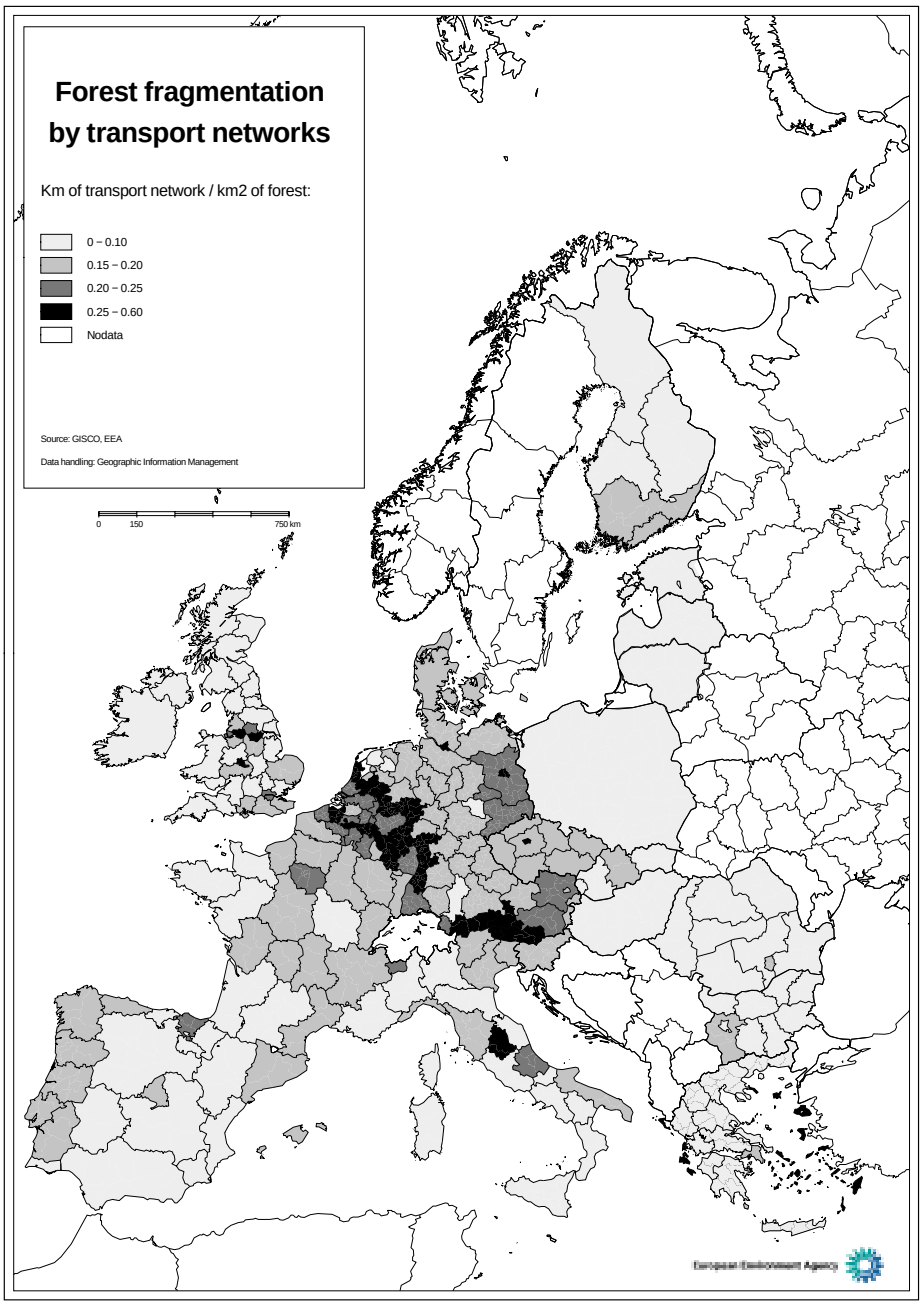
| Indicator | Environmental reporting unit | | | |
|---|---|---|---|---|
| | **Administrative units (NUTS levels 0–3)** | **Biogeographic regions** | **Watersheds** | **Sea drainage basins** |
| Forest area ($km^2$, %) | | | | |
| — forests | ✓ | | ✓ | |
| — forests and other wooded land | ✓ | | ✓ | |
| Forest fragmentation | | | | |
| — on 10 x 10 km grid | ✓ | ✓ | ✓ | |
| — transport length per forest area | ✓ | ✓ | | ✓ |
| — natural | ✓ | | | |
| — transport overlay | ✓ | | | |
| Human pressures | | | | |
| — by transport | ✓ | | | ✓ |
| — urban | ✓ | | | ✓ |
| — agriculture | ✓ | | | ✓ |
| Land take by transport | ✓ | | | |

## 4.1. Examples of land-cover-based indicators for forest assessment

### *4.1.1. Forest fragmentation by transport networks*

A spatial indicator for 'forest fragmentation by transport networks in Europe' is based on Corine land cover information from the EEA and transport data from the Eurostat/GISCO database. The indicator has been developed by extracting all forest classes from the CLC database and overlaying these patches with the road and railway network. This combination permits the determination of roads and railways located inside a forest area. Subsequently, the total length of the transport network per square kilometre of forest is calculated. Figure 5 illustrates forest fragmentation by administrative regions (NUTS level 2).

**Figure 5: Forest fragmentation by transport networks**



This indicator is used to assess the impact of the transport sector on the environment, through the fragmentation of forest habitats. Future improvements of the indicator should include a differentiation per type of road and traffic density as well as a view into the future by inclusion of the planned networks.

### *4.1.2. Forest fragmentation*

An assessment of undisturbed forest areas within grid cells of 10 x 10 km was made across all European CLC countries. For each cell, the amount of forest remote from urban, agriculture and transport pressures was determined. Subsequently, the distribution of the forest patches within the 10 x 10 km cell was analysed, in order to determine whether there are strongly dispersed small units (highly fragmented) or major aggregations of forests in a continuous area. The results have been summarised in a fragmentation index organised in six classes, ranging from minimal to extreme fragmentation.

This specific analysis allows assessment of the status of the forest lands in different regions of Europe. The indicator can assist the process of identifying large continuous forest areas, important for conservation of species' variety or of biodiversity value. The results are provided on administrative levels (NUTS levels 0–3), by watershed and by biogeographic region. For each reporting unit, the area of undisturbed forest per fragmentation class is reported.

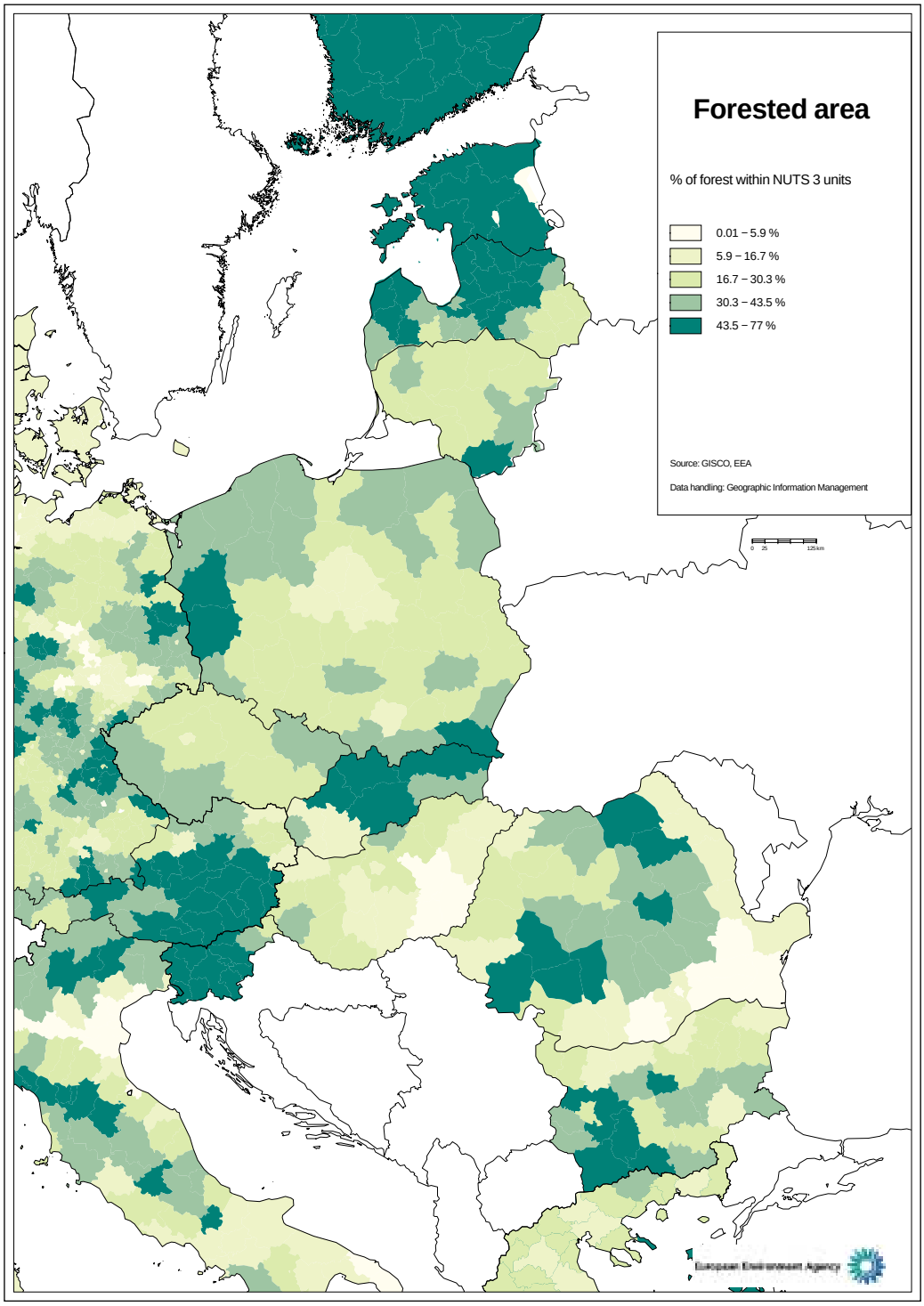
**Table 7: Extract of fragmentation statistics for selected biogeographic regions**

| Biogeographic region | Fragmentation index | Area ($km^2$) |
|---|---|---|
| Alpine | Minimal | 235 241 |
| Alpine | Little | 85 590 |
| Alpine | Average | 32 500 |
| Alpine | Rather strong | 6 689 |
| Alpine | Strong | 936 |
| Alpine | Extreme | 10 |
| Alpine | No forest area present, calculation of index not possible | 15 653 |
| | | |
| Atlantic | Minimal | 62 649 |
| Atlantic | Little | 135 346 |
| Atlantic | Average | 225 951 |
| Atlantic | Rather strong | 217 919 |
| Atlantic | Strong | 65 170 |
| Atlantic | Extreme | 6 069 |
| Atlantic | No forest area present, calculation of index not possible | 49 580 |
| | | |
| Mediterranean | Minimal | 182 668 |
| Mediterranean | Little | 218 109 |
| Mediterranean | Average | 212 507 |
| Mediterranean | Rather strong | 111 881 |
| Mediterranean | Strong | 44 254 |
| Mediterranean | Extreme | 10 156 |
| Mediterranean | No forest area present, calculation of index not possible | 102 719 |

### *4.1.3. Forest area in accession countries*

Figure 6 provides an overview of the distribution of forest land in the Phare accession countries by administrative regions. The indicator is calculated as the total forest area in relation to the total surface of the administrative unit, indicating the percentage of the administrative area covered by forest. The forest area was extracted from the CLC database. The chosen administrative units correspond to NUTS level 3 in 15 EU Member States.

**Figure 6: Percentage of forest area**



# 5. ETC/LC products and achievements

## 5.1. ETC/LC product table for 2000

Table 8 gives an overview of reports, databases and software produced in 2000 and available from the EEA.

**Table 8: Overview of the main products prepared by the ETC/LC during 2000**

| Title | Type | Content |
|---|---|---|
| Land cover — Annual topic update 1999 | Topic report | Summary description of progress and results 1998 (EEA Topic report No 4/2000). |
| ETC/LC and PTL/LC contributions to spatial indicator-based reporting | Technical report | Set of indicators based on Corine land cover and other spatial datasets (EEA, 2001). |
| Quality handbook for CLC2000 | Technical report | Report on aspects to be considered for ensuring a homogeneous quality throughout the entire CLC2000 project (draft report, publication foreseen 2001). |
| Carbon estimate 1990 in EU vegetation and soils based on CLC and soil map | Technical report | Report presenting the feasibility of using CLC data in combination with soil data to estimate carbon sinks in vegetation and soils in Europe (EEA, 2000). |
| Corine land cover 100 m and 250 m grid database | Database | The 250 m grid database is available from the EEA Natlan CD-ROM (updated Corine land cover CD-ROM) directly from the EEA web site; 100 m available from the EEA on request (EEA, 2000). |

## 5.2. Overview of the main achievements of the ETC/LC between 1995 and 2000

The ETC/LC became operational at the beginning of 1996 and concluded work at the end of 2000. During this time, the focus of the work gradually moved from data collection to analysis and assessment in support of EEA reporting obligations.

There are three important core tasks that the topic centre has achieved during these years.

### *5.2.1. Maintaining and extending the CLC database*

Building the Corine land cover database started at the end of the 1980s and continued in different countries until the year 2000. The aim of this database was to provide the first homogeneous land cover database in Europe. This information is helping considerably to provide an objective picture of the land-use footprint and interrelations existing between land cover data and the related information.

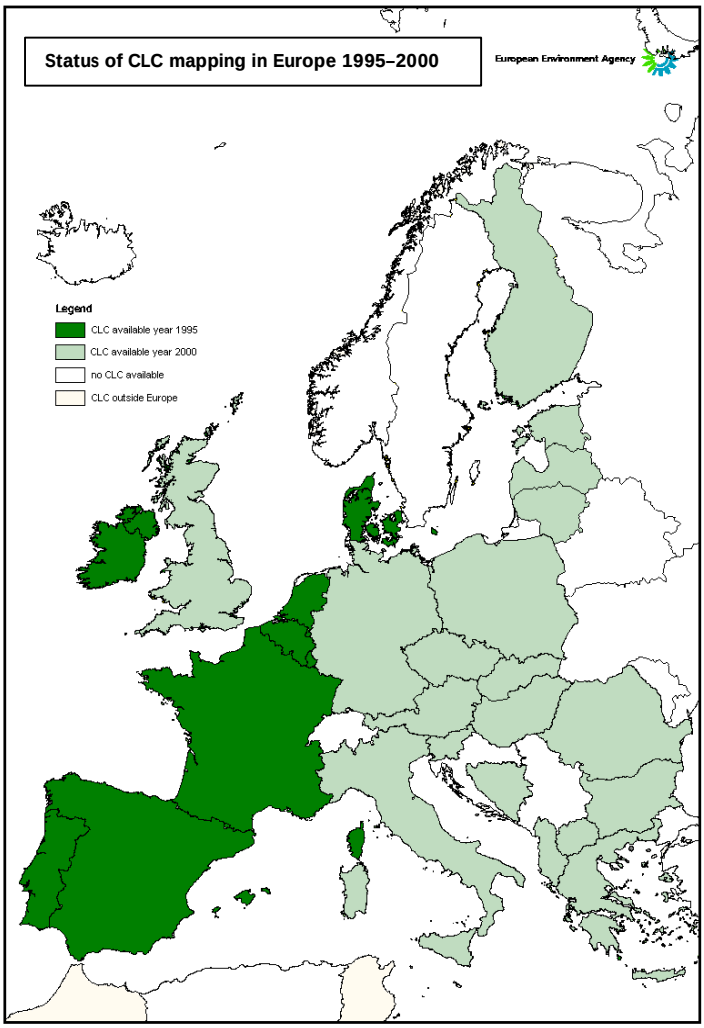
A total of 28 countries are completely covered today, compared with 8 countries at the start of operation of the topic centre in 1996 (see Figure 7). The main role of the ETC/LC was the integration, maintenance and dissemination of CLC data in order to encourage use of the database. In total, several thousand copies of the aggregated 250 m land cover data were disseminated. New countries were continuously integrated into the CLC database and numerous improvements were made to the entire database. An upgraded version is sent biannually to GISCO at Eurostat to be included in the Commission GISCO reference database. The increased use of the data was one of the driving factors for launching the update in 2000.

### *5.2.2. Preparing and supporting the update of the CLC database*

As some countries have CLC databases that are over 10 years old, land cover changes have taken place during this period and an update is needed for reliable assessments. Change detection is relevant at national, regional and European scales. The countries have the possibility to develop additional nomenclatures for CLC levels 4 and 5 adapted to the specific national conditions. For example, Sweden is producing for the 2000 inventory two extra levels with a total of 55 classes and a 25 m geometric resolution mainly focused on the specific differentiation of forest. Such higher-resolution mappings are based on the same source material provided by the IMAGE2000 component of the I&CLC2000 project.

In 2000, after intense preparation, discussions with key users and demonstration of applications, the final signal for the update was given. Although the budget was estimated at about EUR 10 million, most EU Member States committed themselves to starting the update during 2000, proving once more that the added value of updating at regional, national and European level is widely accepted today. The IMAGE2000 product that can be used as a reference database for many other products is a welcome additional product. Support to countries, as well as quality and compliance control will be tasks of the future ETC on Terrestrial Environment.

**Figure 7: Comparative status of CLC mapping, 1995–2000**



### *5.2.3. Supporting the EEA reporting cycle*

The European Topic Centre on Land Cover has developed a large number of products together with other partner organisations that have been used in the EEA reporting process. The ETC/LC has developed a number of spatial indicators (e.g. pressure on protected sites, land fragmentation) and produced several maps which were published in major EEA reports. Many applications based on CLC developed by the ETC/LC were integrated into the Natlan nature and land cover information package which is accessible via the EEA web site and available on CD-ROM.

### *5.2.4. Successful ETC/LC products*

In Table 9 below, the most important products of the ETC/LC are listed. These products are available from the EEA and have been disseminated to users worldwide.

**Table 9: Overview of the most successful products prepared by the ETC/LC during the period 1995–2000**

| Title | Available from | Content |
|---|---|---|
| Corine land cover 250 m grid database | EEA | The 250 m grid database is available derived from the vector database upgraded biannually. |
| Natlan nature and land cover presentation package | EEA | This is the result of close collaboration between the ETC/LC and ETC/NC (European Topic Centre on Nature Conservation). It includes databases and more than 50 maps that were produced for several reports. |
| SEA of TEN | EEA | Study of GIS-supported spatial and ecological assessment of environmental impacts of the trans-European transport network. Indicators have been developed and studied for five environmental themes. |

# 6. Towards a European Topic Centre on Terrestrial Environment

## 6.1. Future outlook

The EEA decided in 2000 to restructure the work of the thematic topic centres and create five new or expanded ETCs from 2001 onwards, as follows:

— the ETC on Terrestrial Environment (ETC/TE) to carry forward the work on Corine land cover and selected aspects of soil and coastal areas (spatial assessment to be worked out with the EEA advisory group on spatial analysis);
— the ETC on Water (ETC/W) to carry forward the work on fresh and marine waters;
— the ETC on Air and Climate Change (ETC/ACC) to carry forward the work on air quality, air emissions and climate change;
— the ETC on Nature Protection and Biodiversity (ETC/NPB) to support the work under the habitats directive and Community biodiversity strategy;
— the ETC on Waste and Material Flows (ETC/WMF).

The main objectives of the ETC on Terrestrial Environment will be:

— to provide relevant information on land and soil (past trends, current state and prospective development) in order to support related EU policy and legislative frameworks on sustainable land use, soil protection and integrated coastal zone management strategies;
— to coordinate the quality control of Corine land cover update 2000;
— to analyse the environmental effects of policies on land and soil in a spatial dimension (territorial or spatial analysis) using GIS and mapping tools. Therefore, the ETC/TE will collaborate closely with other ETCs and international bodies on land- and soil-related territorial and spatial assessments;
— to support the further development of the EEA geographic information system (GIS). In doing so, to ensure within EIONET, and in cooperation with other networks, the appropriate collection, harmonisation, handling, quality assurance and dissemination of data, including spatial data;
— to establish on a long-term perspective a soil monitoring and assessment framework;
— to contribute to the writing of main EEA reports on land-use and land cover change, soil degradation and the coastal environment focusing on past trends, current state and prospective development.

The work of the ETC/TE will build on the results achieved by the ETCs on Land Cover, Soil, and Marine and Coastal Environment. The main focus of the ETC/TE will be on indicator development and spatial analysis. For the assessment of cross-cutting environmental issues, the ETC/TE will actively cooperate with other ETCs under EEA coordination. The JRC will provide support to the ETC/TE by covering aspects related to monitoring, data and information on land and soil.

The primary role of the ETC/TE will be to provide relevant expertise, develop indicators and, in relation to assessments in particular, provide information on the following spatial issues:

— land-use and land cover change in connection with sustainable land-use issues;
— soil degradation, namely soil sealing, erosion, diffuse and local contamination;
— coastal environment, especially territorial impact assessment.