CLC2000 Land Cover database of the Netherlands

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Monitoring land cover changes between 1986 and 2000

G.W. Hazeu

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ABSTRACT

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The 1986 CORINE land cover database of the Netherlands was revised and updated on basis of Landsat satellite images and ancillary data. Interpretation of satellite images from 1986 and 2000 resulted in the CLC2000, CLC1986rev and CLCchange databases. A standard European legend and production methodology was applied. Thirty land cover classes were discerned. Most extended land cover types were pastures (231), arable land (211) and complex cultivation patterns (242). Between 1986 and 2000 around 4.76% of land changed its land cover. Most typical change was the conversion of agricultural land into artificial areas. The thematic accuracy of CLC2000 was almost 95% and 88% of the changes were correctly classified as changes.

Keywords: CORINE, land cover, changes, 1986-2000, satellite images, monitoring

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P.O. Box 47, NL-6700 AA Wageningen (The Netherlands).
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Preface

The European Environmental Agency (EEA) and Joint Research Centre (JRC) launched the IMAGE2000 & CLC2000 project (I&CLC2000) which consist in the update of the CLC databases. As part of the EEA mandate, the CORINE Land Cover (CLC) database initiated by the Commission in 1985 should be further maintained and regularly updated. National and European policies have identified consistent geo-referenced land cover information as a key database for integrated environmental assessments.

The CORINE land cover databases (CLC86rev, CLC2000, CLCchange) of the Netherlands were produced by Centre for Geo-Information of Alterra. JRC delivered the ortho-rectified Landsat7-ETM images. The EEA through its European Topic Centre on Terrestrial Environment (ETC-TE) coordinated the LC updating to obtain consistent and comparable land cover databases throughout Europe. The funds for the production of the databases were provided by European Commission Directorate-General Regional Policy, Alterra and the Dutch Ministries of Agriculture, Nature Management and Fisheries (LNV: DWK program 358 – GIS & Remote Sensing) and Housing, Spatial Planning and Environment (VROM).

A kick-off meeting in Budapest (Hungary), a training mission at the start of the Dutch CLC project (February 2002), two verification missions (December 2002 and January 2003), technical control of databases by GISAT (Czech Republic) and regular e-mail contact have guaranteed that consistency was reached between the Dutch land cover databases and the final European land cover databases. The training and verification missions were executed by members of the ETC-TE.

The Dutch CLC2000 and CLCchange database have been validated at national level to obtain an idea of the thematic accuracy of both databases. The national validation was possible with funds from our department generated out of LGN4 (national land cover database). In this case, a special word of thanks to Allard de Wit (projectleader LGN4) is due here.

Furthermore, I want to thank all who participated in this work. Especially, Theo Jacobs who did a great job by interpreting a part of the Netherlands, developing ARCInfo tools for image interpretation and assisting me in other technical matters (ArcInfo).

Summary

Consistent geo-referenced land cover information has been identified as key information for integrated environmental assessments. To supply policy makers with this information the European Environmental Agency (EEA) and Joint Research Centre (JRC) launched the IMAGE2000 and CLC2000 project. The I&CLC2000 project consists in the update of the CORINE Land Cover database. Satellite images of the EU territory are the basic material to undertake this update. The update is carried out for the 15 Member States of the European Union, Liechtenstein and 10 Phare accession countries. Main outputs will be as follows:

– a satellite image based spatial reference of Europe for the year 2000
– a national and European CLC inventory for the year 2000
– a database of LC changes between 1990's and 2000 at national and European level
– a corrected national CLC inventory for the 90's and corrected European CLC90

The CORINE Land Cover database is based on a standard legend and production methodology. The CLC database is characterised by the following elements:

– the mapping scale is 1 : 100 000. Mapping accuracy is at least 100 m for national and European products
– the minimum unit for inventory is 25 ha. Only area elements (polygons) are identified
– the minimum mapping unit for changes is 5 ha with a land cover boundary displacement of minimal 100m
– the CLC nomenclature is hierarchical and distinguishes 44 classes at the third level, 15 classes at the second level and 5 classes at the first level.

The improvements of the updated CLC database are a more time consistent product (2000 +/- 1 year), higher geometric accuracy (25m for satellite images and 100m for thematic data), faster provision of results, better documentation (metadata), lower production costs and more broadly dissemination of products.

The European Environmental Agency (EEA) delegated the European co-ordination through its European Topic Centre for Terrestrial Environment (ETC-TE). Their main objective is to obtain relatively homogeneous European databases. The ETC-TE took care of the training, external verification and final delivery of the databases. In case of the Netherlands, they were involved in one training mission, two verification missions, the approval of the databases and technical assistance by e-mail.

The update of the CORINE Land Cover database of the Netherlands was carried out under the umbrella of the I&CLC2000 project. The project was executed between 2001 – 2003. The national authority responsible for the update was the Centre Geo-Information of Alterra, Wageningen Wageningen University and Research Centre. The project was financed by the EU, Alterra, Ministry of

Agriculture, Nature Management and Fisheries and the Ministry of Housing, Spatial Planning and Environment.

The main aim to update the CORINE Land Cover database was to get an actual land cover database for the Netherlands based on standards applied in Europe. The project in the Netherlands started with the collection of data used for the production of the CORINE Land Cover database of 1986 and the selection of cloudfree images for the period of 1999-2001. The CLC86 database together with the satellite images of 2000 (+/- one year) formed the basis for the updating process. In order to produce an accurate national CLC2000, the CLC86 database was revised. By using satellite data of 1986 and old ancillary data, errors of the CLC86 were corrected in order not to influence the evaluation of the land cover changes between the two inventories. The CLC2000 database was based on the interpretation of satellite images selected and used in the IMAGE2000 products. The interpretation was done in such a way that the intersection of CLC86rev and CLC2000 resulted in the CLCchange database.

The Dutch CORINE Land Cover project resulted in the following three databases containing land cover data of the Netherlands:

- CLC86rev, which was a revised and corrected version of the old database (CLC90_NL),
- CLC2000 representing the land cover of year 2000 (CLC00_NL) and
- CLCchange containing land cover changes between 1986 and 2000 (CHANG_NL).
- Together with these three databases the metadata at country and working unit level were products of the I&CLC2000 project for the Netherlands.

The Netherlands were characterised by 30 out of 44 CORINE land cover classes. Within both CLC86rev and CLC2000 databases similar CORINE land cover classes were represented. The most extended land cover types in both databases were pastures (231), arable land (211) and complex cultivation patterns (242). Almost ¾ of the Dutch land surface was classified as agricultural land. Land classified as artificial areas or as semi-natural and forest areas occupied each around 10% of the national territory. The remainder of the Dutch land surface was classified as wetland or water bodies, rivers and/or canals.

Between 1986 and 2000 around 4.76% of the Dutch land area had changed its land cover. This percentage match with the extent of changes that could be derived from the changes detected by our national land cover database (LGN). The most typical land cover change for the Netherlands was the conversion of agricultural land into artificial areas (112, 121, 133 and 142). The conversion of agricultural land into deciduous forest (311), natural grassland (321) and inland marshes (411) were other important changes in the Dutch situation. Furthermore, a considerable part of the registered land cover changes dealed with the conversion of pastures (231) into arable land (211), mainly greenhouses. Some country specific changes of importance were the construction of dams and canals, changes caused by erosion and sedimen-

tation along the coast (difficult to monitor) and the conversion of salt into fresh water environments.

The total thematic accuracy of the CLC2000 database was almost 95% and meets the European target of 85%. Only a few classes (132, 141, 142, 243 and 313), which occupied only small tracts of land, had a relatively low accuracy. Also the validation of the change database resulted in a high total thematic accuracy of 98.7%. The accuracy percentages for the areas changed and not changed were 76.1% and 99.7%, respectively. Out of 476 points only 42 were incorrectly classified as a change, which meant 88% of the changes were correctly classified as changes.

1 Introduction

1.1 Background

The existence of good quality information on the state of the environment and natural resources is essential in order to ensure an efficient implementation and orientation of the European Community (EC) environmental policy. It was against this background that the CORINE (Co-ordination of Information on the Environment) Programme was implemented by the European Commission. From 1985 to 1990, an information system on the state of the European environment was created (the CORINE system) and nomenclatures and methodologies were developed and agreed at EU level. One of the primary thematic items of the CORINE Programme was land cover.

At the Dobris Conference in 1991 the European Environment Ministers requested that the program should be extended to the Central and Eastern European countries covered by the EC Phare programme. Through the support of the Phare Programme, the CORINE databases were as well implemented in the 13 eligible countries.

Following the European Council decision to set up the European Environmental Agency (EEA) and the establishment of the European Environment Information and Observation Network (EIONET), the responsibilities of the CORINE databases (and their up-dates) rely now to the EEA.

The CLC90 inventory was recognised by decision-makers as a key reference data set for spatial and territorial analysis for integrated environmental assessments at different territorial levels. The need for an updated CLC database was expressed by users at national and European level. The EEA and JRC (Joint Research Centre) launched the IMAGE2000 and CLC2000 (I&CLC2000) project which consists in the update of the CLC database. Preparatory work to update the CLC database for the reference year 2000 started in 1999. The I&CLC2000 project is based upon a number of key elements: lessons learnt form earlier CLC Projects, a current list of user needs, the options available for satellite images and the processing and management requirements for the vast amount of data. The overall aim of updating is to produce a consistent European CLC2000 database and CLC changes database between the 1990's and 2000. To guarantee full coverage and to maximise consistency with the previous inventory, the I&CLC2000 project will call upon existing local expertise and will require access to both the ancillary data and the satellite data used for the first CLC inventory.

The I&CLC2000 project consist of 2 main components which are interconnected:
– IMAGE2000: covering all activities related to satellite image acquisition, ortho-rectification and production of European and national satellite image mosaic and

– CLC2000: covering all activities related to detection and interpretation of LC changes.

The EEA delegated the European co-ordination of the CLC2000 component through its European Topic Centre for Terrestrial Environment (ETC-TE). The ETC-TE took care of the training, external verification and final delivery of the databases. In case of the Netherlands, they were involved in one training mission, two verification missions, the approval of the databases and technical assistance by e-mail. Appendix 6 presents a time schedule of the I&CLC2000 project for the Netherlands with starting date, periods of training and verification missions and the final delivery.

1.2 Objective

The main aim to update the CORINE Land Cover database is to get an actual land cover database for the Netherlands based on standards applied in Europe. The CORINE Land Cover database will be based on a standard legend and production methodology that will facilitate European land cover studies and make comparisons between EU countries more straightforward. The update of the CORINE Land Cover database will make it also possible to identify the major land cover changes for the period 1986 – 2000. The results of the CORINE Land Cover update project for the Netherlands will be the following three databases with their metadata:

– CLC86rev, which was a revised and corrected version of the old database (CLC90_NL),
– CLC2000 representing the land cover of year 2000 (CLC00_NL) and
– CLCchange containing land cover changes between 1986 and 2000 (CHANG_NL).

1.3 Introduction to the report

After a short introduction (chapter 1) the I&CLC2000 project is introduced in Chapter 2. The main characteristics, nomenclature and products expected from the project are presented. In Chapter 3 the material used in the Dutch part of the project are described. CLC86, satellite data and ancillary data are briefly described. The methodology used for correction and updating of the old CLC86 database are presented in Chapter 4. Subdivision is made into the preparation, interpretation, verification and validation phase. Chapter 5 deals with the results and discussion for the Dutch part of the I&CLC2000 project. The different products (CLC2000, CLC86rev, CLCchange and metadata), validation results and the land cover changes between 1986 and 2000 are treated. In Chapter 6 conclusions and recommendations are presented.

2 I&CLC2000 project

2.1 Basic specifications CLC

The CLC specifications have been defined during the CORINE programme (Heymann et al., 1994). The three determining elements of the CLC Project are:

- The mapping scale is 1 : 100 000. Boundary accuracy is at least 100 m for national and European products. By using IMAGE2000 as the geometric reference for the CLC database with minimum accuracy of 25 m, this scale and precision is ensured.
- The minimum unit for inventory is 25 ha (at a scale 1 : 100 000 it is represented by a 5x5 mm square or a circle with a 2.8 mm radius; minimum width of unit is 100 m – at scale 1 : 100 000 it is 1 mm). Only area elements (polygons) are identified. Areas smaller than 25 ha are allowed in the national land cover database as additional thematic layers, but should be aggregated into the European database.
- The CLC nomenclature is hierarchical and distinguishes 44 classes at the third level, 15 classes at the second level and 5 classes at the first level.

The nomenclature has been developed in order to map the whole Community territory (CORINE Land Cover. Technical Guide by Heymann et al., 1994; Addendum 2000 by Bossard et al., 2000), including the foreseen extension to Phare accession countries. The use of the CLC nomenclature with its 44 classes at three hierarchical levels is mandatory. Additional national levels can be mapped but should be aggregated to level 3 for the European data integration. No unclassified areas should appear in the final version of the data set.

2.2 Novelties I&CLC2000

Based on the lessons learnt from the first CLC inventory (CLC90), novelties listed in Table 1 are considered for I&CLC2000.

Table 1. Description novelties I&CLC2000

User requirement	*CLC1990*	**CLC2000**
The updated CLC inventory shall be more time consistent	mainly 1986-1995	2000 +/- 1 year
The geometric accuracy shall be improved. RMS error of: • Satellite images • Thematic LC data	 50 m 100 m	 25 m better than 100 m
The thematic accuracy remains the same	= 85%	= 85%
Changes smaller than the minimum mapping unit (25 ha) shall be identified	-	• boundary displacement (width) should be minimum 100 meter • area change should be minimum 5 ha (for a contiguous area)
The results shall be provided faster (project duration as short as possible)	10 years	3 years
The production costs shall be substantially lower than those of the first inventory (average cost/km^2)	6 €/km^2	3 €/km^2
The documentation of the data and the production process shall be improved	incomplete metadata	standard metadata
The access to the data shall be easier	unclear data dissemination policy	agreed dissemination policy from the start
The basic geographical databases, including the satellite images and LC used for spatial analysis at European level shall be harmonised	inconsistencies between GISCO reference DB and CLC90	close co-operation with JRC and Eurostat for a common GI/GIS policy

2.3 Geographical coverage

The area of interest of the I&CLC2000 project is shown in Figure 1. I&CLC2000 will be implemented in the 15 Member States of the European Union and Liechtenstein, as well as in the 10 Phare accession countries (see Table 2). Initiatives to extend the inventory to other geographical areas are under preparation.

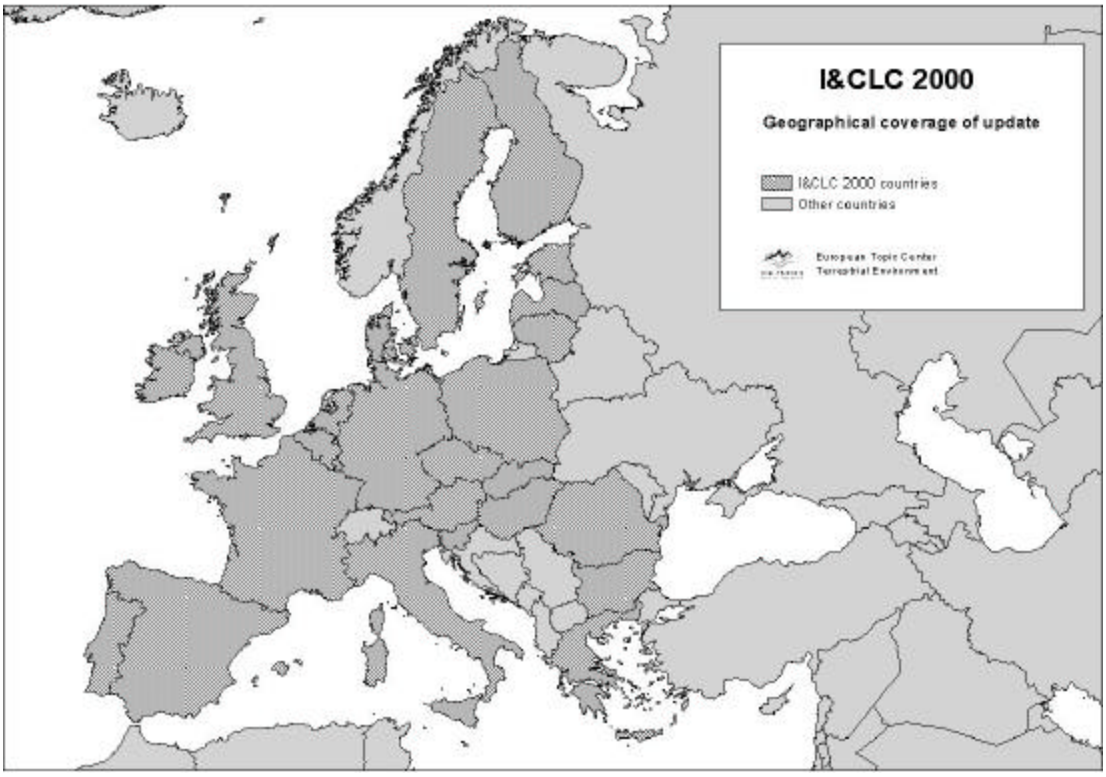


Figure 1. Geographic coverage for updating of CLC (EEA & ETC-TE, 2002).

Table 2. Current I&CLC2000 countries (EEA & ETC-TE, 2002)

• Austria • Belgium • Bulgaria • Czech Republic • Denmark • Estonia • Finland • France • Germany • Greece • Hungary • Ireland • Italy	• Latvia • Liechtenstein • Lithuania • Luxembourg • Poland • Portugal • Romania • Slovakia • Slovenia • Spain • Sweden • The Netherlands • United Kingdom

2.4 Description of nomenclature

The CORINE legend is presented in Table 3. The definition of every class with clarifications (photographs, inclusions, exclusions) are well documented in the Addendum 2000 (Bossard et al., 2000). The legend is hierarchical and characterised by three levels. The interpretation of CORINE land cover is done at the most detailed level (level 3).

Table 3. The CORINE Land Cover nomenclature

Level 1	Level 2	Level 3
1. Artificial Areas	1.1 Urban fabric	1.1.1 Continuous urban fabric
		1.1.2 Discontinuous urban fabric
	1.2 Industrial, commercial and transport units	1.2.1 Industrial or commercial units
		1.2.2 Road and rail networks and associated lands
		1.2.3 Port areas
		1.2.4 Airports
	1.3 Mine, dump and construction sites	1.3.1 Mineral extraction sites
		1.3.2 Dump sites
		1.3.3 Construction sites
	1.4 Artificial, non-agricultural areas	1.4.1 Green urban areas
		1.4.2 Sport and leisure facilities
2. Agricultural Areas	2.1 Arable land	2.1.1 Non-irrigated arable land
		2.1.2 Permanently irrigated land
		2.1.3 Rice fields
	2.2 Permanent crops	2.2.1 Vineyards
		2.2.2 Fruit trees and berry plantations
		2.2.3 Olive groves
	2.3 Pastures	2.3.1 Pastures
	2.4 Heterogenous agricultural areas	2.4.1 Annual crops associated with permanent crops
		2.4.2 Complex cultivation patterns
		2.4.3 Land principally occupied by agriculture with significant areas of natural vegetation
		2.4.4 Agro-forestry areas
3. Forest and Semi Natural Areas	3.1 Forests	3.1.1 Broad leaved forest
		3.1.2 Coniferous forest
		3.1.3 Mixed forest
	3.2 Scrub and/or herbaceous vegetation	3.2.1 Natural grasslands
		3.2.2 Moors and heathland
		3.2.3 Sclerophyllous vegetation
		3.2.4 Transitional woodland-shrub
	3.3 Open spaces with little or no vegetation	3.3.1 Beaches, dunes and sands
		3.3.2 Bare rocks
		3.3.3 Sparsely vegetated areas
		3.3.4 Burnt areas
		3.3.5 Glaciers and perpetual snow

Level 1	Level 2	Level 3
4. Wetlands	4.1 Inland wetlands	4.1.1 Inland marches
		4.1.2 Peat bogs
	4.2 Maritime wetlands	4.2.1 Salt marches
		4.2.2 Salines
		4.2.3 Intertidal flats
5. Water Bodies	5.1 Inland waters	5.1.1 Water courses
		5.1.2 Water bodies
	5.2. Marine waters	5.2.1 Coastal lagoons
		5.2.2 Estuaries
		5.2.3 Sea and ocean

* marked classes are land cover classes which are present in the Netherlands.

2.5 Product specification

Table 4 shows the different output products of the I&CLC2000 project. The type of product and their provider are mentioned. The participating countries will deliver the products 3, 4 and 11. The specifications are briefly described in section 2.5.1 and 2.5.2. For an extended description of the other products and specifications we refer to 'CORINE Land Cover Update I&CLC2000 project - Technical Guidelines' (EEA & ETC-TE, 2002) and 'Guideline for CLC delivery' (EEA & ETC-TE, 2003).

Table 4. Description of products and their providers

OUTPUT PRODUCTS	DELIVERED BY
Product 1 - Ortho-rectified images + working units	EEA / JRC
Product 2 - National IMAGE 2000 Mosaic	EEA / JRC
Product 3a - National CLC2000 *Product 3b - Revised National CLC90 (optional)*	Countries
Product 4 - National CLC Changes	Countries
Product 5 - European IMAGE2000 Mosaic	EEA / JRC
Product 6a - European CLC2000 Product 6b - Revised European CLC90s	EEA / JRC
Product 7 - European CLC Changes	EEA / JRC
Product 8 - CLC 250 m raster	EEA / JRC
Product 9 - CLC 100 m raster	EEA / JRC
Product 10 - CLC 1 km^2 statistics	EEA / JRC
Product 11 - National Metadata	Countries
Product 12 - European Metadata	EEA / JRC

2.5.1 CLC90rev, CLC2000 and CLC changes

Strict database specifications are required to guarantee that no information in the integration process between national inventory and European integration is lost. To assure a perfect overlay with neighbouring countries the CLC data sets should have a buffer zone of at least 1 km into the neighbouring countries across the national boundaries.

Topologic and attribute specifications

Topologic specifications are required to control the data contents with regard to the requirements of the database management system. The database format should be in ArcInfo, polygon topology. File name of delivered national products should be 8 characters long. The file name should include the 2 characters long standard EU county code (CLC90_NL, CLC00_NL and CHANG_NL).

- No lines will be present more than once.
- All polygons are closed, no dangles.
- The number of polygons will be equal to the number of labels.
- The feature ID will be unique; it should not contain the CLC code.
- Each polygon must have a character attribute: the 3-digit CLC code. For the change database each polygon must have a 3-digit CLC code for both 1990 and 2000.
- Unclassified polygons (0 code) are not permitted, only codes compatible with nomenclature. For the change database the two CLC codes should not be equal.
- The neighbouring polygons should not have the same CLC code (dissolve).
- A seamless digital database should be produced without any non-coded gaps; this means a perfect edge matching between the working units.

Geometric specifications

- The final delivery of the National CLC2000 and CLC changes products of each country is produced in the national projection system.
- The co-ordinates of the data delivered to the EEA should be in 'double precision'.
- The final data sets will be the spatially integrated working units; there should be no visible map sheet boundaries in the data sets.
- There should be no gaps between data sets from adjacent countries or deliveries.
- The area of smallest polygon should be => 25 ha for the CLC90rev and CLC2000 database.
- Only LC changes larger than 5 ha should appear in the CLC changes database. The contiguous 5 ha change area could consist of more than a single change polygon, some of them not necessarily exceed the 5 ha limit.

2.5.2 Metadata

Metadata is the information that gives characteristics of a given dataset. Spatial metadata or geoinformation (GI) metadata is the information that characterises spatial datasets. Traditionally map users were able to look at a map legend to find out where the map came from, when it was updated and what the map described. Similarly, the I&CLC2000 datasets metadata has to provide information on the content, representation, spatial reference, quality, administration and other characteristics of a the respective I&CLC2000 products. An obstacle avoiding wider use of CLC90 dataset on various levels was just a lack of such description.

Based on lessons learnt, the CLC2000 Technical Team is providing a metadata structure to the participating countries. A metadata structure is provided for country level and working unit level. (see Appendix 5). This will guarantee that the metadata will be recorded in a standardised way in all the countries.

3 Materials

3.1 CLC86

The CORINE86 database of the Netherlands (CLC86) is the original database which formed one of the pillars for the I&CLC2000 project for the Netherlands. The database was mainly based on satellite images of 1986. Besides the mentioned satellite images, also ancillary data like topographic maps, land use statistics (CBS), maps on nature conservation areas and forest areas and aerial photographs were used for the production of CLC86. The satellite images were prepared for visual interpretation through geometric correction, spectral enhancement and the production of hard copies at scale 1 : 100 000. The visual interpretation took place on 29 hard copies (working units). Only 28 of the total of 44 CORINE Land Cover classes at level 3 were relevant for the Netherlands (Thunnissen & Middelaar, 1995). The CLC86 covered the area of the Netherlands and a buffer zone of at least 1 km around its national borders to make tuning between countries possible.

3.2 Satellite images

The satellite data constituted the fundamental source for the project since they were the interpretation base for CORINE Land Cover. The images on which CLC86 was based, were Landsat 5 TM images from the period 1986 – 1988. As they were digital available at our institute we could use them for the correction of CLC86.

The satellite images from 1999 and 2000 used in the updating process were Landsat 7 TM images with specifications as mentioned in Table 5. The images delivered by the IMAGE2000 were ortho-rectified, in national projection and in a ready to use format. The geometric deviation of the 1999 and 2000 images was smaller than 25 meter. As the systematic deviation of the 1986 images was smaller than 50 meter no image to image correction was necessary. The selection of these images was based on the following criteria and priorities:

– cloud free images (i.e. 0 % or, in difficult regions <5% cloud coverage),
– acquired within the year 2000,
– an appropriate date (2000 + / - one year if no cloud free images were available)

In case of overlap between countries only one image was selected. This cross boundary selection of images was co-ordinated by the IMAGE2000 team. Table 6 list the images of 1986 and 2000 used in the updating and correction process.

Table 5. Specifications of Landsat 7 TM satellite data used for the updating process

Band number	Spectral range (microns)	Final pixel size (m)
ETM1	0.45 – 0.515	25
ETM2	0.525 – 0.605	25
ETM3	0.63 – 0.69	25
ETM4	0.75 – 0.9	25
ETM5	1.55 – 1.75	25
ETM6	10.4 – 12.5	25
ETM7	2.09 – 2.35	25
ETM Pan	0.52 – 0.9	12.5

Table 6. Satellite images used for the correction and updating of CLC86

Satellite images CLC86rev (Landsat-5 TM)*		Satellite images CLC2000 (Landsat-7 ETM+)*	
06/16/1986	198/23	07/30/1999	198/23
06/16/1986	198/24	07/30/1999	198/24
08/03/1986	198/23	09/09/1999	197/24
08/03/1986	198/24	08/24/2000	199/24
08/12/1986	197/24	08/26/2000	198/24
07/14/1987	197/23		
06/14/1988	197/24		

* date of acquisition, path and row of satellite image used

3.3 Ancillary data

The CLC86 database was the basis for the updating and correction process. During the different phases of this process various other sources of ancillary data were used. Those data were indispensable for the delineation and/or identification of a number of land cover classes. Table 7 summarises the ancillary data used for the processing of CLC86rev and CLC2000.

Table 7. Ancillary data used in correcting and updating of CLC86

CLC86rev	CLC2000
Topographical map 1 : 50 000	Top10Vector
LaCoast database	Top50Vector
LGN1*	LGN4
CBS89*	Geomorphological map
	Aerial photographs
	CBS96*

* marked datasets were used only in the validation of the CLC2000 and CLCchange database

The topographical map of the Netherlands (1 : 50 000) and the LaCoast database were used as ancillary data in the revision of the CLC86 database. The topographical map (1 : 50 000) was based on carthography done between 1972 and 1989. The LaCoast database represents the CORINE Land Cover for a 10 km wide zone of the Dutch coast. Compared to the original CLC86 database, some thematic corrections were made. Therefore, it was used to correct land cover classes for CLC1986. Our National Land Cover database (LGN1) based on the satellite images of 1986 and the Land Use Statistics (CBS1989) were used only for validation of some classes. The CBS1989 discriminates 33 land use classes for the entire Netherlands. It is regularly updated (every 3-4 years).

The Netherlands Topographical Service (TDN) produces 1 : 10 000 and 1 : 50 000 digital topographic maps of the Netherlands (Top10Vector and Top50Vector). Since 1998, the entire Netherlands is covered by around 1350 map sheets, which cover an area of 5 km to 6.25 km each. Top50Vector was only used for the delineation of intertidal flats (423). Our National Land Cover database (LGN4) based on satellite images of 1999 and 2000 is a grid database with a cell size of 25 meters. It discriminates between urban area, forests, water, several crop types and natural areas. Both Top10Vector and LGN4 were used for the delineation and/or identification of land cover classes (mainly agricultural classes). The geomorphological map is not yet digital available for the entire Netherlands. However, a preliminary version of this vector database was useful for the separation of moors and heathlands (class 322) and peat bogs (class 412). True-color aerial photographs covering the entire Netherlands at a resolution of 2 and 4 meters were used mainly for verification (separation of discontinuous urban fabric (112) and industrial or commercial units (121)) and validation of land cover for the year 2000. The photographs represent the situation in June/July 2000. The Land Use Statistics of 1996 (CBS1996) were used only for validation of the CLC2000 and CLCchange databases

Some reports which describe the CLC86 database were used in the preparation and interpretation phase of the project. The CORINE Land Cover database for the Netherlands (Thunnissen & Middelaar, 1995), LaCoast project (Schmidt, 1998) and Test of the prototype system Cartha for Windows for updating the CORINE land cover database (Kramer & Mucher, 1994) were the most important ones.

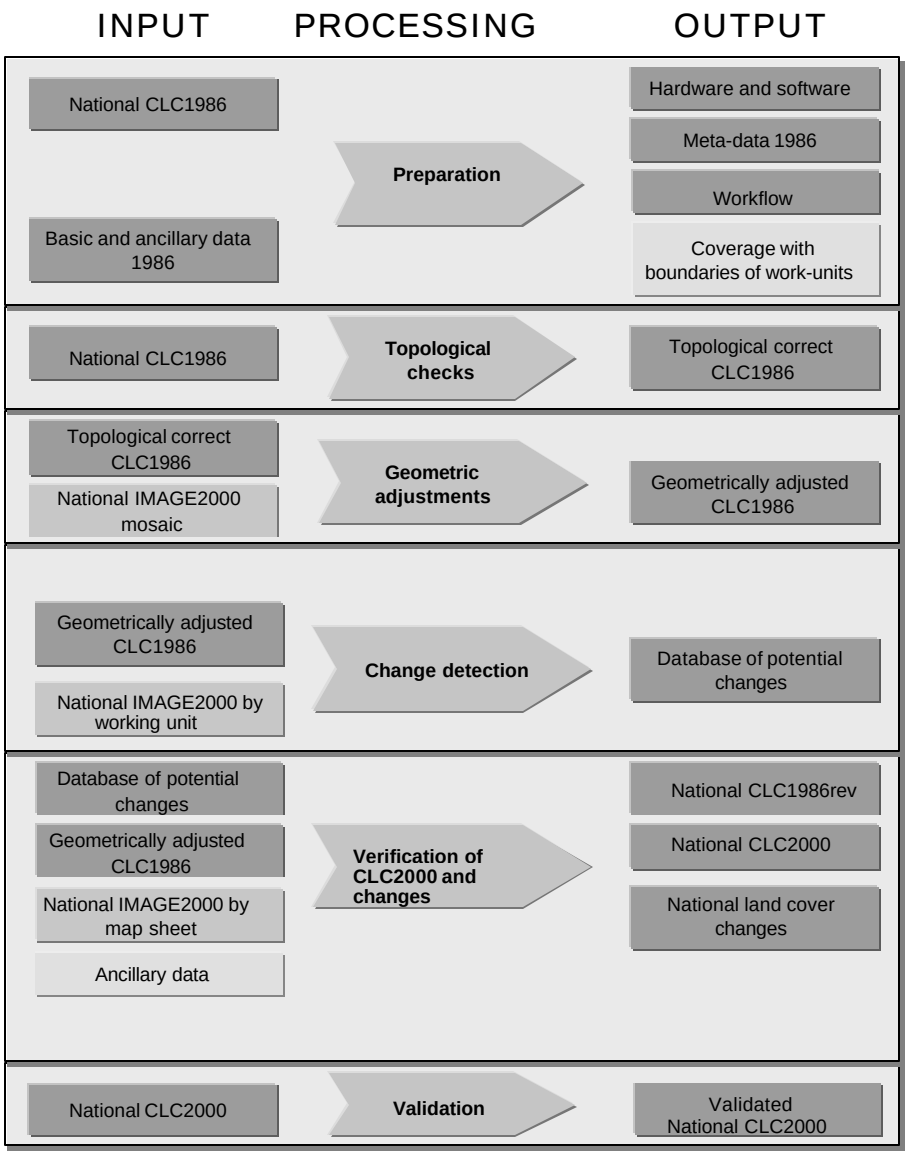


Figure 2. Production flow of CLC2000 for the Netherlands (after ETC-TE, 2002).

4 Methodology

In Figure 2 the working methodology for the Dutch CLC2000 project has been visualised. A preparation, interpretation (topological checks, geometrical adjustments and change detection), verification and validation phase can be distinguished. The technical and methodological guide for updating CORINE Land Cover database (Perigao and Annoni, 1997) was a useful tool in developing a methodology. Also, the CORINE land cover - Technical guide (Heymann et al., 1994) was used to get acquainted with CORINE Land Cover.

4.1 Preparation

All relevant data needed for the correction and updating process were collected. Satellite images used for the 1986 interpretation were retraced. Cloud free images for the year 2000 +/- one year were selected and delivered by IMAGE2000 team. The satellite images were geometrically verified and corrected if necessary. All satellite images were transformed for using them in ArcInfo.

The availability of ancillary data for the year 2000 was checked, old satellite images and ancillary data used in the CLC86 exercise were looked up. All ancillary data and the CLC86 coverage were prepared, if possible, for the digital use in ArcInfo. The CLC86 database was subdivided into 6 working units (Figure 3). The former sub-division (see Thunnissen & Middelaar, 1995) used for the separation into 29 hard copies was not reproducible.

The software to be used for the interpretation of satellite images was selected. ArcInfo was used for the interpretation of the images. ArcView was used for the verification and visualisation of the land cover databases. For the display and interpretation of the satellite images and ancillary data a working menu was written in ArcInfo Macro Language (AML's). The interpretation work was subdidvided. Two persons of Alterra did all the interpretation work.

For the smallest province of Netherlands, Utrecht, a case study was carried out to familiarise with the CORINE methodology. This step was important as the team to carry out the correction and updating of CLC86 was not involved in the CORINE land cover interpretation of the 1986 satellite images. For this reason, a national training seminar in which a member of the Technical Team participated was also organised to tune the Dutch situation with the overall European I&CLC2000 project. The focus of this training was on the explanation of CORINE land cover (CLC) nomenclature relevant for the Netherlands and the CLC2000 methodology for updating (Feranec, 2002). On basis of experiences in this case study the working methodology was developed. Together with insights in the complexity of the correction and updating of CLC86, also an idea of the time needed for the total process was obtained.

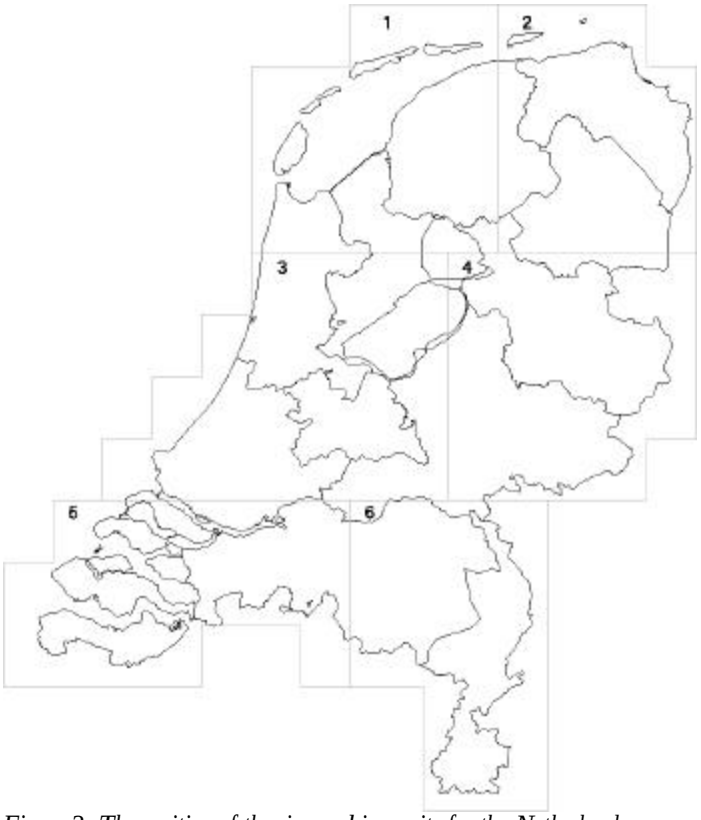


Figure 3. The position of the six working units for the Netherlands.

4.2 Interpretation

The interpretation phase required strict database specifications to guarantee that no information in the integration process between national and European integration will be lost. To ensure consistency between the three databases, the technical team recommended fulfilling the following condition:

$$\textbf{CLC changes} = \textbf{CLC2000} - \textbf{CLC86}_{\textbf{rev}}$$

(where '-' means intersect)

The interpretation component was divided into the next steps:

– correction of CLC86 (topological checks and geometrical adjustments (seeFigure 3).
  - systematic and random geometric correction of CLC86
  - systematic and random thematic corrections of CLC86
– updating of CLC86 (or detection of changes)

The correction and updating of CLC86 were simultaneously applied. Only the systematic errors were corrected for each working unit at the start of the interpretation.

The interpreted changes (updating) and corrections were digitised in the same ArcInfo coverage. The corrections were made in the coverage by comparing the old interpretation with the satellite images of 1986. After correction, the same track was interpreted by using satellite images of 2000. For every corrected area, the updating (or change detection) was done directly after the correction. At the start of the interpretation phase this so-called 'mother' coverage was a copy of the original CLC86 database. However, three items were added to indicate the revised CLC86 land cover, the CLC2000 land cover and the type of change (changed/ not changed). From this coverage the three different products; a corrected/revised CLC86 (CLC90_NL), a CLC2000 (CLC00_NL) and a change database (CHANG_NL) for the Netherlands were derived by dissolving and selection of differently labelled polygons.

This way of implementing corrections and changes in the original CLC86 database avoided the generation of sliver polygons in the change database. Slivers would be more easily generated if boundaries of the same LC object were delineated separately in the CLC86 as well as in the CLC2000 database.

4.2.1 Correction CLC86

Geometric corrections

The main time consuming correction of CLC86 consisted of the geometric correction of inaccurately delineated land cover types. Interpretation of hard copies, transformation to digital format and unification of 29 working units into one database had caused geometric inaccuracies. Random and systematic deviations larger than 100 m were corrected by transforming CLC86 data on basis of obvious land cover features on the image and their respective boundaries on CLC86 data.

A correction for a systematic geometric shift compared to the 1986 satellite images was very difficult to carry out for the six working units. The systematic geometric errors were generated by the manual interpretation of land cover on transparencies for the 29 working units, the subsequent transfer of the hard copies into a digital format (digitalisation) and the production of a seamless CLC86 database. As a consequence, the systematic geometric errors were different for all 29 working units of CLC86. Furthermore, CLC86 working units were not of the similar size and position as those of CLC2000 and the limits of the CLC86 working units were not exactly known. Therefore, within one working unit of CLC2000 existed different 'systematic' errors which were very difficult to correct in a systematic way. Locally, it was possible but in most cases they had a random character.

As a kind of general rule it could be stated that at least random geometric errors of CLC86 were corrected if the area of change was influenced by incorrect land cover boundaries of CLC86. However, in many cases they were also corrected if they did not had any influence on the area of change. Also topological problems like dangles, polygons without labels and unnecessary boundaries were corrected.

Thematic corrections

The thematic correction of land cover codes of CLC86 was possible by using topographical maps at scale 1 : 50 000 (2nd edition, 1989) and checking the consequent appliance of CORINE codes throughout the entire Dutch database. The old land cover database of the Netherlands (LGN1) was not used (only used for validation purposes).

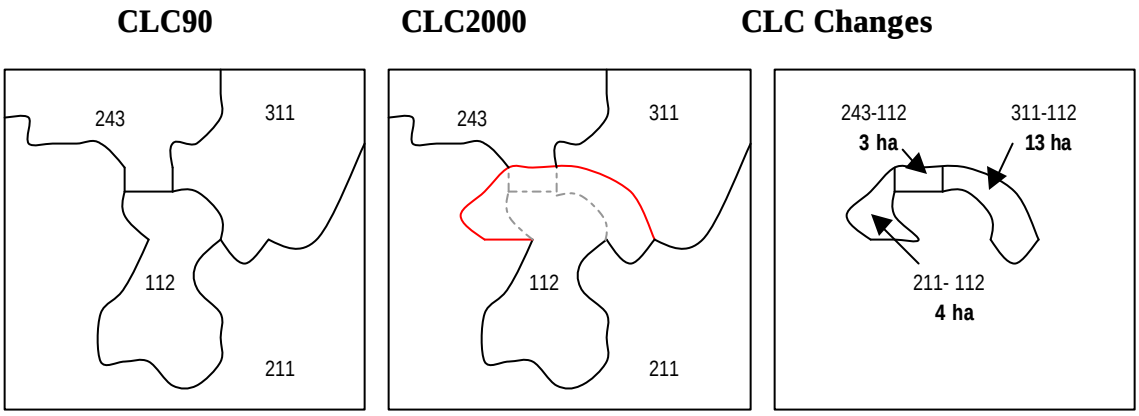
Systematic thematic errors in the CLC86 database were introduced due to differences in interpretation during the production of CLC86 database for the Netherlands (Kramer & Mucher, 1994). The definition of most land cover types of the standard CLC nomenclature was refined in the CORINE Land Cover Technical Guide, Addendum 2000 (Bossard et al., 2000). This refined nomenclature was used both in the revision and updating of CLC86. Also the subjectivity in attribute designation by the different interpreters of the 1986 team introduced a kind of systematic thematic errors.

Furthermore, the original CLC86 database contained a lot of polygons with areas between 20 and 25 ha. Those land cover units (polygons) smaller than 25 ha were generalised with help of a priority table (Appendix 1). The priority table is a kind of a matrix in which you can find the land cover class (highest priority) to which a polygon smaller than 25 ha needs to be generalised.

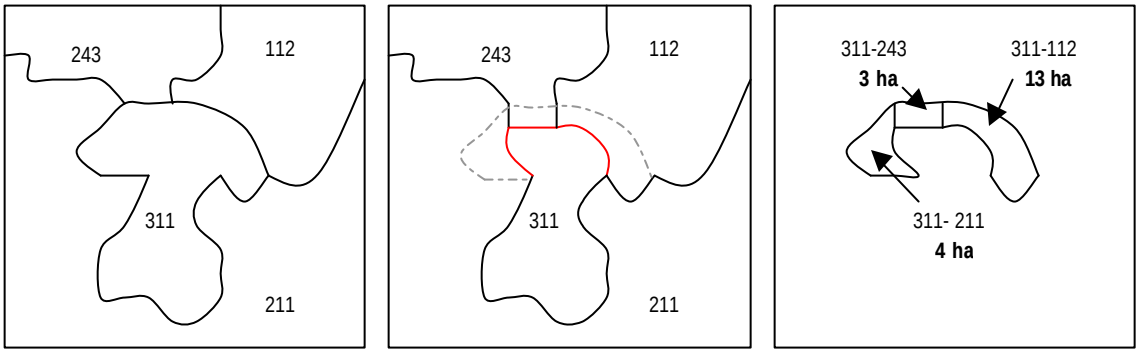
Random thematic errors like zero or invalid codes and incorrect denominations (e.g. 321 instead of 231 or heterogeneous polygons containing contiguous areas of >25ha of a different land cover) were corrected by drawing new lines and/or changing the attribute values of the discerned polygons. No non-existing land cover codes, zero values or neighbour polygons with the same label were detected in the original CLC86 database.

4.2.2 Updating

The updating of each working unit of the CLC86 database was carried out together with the correction of the database. However, changes and corrections were labelled differently in such a way that they could be retraced. Changes in land cover were registered when change polygons or contiguous change polygons were larger than 5 ha and had a minimum width of 100 meter (see Appendix 2 for simple changes). Figure 4 gives examples of contiguous/complex changes to be detected: the growing of a settlement and the shrinking of a forest. However, changes in land cover which created complete new polygons, i.e. the change polygon was not adjacent to a polygon with a similar land cover denomination, need to be larger than 25 ha. This meant that changes inside polygons were not recorded when the changes were between 5 ha and 25 ha were not recorded (see D in Figure 5).



Example 1:
Total increase of a polygon (> 5 ha) can include several contiguous elementary changes, some of them smaller than 5 ha. The example illustrates the growing of a settlement.



Example 2:
Total decrease of a polygon (> 5 ha) can include several contiguous elementary changes, some of them smaller than 5 ha. The example illustrates the shrinking of a forest.

Figure 4. Examples of complex changes (EEA & ETC-TE, 2002)

Besides these complex changes, the update of CLC86 had to deal with different type of changes. The different type of changes could be grouped into following four main types:

– normal change (> 5 ha, 100 m width)
– changes due to disappearing polygons (or **rest** change)
– changes due to newly created polygons (or **virtual** change)
– changes restricted to an island (**isolated** change)

These different change types presented in Figure 5 could also be subdivided according to their size (< or > 5ha) and their complexity (see Buttner, 2003). However, this subdivision was not applied as we were not interested in contiguous changes smaller than 5ha.

Among other things the following two conditions were set for the detection of changes:

– to detect and label only **real** changes (contiguous change area > 5ha)
– to fulfil the condition CLCchange = CLC2000 – CLC86rev (minimum mapping unit 25ha for CLC86rev, CLC2000)

These conditions are contradictory to each other, which will be explained with help of Figure 5. Preference was given to the second condition which is also called the intersect condition.

Legend:

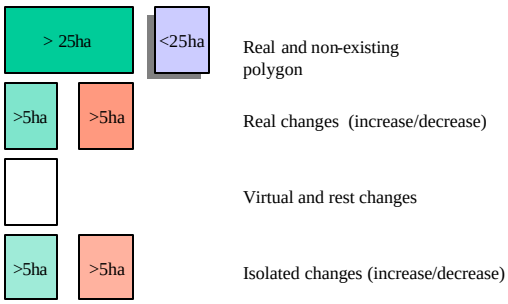


Figure 5. Type of changes between CLC86 and CLC2000

Situation A presents a change between 1986 and 2000 larger than 5ha in which the 1986 land cover polygon increases or decreases due to a change. In both cases the resulting land cover polygons are larger than 25ha in CLC2000.

In situation B a land cover polygon of 1986 becomes too small due too changes (e.g. shrinking of forest). The **rest** polygon has to be merged with another land cover polygon in CLC2000. This generalisation is done with help of the priority table (Appendix 1). To fulfil the intersect condition both the **rest** polygon and the real change were denominated as a change causing a slight overestimation of changes.
Situation C presents the contrary of situation B. In this case a land cover polygon occupies a contiguous area of less than 25ha in 1986. The (**virtual**) polygon is not delineated but merged according to the priority table to another land cover class. Due to adjacent changes larger than 5ha, a new land cover polygon can be created with an area larger than 25ha in CLC2000. The new land cover polygon is a combination of the **virtual** polygon of 1986 and the change polygon. The real change and the **virtual** polygon will be both denominated as changes to fulfil the intersect condition mentioned above. As in situation B, this will result in a slight overestimation of changes.
Situation D shows the case of **isolated** changes larger than 5ha where the resulting CLC2000 polygon does not meet 25ha requirement. Such changes will not be registered which will result in an underestimation of changes.

4.3 Verification

After finishing the correction and updating of CLC86 an internal and external verification took place. The CLC2000 and CLC change databases were verified. The land cover for the year 1986 was already verified during the interpretation phase of the project. Ancillary data like LGN4 and Top10Vector were used to verify the interpretations.

The internal verification was carried out by the national project leader. He decided if the quality of the updated working unit reaches the previously defined quality level (see 2.5.1). The external verification was carried out by the technical team of the European Topic Centre of Terrestrial Environment (ETC-TE). The external verification consisted of two verification missions held in November 2002 and January 2003. The main goal of the external verifications was to guarantee a harmonised European CLC2000 and CLC change database. For each of the six working units, well-distributed verification units of 10*10km squares were selected on basis of pre-defined selection criteria (landscape complexity, CLC classes, area of change). Almost 10% of the total area was verified (Figure 6).

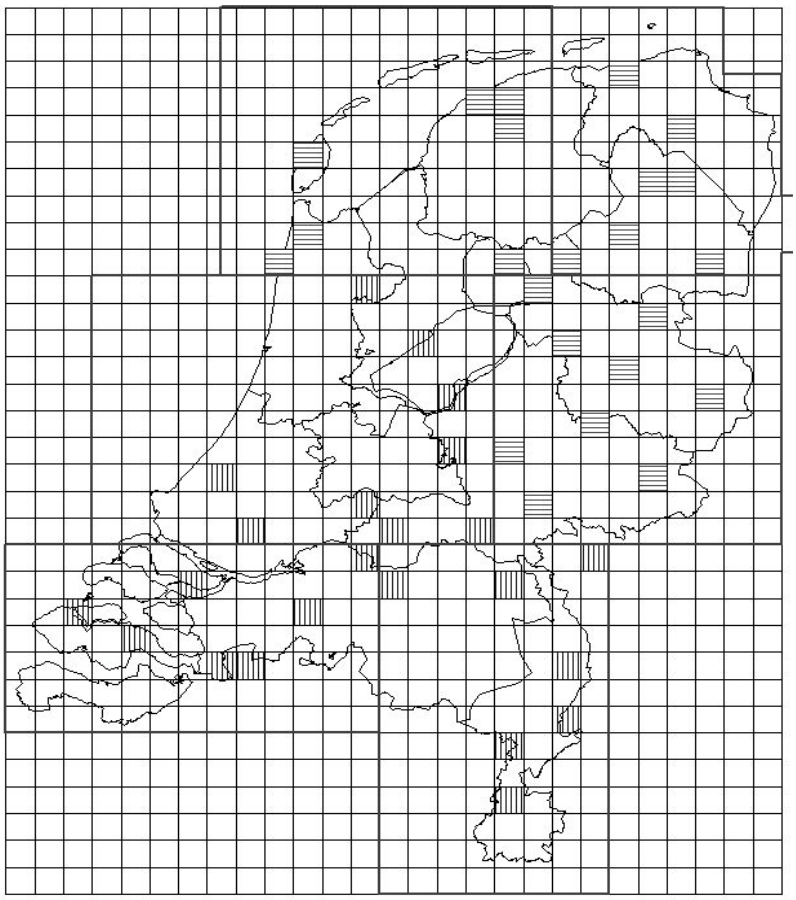


*Figure 6. The selected 10*10 km squares verified during the verification missions (horizontal lines - first mission; vertical lines | second mission)*

Both verifications consisted of two steps:
- thematic verification with help of ancillary data
- checking topological, geometric and attribute specifications (2.5.1)

The internal verification was focussed on the homogenous application of CLC nomenclature for the entire Netherlands. Also, the thematic denominations were checked with the land cover classes of the national land cover database (LGN4) and aerial photographs. Unlikely CLC changes were checked and corrected. Furthermore, dangling errors (open polygons) and labelerrors (missing labels or more than one label per polygon) were corrected. Double lines were eliminated. Non-existing CORINE land cover codes or labels with zero values were corrected. No gaps existed in the databases which means a perfect edge matching between the working units. A buffer of 1 km around the Netherlands was interpreted to make comparison with neighbouring countries possible. No polygons with a similar land cover code existed alongside each other (dissolved databases). In case of changes, polygons smaller than 5 ha were eliminated. For polygons representing the land cover of 1986 and 2000, all polygons smaller than 25 ha were generalised according to the priority

table (Appendix 1). All three databases were produced in ArcInfo format, had polygon topology and were produced in the national projection system.

The thematic and geometric quality of CLC86, CLC2000 and CLC change were evaluated as good by the external verification missions. On basis of discussions with the technical team it was decided which corrections had to be made in the CLC2000 and CLC change databases. In general, an overestimation of changes was recorded between the agricultural classes and between pastures (231) and natural grasslands (321). Correction of systematic errors was applied to the entire database. A more elaborate report on the external verification can be found in two mission reports in which verification protocols for the checked 10*10km squares are described (Christensen & Jaffrain, 2002 and Buttner & Jaffrain, 2003). All three databases were technically approved by ETC – TE in June 2003 (Soukup, 2003).

4.4 Validation

A validation was carried out to define the classification results for the CLC2000 and CLCchange database. In the I&CLC2000 project a European validation will be carried out by the technical team when all data will become available. Most likely, LUCAS data will be used as a reference dataset in this validation process. However, we decided to carry out a validation at national level.

The national validation was carried out for the CLC2000 and CLCchange databases. For each CLC2000 land cover class 62 sample points were selected in a stratified, random way. The number of points was calculated using the binomial distribution (de Gruijter, 1999) and assuming an a-priori thematic accuracy of 80% and a reliability of 90% (the CLC2000 database must have at least a 85% accuracy). For each of these points the attributed CORINE land cover class was compared with the 'real' land cover. Reference datasets were used to obtain the 'real' land cover. The used reference databases were colour aerial photographs, Land Use Statistics of 1996 (CBS 96), digital topographical map 1 : 10 000 (Top10Vector) and the Land Use database for the Netherlands for 1999/2000 (LGN4). The classification results were presented in so-called confusion matrices. For each land cover class the percentages of correctly and incorrectly classified sample points could be determined. This method made it possible to evaluate the accuracy and reliability of the classification results. The accuracy and reliability for each CLC class were corrected for the map category proportion each class was occupying which resulted in bias corrected confusion matrices (Card, 1982). The accuracy of the classification was defined as the probability that the 'real' land cover would be classified in accordance with the land cover class in the CLC2000 database. The reliability of the classification was defined as the probability that a certain land cover class of the CLC2000 database would agree with the 'real' land cover. The total classification accuracy will outline the total thematic accuracy of the CLC2000 database. The total accuracy was defined as the total number of points which were classified correctly for all classes divided by the total number of sample points (Congalton and Green, 1999).

Also a validation was carried out by omitting the CORINE rules of a minimum mapping unit of 25ha, a maximum boundary displacement of 100m and 'broad' CORINE class definitions. The same validation points were used as for the validation of CLC2000. This so-called 'point-method' would give more precise information on the accuracy and reliability of the land use/cover at that point. With help of the reference datasets, CLC classes were attributed to the selected validation points valid for that specific point.

In the case of the CLCchange database the changes were validated. For this reason 100 and 500 sample points were randomly selected in areas denominated as respectively non-changed and changed. The 'real' land cover for 1986 and 2000 was determined. The classification results were also presented in confusion matrices. The accuracy and reliability for each class changed and non-changed were corrected for the map proportion each class was occupying.

5 Results and Discussion

5.1 Products

The three land cover databases CLC86rev (CLC90_NL), CLCchange (CHANG_NL) and CLC2000 (CLC00_NL) were generated out of the 'mother' coverage. Dissolving and selecting on basis of the CLC86, CLC2000 and change items resulted in those databases. The names for the databases between brackets are referring to the databases containing a 1 km buffer around the Netherlands to facilitate European intergration of the databases.

The CLC86rev database (CLC90_NL) represents the land cover for the Netherlands in 1986. This database is not compatible with the original CLC86 database. Thematic and geometric corrections as described in section 4.2.1. were introduced in the original database. The internal geometry of the original database was corrected to make monitoring of land cover changes possible. On screen interpretation of satellite images was far more precise as the interpretation of hard copies. Also the delineation of land cover units and the integration of different working units into one database could be done more accurate in this way.

The CLC2000 database (CLC00_NL) represents the land cover for the year 1999/2000. The visual interpretation of satellite images of 1999 and 2000 resulted in this database. The CLC86rev database served as basis for the CLC2000 database. Changes were digitized and labelled.

The change database (CHANG_NL) presents the changes in land cover between 1986 and 2000. The change database consists of polygons of the 'mother' coverage which were labelled as a change. The database was generated by the selection of change polygons out of the 'mother' coverage. The condition mentioned in section 4.2 was fulfilled.

The land cover classes present in the Netherlands are marked in Table 3. In both the CLC86rev and CLC2000 similar land cover classes exist. Comparing the number and type land cover classes with the original CLC86 database some land cover classes were eliminated or introduced; continuous urban fabric (111) and coastal lagoons (521) were eliminated and moors and heathland (322), transitional woodland-shrub (324) and peat bogs (412) were introduced (Thunnissen and Middelaar, 1995).

All three databases meet the product specifications mentioned in section 2.5.1.

5.1.1 CLC86rev database

The CLC86rev database was initially a copy of the CLC86 database. Correction for geometric and thematic errors changed the database into the CLC86rev database.

The corrected version (CLC68rev) is not compatible with CLC86. In consultation with the Technical Team of ETC-TE (see Feranec, 2002, Christensen and Jaffrain, 2002 and Buttner and Jaffrain, 2003), the following main (systematic) corrections were made:

- Continuous urban fabric (111) was changed to discontinuous urban fabric (112) as most urban areas have at least 20% of permeable surface area.
- Discontinuous urban fabric (112) called 'lintbebouwing' missing in the agricultural areas (along rivers etc.) was digitized and introduced as a correction in the CLC86 database (see also Kramer & Mucher, 1994).
- Discontinuous urban fabric (112) and industrial and commercial units (121) were unmixed .
- Separation of port areas (123), industrial and commercial units (121), water courses (511) and sea and ocean (523) became more straight forward (see also Kramer & Mucher, 1994).
- Coastal lagoons (521) were changed to water bodies (512) as they were not existing in the Netherlands. A geomorphological map was consulted. Most reasonable explanation is a typing error.
- Water bodies (512) along water courses (511) were separated if the area of the water body exeeded 25 ha.
- More detailed delineation of the mixed classes complex cultivation patterns (242) and land principally occupied by agriculture with significant areas of natural vegetation (243).
- Separation of water bodies (512), extraction sites (131) and sport and leisure facilities (142) became more straight forward (see also Kramer & Mucher, 1994).
- Some forested parts of inland marshes (e.g. the Biesbosch) classified as 411 were corrected into deciduous forest (311) (see also Kramer & Mucher, 1994).
- Bare soil interpreted as construction sites (133) was corrected into arable land (211) when appropriate (see also Kramer & Mucher, 1994).
- An almost complete absence of intertidal flats in the northern and southwestern parts of the Netherlands was corrected. On basis of the digital topographical map (Top50Vector and Top10Vector) they were introduced. The contour lines of –5m and –1.5m for respectively the northern and southwestern part of the Netherlands were used. Those contour lines represented a situation of the past, but a more actual delineation of intertidal flats (423) on basis of remote sensing images was not possible. The use of those contour lines overestimates the surface area of the intertidal flats. The situation of the 0 meter contour line could not be reconstructed out of satellite images. More detailed ancillary data was not available.
- Areas with moors and heathland (322) were not corrected for the Netherlands. According to the CORINE definitions the areas should not be classified as moors and heathland (it is not a climax vegetation), but as transitional woodland/shrub (324). However, those areas in the Netherlands do not evolve into another vegetation type due to active (nature) management. For that reason they were classified as moors and heathland (322) and the surface area occupied by class 324 was restricted.

– Some polygons classified as moors and heatland (322) in the original CLC86 database were changed into peat bogs (412) with help of the geomorphological map.
– Some intertidal flats were corrected into sand plains (331) and some inland marshes (411) were corrected into intertidal flats (423) (see also Kramer & Mucher, 1994 and Schmidt, 1998).

More at random corrections due to inferior quality of remote sensing material (e.g. cloud coverage) or typing errors were also corrected in the CLC86rev database (e.g. 112 – 121, 521 – 512, 321 – 231 etc.). They were corrected on basis of ancillary data (e.g. topographical maps at scale 1 : 50 000 (2nd edition, 1989) in combination with recent remote sensing material.

5.1.2 CLC2000 and CLCchange database

The CLC2000 database is reflecting the land cover of the Netherlands according to the CORINE nomenclature (3th level). The visual interpretation of satellite images of 1999/2000 combined with ancillary data resulted in a land cover database for the year 1999/2000. The CLC2000 database can be seen as a combination of the CLC86rev and CLCchange database. Figure 7 presents the CLC2000 database for CLC classes at level 2.

The change database reflects the changes in land cover between 1986 – 2000. The CLCchange database contains attribute values representing the land cover for 1986 and 2000. The minimum area of change is at least a contiguous area of 5 ha. Figure 8 presents the changes between 1986 – 2000. The changes are differentiated according to their type of change. The land cover changes presented can be between level 1 classes and or within one class at a more detailed level. Urbanisation (mainly increase of artificial areas), changes within agricultural areas (mainly from pasture (231) to arable land (greenhouses) (211)), afforestation (increase of forest and semi-natural areas), extension of areas occupied by wetlands and/or water are the main change types presented in Figure 8.

During the updating of the land cover database certain assumptions were made to create a homogeneous CLC2000 database. These assumptions deal mainly with classes which were difficult to interpret on basis of satellite images alone. The following general remarks on the updating of classes 131/132 and 141/142, agricultural land (211, 222, 231, 24), forest (31), natural grasslands (321), transitional woodland/shrub (324) and intertidal flats (423) can be made:
– The update of classes 131, 132, 141 and 142 was difficult due to the fact that they do not have a distinct reflection on satellite images (with the exception of golf courses). However, those classes were updated by using aerial photographs for the areas where we expected those classes.
– Changes within agricultural areas (level 2) were difficult to detect, especially between the heterogeneous classes like 242 and 243 and the more homogeneous classes (211, 222 and 231). Also changes from non-irrigated arable land (211) to

pastures (231) were restricted in number due to the CORINE definitions of these classes. Land is only denominated as pasture if it is covered by grass for at least three consecutive years. Therefore, changes between agricultural classes were restricted in number and surface area. Above all changes in type of agriculture can have a very temporary character in the Netherlands.

- Due to nature policies in the last 10 – 15 years a lot of agricultural land was transformed into extensive used pastures/natural grassland (nature destination, extensive use) in the Netherlands. A class like natural grassland (321) could be updated on basis of ancillary data, it was classified in LGN4 as 'overige open begroeid natuurgebied'. However, during one of the verification missions it was decided not to classify those areas as 321 (see Christensen and Jaffrain, 2002). Only some areas for which the visual charateristics changed between the images of 1986 and 2000 were updated. Therefore, the land cover natural grassland remained restricted almost to the coastal zone (vegetated dunes).
- The updating of the forest land cover classes within the 2nd level 31 was only restricted to changes from other land cover classes to forest classes (311, 312 and 313). For this case Top10vector was used to assign the correct forest code to the newly created forest. Increase or decrease in area between the classes broad leaved forest (311), coniferous forest (312) and mixed forest (313) were not taken into account as these changes within 10 –15 years were thought to be marginal and/or not interpretable on Landsat images.
- Areas with transitional woodland/shrub vegetations (324) were restricted too a few small polygons. Large forest clearcuts (> 25 ha) were very exceptional in the Netherlands. Small forest clearcuts were incorporated into the forest classes or into class 243 according to the priority table.
- The Dutch moors and heathland are managed by man (active nature management). In fact the moors and heathland are man-induced climax vegetations which do not evolve into forest. According to the CORINE nomenclature they must be classified as class 324, because they are not a natural climax vegetation. However, they were classified as moors and heathlands (322) in both Dutch databases.
- Some specific (unexpected) changes in the province of Zeeland need to be verified by field trip (421/423 – 411/321/324) as the verification mission suggested. However, the enclosure of former coastal waters by dams made these changes possible.
- Tidal flats (423) were introduced as a correction in the land cover database of 1986. They were to a large extent not updated due to the lack of actual/recent ancillary data. In spite of their dynamic character they were presented as a static land cover type in the CLC2000 database. The satellite images were not an accurate source as it was impossible to determine the geographical position of the 0 meter line. Possible changes could be attributed to different phases of the tide.
- Changes of the coastline between 1986 and 2000 were attributed to different phases of the tide. They were not recorded as a change.

Figures on following two pages:

Legend

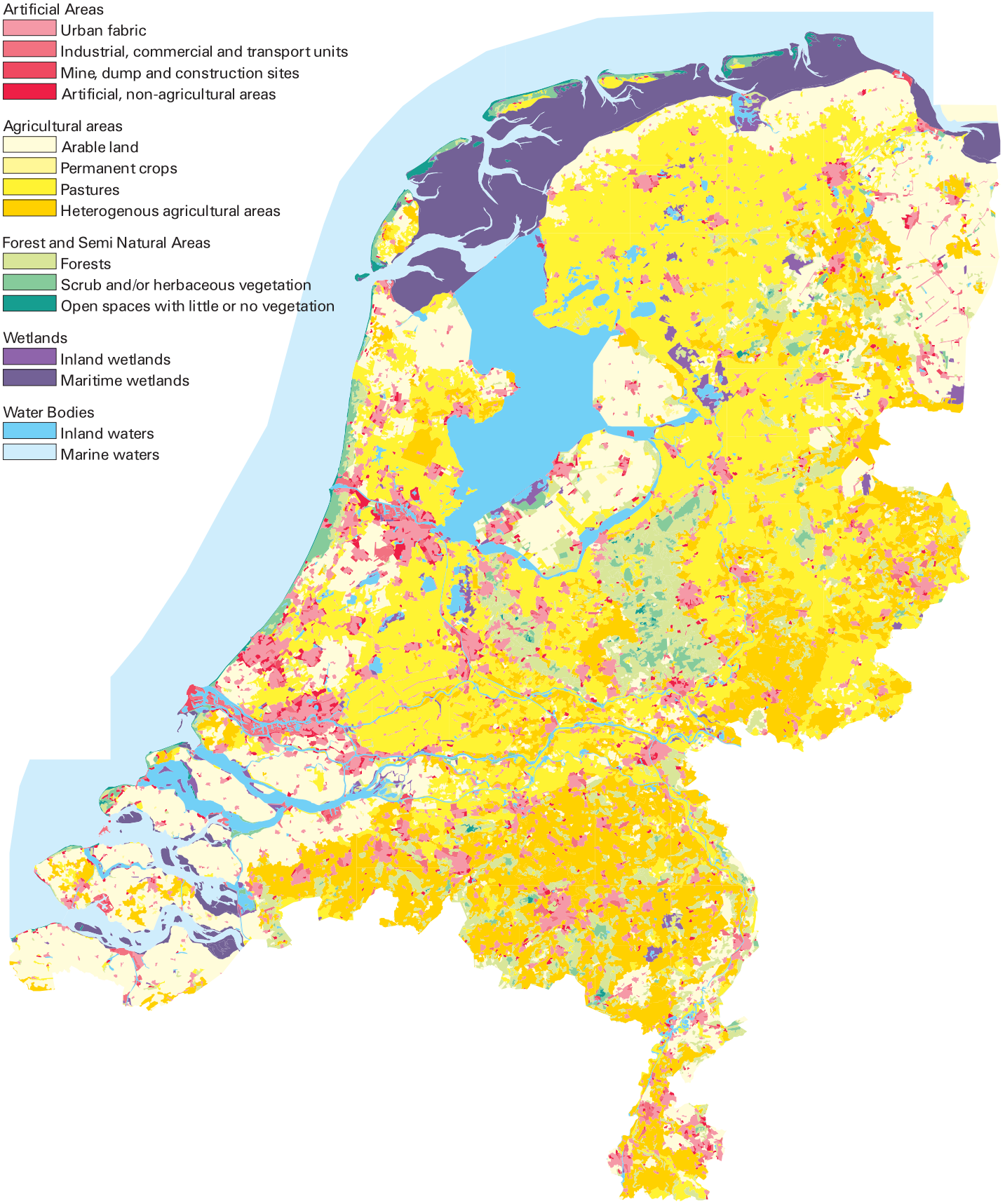
Artificial Areas
- Urban fabric
- Industrial, commercial and transport units
- Mine, dump and construction sites
- Artificial, non-agricultural areas

Agricultural areas
- Arable land
- Permanent crops
- Pastures
- Heterogenous agricultural areas

Forest and Semi Natural Areas
- Forests
- Scrub and/or herbaceous vegetation
- Open spaces with little or no vegetation

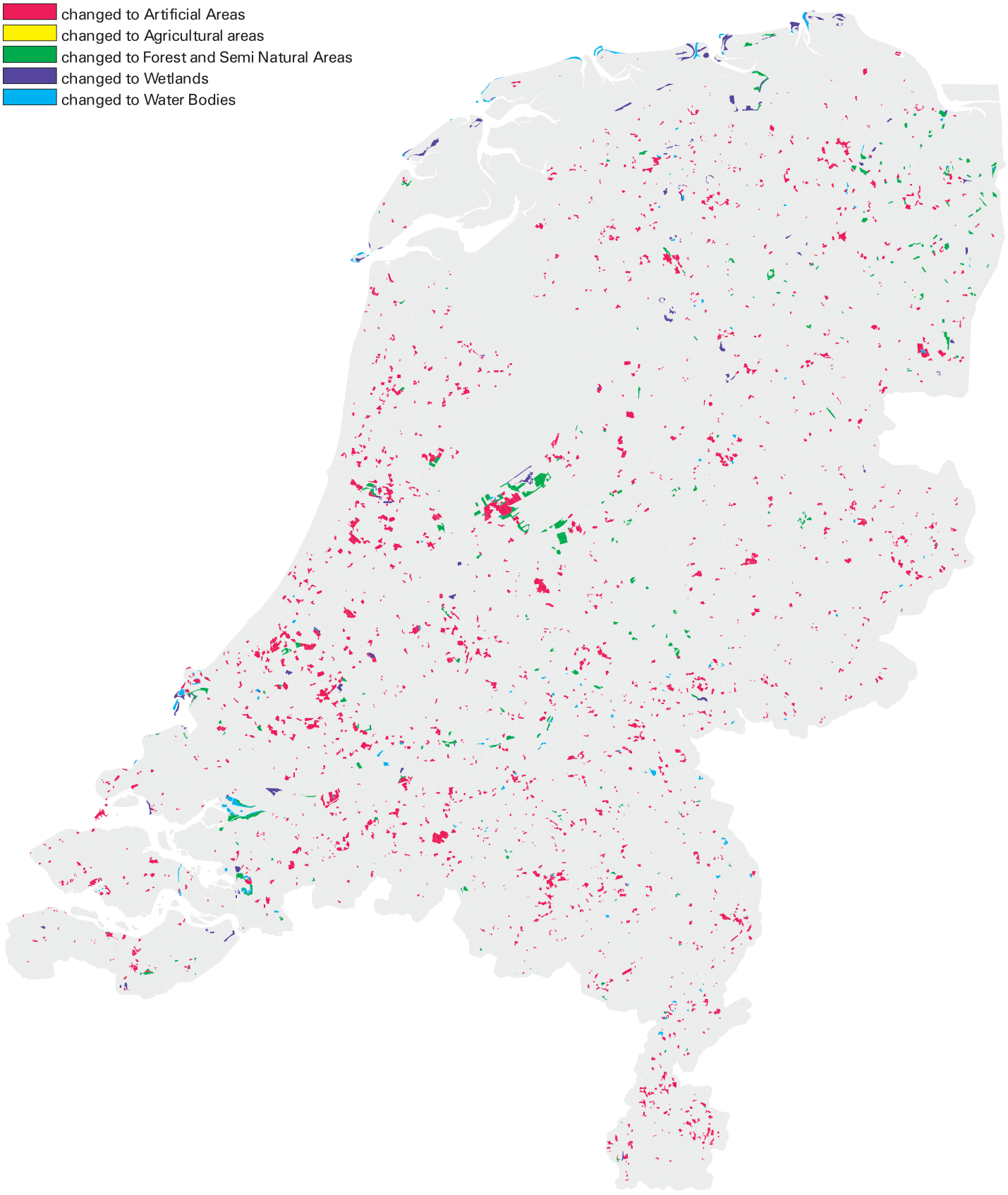
Wetlands
- Inland wetlands
- Maritime wetlands

Water Bodies
- Inland waters
- Marine waters



Legend

- changed to Artificial Areas
- changed to Agricultural areas
- changed to Forest and Semi Natural Areas
- changed to Wetlands
- changed to Water Bodies



The intersection of CLC86rev and CLC2000 resulted in a slight overestimation of changes for the period concerned. Areas were labelled as a change which in fact had not changed between 1986 – 2000 due to the fact to fulfill the intersect condition CLCchange = CLC2000 – CLC86rev. However, the labelling of only real changes would create a more precise/accurate change database than the database resulting from an intersection of CLC86rev and CLC2000.

5.1.3 Metadata

Every step in the updating process was documented to implement the internal quality control. Metadata were recorded at country and working unit level.

The metadata was provided according to the structure as provided by the CLC2000 Technical Team. It comprised information on the following items:

- identification information: basic information on the data used (images, maps, ancillary data),
- spatial reference information: map projections,
- information on basic working unit,
- responsible photo-interpreters, supervision and control,
- hardware, software,
- image processing procedures,
- field verification,
- quality assurance/quality control.

For every database, i.e. CLC00_NL, CLC90_NL and CHANG_NL at country level metadata sheets were filled in to characterise them. At working unit level, metadata was documented at a more detailed level concerning general information, data preparation, interpretation of changes and creation of CLC2000 and final technical control. In the case of the Netherlands it comprised 6 working units of almost equal size. The metadata were attached to this document (see Appendix 5 for metadata at working unit level and at country level). The metadata were delivered together with the databases to GISAT for external control. Also the coordinator of the Technical Team was informed.

5.2 Validation

5.2.1 CLC2000

A number of 1669 sample points were validated, which is slightly less than the 1860 points foreseen (30 land cover classes * 62 sample point/class). The following reasons for this discrepancy can be mentioned:

– it was decided not to validate class 423 because this class was not updated
– the surface areas occupied by classes 131, 132 and 324 were too small to select 62 sample points

– sample points were positioned in Germany and/or Belgium for which we didn't had reference data (within the 1 km buffer zone).

The 'real' land cover for each sample point was determined with help of reference datasets. Colored aerial photographs of July 2000 and Land Use Statistics of 1996 (CBS 96) were the main data sources. However, the digital topographical map 1 : 10 000 (Top10Vector) and the Land Use database for the Netherlands for 1999/2000 (LGN4) database were especially used for the forest and agricultural areas. The CBS96 and Top10Vector for some parts of the Netherlands were slightly outdated, but the best source to validate CLC2000 for forest classes and some artificial classes like mineral extraction sites (131), dump sites (132), urban green (141) and sport and leisure facilities (142).

The accuracy and reliability for the different land cover classes is presented in Table 8. These data were corrected for the map proportion of each class. The bias corrected confusion matrices for CORINE level 1 – 3 are presented in Appendix 4. The total accuracy of the CLC2000 database is almost 95% and meets the requirement of 85% set by the Technical Team. The classes 132, 141 and 324 have low accuracy (< 50%). The accuracy of the classes 142, 243 and 313 are only slightly below 85%. The relatively low accuracy can be explained by the nature of those classes. These classes are mixed classes (243, 313) or classes representing land use instead of land cover (132, 141 and 142) which makes them more sensitive to misclassifications on basis of satellite images. CORINE classes representing land use are difficult to detect on satellite images. Grass in pastures (class 231) or in a football field (class 142) have an identical reflection characteristics (see also Kramer & Mucher, 1994). Therefore, it is difficult to classify and separate without ancillary data. The reliability is above 84% for all classes at CORINE level 3.
At CORINE level 1 and 2 the total accuracies are 99% and 96%. The difference in total accuracy between level 2 and 3 is minimal.

The accuracy and reliability for all classes at CORINE level 1- 3 are considerably lower when excluding the conditions set for CLC2000: minimum mapping unit 25ha, maximum boundary displacement 100m and class definitions ('point – method'). For some classes more than 30%. Only at CORINE level 1 the total accuracy meets the 85% limit. Due to the definition of the used method, mixed classes could not be validated with this method. The exception was class 313, because it existed in our reference databases. This unmixing of CLC classes, i.e. omitting land cover information of the surroundings of the points, caused in some cases a dramatic drop in accuracy (e.g. 122, 222, 311 and 313).

Table 8. Accuracy and reliability of CLC2000 classes for CORINE level 1, 2 and 3 (%)

	CLC method							Point method					
	Accuracy			Reliability			Map	Accuracy			Reliability		
CLCcode	level3	level2	level1	level3	level2	level1	proportion	level3	level2	level1	level3	level2	level1
112	94,5	94,5		98,4	98,4		6,577422	55,8	55,8		72,6	72,6	
121	91,3			93,5			1,370123	76,8			62,9		
122	100,0			96,8			0,133431	4,5			46,8		
123	100,0			90,3			0,277126	100,0			66,1		
124	100,0	93,7		98,4	93,8		0,135833	100,0	49,7		88,7	73,0	
131	96,0			83,9			0,056779	100,0			61,3		
132	38,9			80,0			0,015068	36,9			73,3		
133	83,9	88,6		88,7	94,8		0,293286	46,9	53,9		72,6	76,5	
141	50,0			91,9			0,24961	20,4			64,5		
142	78,4	70,7	93,4	88,7	90,8	99,2	0,904753	61,9	47,7	63,3	72,6	76,5	86,9
211	95,6	95,6		95,2	95,2		17,63821	56,0	56,0		79,0	79,0	
222	100,0	100,0		91,9	91,9		0,177981	16,7	16,7		66,1	66,1	
231	99,1	99,1		91,9	91,9		23,72602	61,7	61,7		66,1	66,1	
242	87,1			95,2			12,61763	0,0			0,0		
243	78,7	87,2	99,7	88,7	95,7	99,1	2,467707	0,0	0,0	96,7	0,0	0,0	87,6
311	96,4			82,3			1,311816	26,2			53,2		
312	96,7			86,9			3,738685	58,6			41,0		
313	79,5	99,4		93,5	96,7		2,134239	27,3	71,4		33,9	78,8	
321	94,8			91,9			0,704934	85,6			83,9		
322	100,0			93,5			0,843825	81,7			75,8		
324	47,7	97,7		100,0	95,3		0,033194	27,8	80,9		100,0	81,5	
331	96,0	96,0	99,0	93,5	93,5	96,3	0,364041	80,4	80,4	77,2	79,0	79,0	83,6
411	99,0			88,7			0,739657	53,2			66,1		
412	100,0	99,2		96,6	90,3		0,181693	100,0	58,6		66,1	66,1	
421	100,0	89,3	97,8	93,5	93,5	91,5	0,210519	88,2	78,8	62,7	82,3	82,3	69,7
423							0						
511	100,0			100,0			1,02115	61,6			93,5		
512	99,6	99,7		100,0	100,0		5,862223	97,0	89,8		100,0	99,0	
522	100,0			100,0			0,500748	100,0			100,0		
523	100,0	100,0	99,9	100,0	100,0	100,0	15,7123	99,9	99,9	96,7	100,0	100,0	99,7
Total	94,9	95,8	99,0				100	65,2	68,1	89,7			

5.2.2 CLCchange

For the validation of the CLC change database also a stratified, random approach was applied. From the 600 selected points only 572 could be used for the validation of the change database (476 and 96 point for the changed and non-changed area within the change database, respectively. For those points the land cover of 1986 and 2000 was established. To obtain the 1986 land cover for the 600 points the Land Use Database of the Netherlands of 1986 (LGN1) and Land Use Statisitics of 1989 (CBS89) were used as reference data sources. Reference data that were used to obtain the land cover of 2000 were the same as the ancillary data used in the CLC2000 validation. The changes and non-changes were validated on basis of the land cover established for 1986 and 2000 with help of the above mentioned reference databases.

The accuracy and reliability of changes is presented in Table 9. The total accuracy of the change database is 98.7%. The changes have an accuracy of 76.1% and the non-changed area has an accuracy of 99.7%. These data were corrected for the area they were occupying in the database. Due to the fact that one validation point for the non-changed area was incorrectly denominated in the change database the accuracy for changes was relatively low. An incorrect classification in the large non-changed area had big consequences on the accuracy. However, only 42 out of 476 selected change points were incorrectly denominated as a change, which means 88% was correctly classified.

Table 9. Accuracy and reliability of changes (%).

	Reference data (sample points)				area	map		Reference data (corrected)			
CLC database	change	no change	total	reliability		portion	CLC database	change	no change	total	reliability
change	434	42	476	91,2	1685	3,5	change	3,2	0,3	3,5	91,2
no change	1	95	96	99,0	46415	96,5	no change	1,0	95,5	96,5	99,0
total	435	137	572		48100	100,0	total	4,2	95,8	100,0	
accuracy	99,8	69,3		92,5			accuracy	76,1	99,7		98,7

5.3 Land Cover in 1986 and 2000

The area and proportion of land cover for the three CORINE levels are presented in Table 10. For each CLC class, the difference in land cover between 1986 and 2000 is also presented. The Table presents the data for the national territory of the Netherlands. The data have only reference to the land area of the Netherlands which is approximately 35400 km2. The area covered by classes 423, 522, 523 and part of 512 (IJsselmeer) were not taken into account. The area and proportions of land cover for the datasets delivered to the EEA are presented in Appendix 3. Those data incorporated all land and water surfaces of the national territory and a buffer zone of 1km (total area approximately 48100 km2).

Table 10. The area and proportion of land cover for the CLC1986rev and CLC2000 databases

	CLC2000						CLC1986						increase/
CLC	*level3*		*level2*		*level1*		*level3*		*level2*		*level1*		decrease
code	km2	%	km2	%	km2	%	km2	%	km2	%	km2	%	km2
112	2982,4	8,4	2982,4	8,4			2540,9	7,2	2540,9	7,2			441,5
121	617.7	1.7					382.3	1.1					235.4
122	61,1	0,2					52,1	0,1					9,0
123	126,9	0,4					105,2	0,3					21,7
124	61,2	0,2	866,9	2,4			62,1	0,2	601,7	1,7			-0,9
131	23,9	0,1					12,8	0,0					11,2
132	6,9	0,0					3,3	0,0					3,6
133	133,2	0,4	164,0	0,5			138,1	0,4	154,1	0,4			-4,9
141	112,7	0,3					102,0	0,3					10,7
142	411,1	1,2	523,8	1,5	4537,2	12,8	305,9	0,9	407,9	1,2	3704,6	10,5	105,2
211	7775,5	21,9	7775,5	21,9			7975,7	22,5	7975,7	22,5			-200,2
222	78.2	0.2	78.2	0.2			72.7	0.2	72.7	0.2			5.4
231	10735,7	30,3	10735,7	30,3			11398,5	32,2	11398,5	32,2			-662,8
242	5560,5	15,7					5738,4	16,2					-178,0
243	1091,6	3,1	6652,1	18,8	25241,6	71,2	1085,7	3,1	6824,1	19,3	26271,1	74,2	5,9
311	583,8	1,6					498,8	1,4					85,0
312	1617,6	4,6					1627,3	4,6					-9,7
313	941,6	2,7	3143,1	8,9			936,2	2,6	3062,4	8,7			5,4
321	322,7	0,9					260,3	0,7					62,5
322	377,0	1,1					376,0	1,1					0,9
324	15,1	0,0	714,8	2,0			5,3	0,0	641,6	1,8			9,8
331	166,7	0,5	166,7	0,5	4024,5	11,4	189,0	0,5	189,0	0,5	3893,0	11,0	-22,4
411	338,7	1,0					296,4	0,8					42,3
412	77,5	0,2	416,2	1,2			76,3	0,2	372,8	1,1			1,2
421	94.3	0.3					92.9	0.3					1.5
423	0,0	0,0	94,3	0,3	510,5	1,4	0,0	0,0	92,9	0,3	465,6	1,3	0,0
511	459,3	1,3					457,7	1,3					1,6
512	659,1	1,9	1118,4	3,2			606,1	1,7	1063,8	3,0			53,0
522	0,0	0,0					0,0	0,0					0,0
523	0,0	0,0			1118,4	3,2	0,0	0,0			1063,8	3,0	0,0

* CLC classes 423, 522 and 523 were not taken into consideration. They do not belong to the land surface of the Netherlands.
For the same reason CLC class 512 was decreased by not taking into account the IJsselmeer

In 1986, the Netherlands was mainly covered by agricultural classes (74%). Artificial areas and forest and semi-natural areas covered each 10 – 11 %. The far most important land cover class was pastures (231) with more than 11400 km2 (32%). Besides the agricultural classes, discontinuous urban fabric was relatively large, covering more than 7% of the Netherlands (2540 km2). Other level 3 classes of some importance (i.e. area covering) were 121, forest classes, 322, 511 and 512. Level 3 land cover classes which covered less than 0.1% of the national land territory were 131, 132 and 324.

The Netherlands was still mainly covered by agricultural classes (71%) in the year 2000. Artificial areas and forest and semi-natural areas covered each 11 – 13 %. Pastures (231) with more than 10700 km2 (30%) were still the most important land cover class. Besides the agricultural classes, discontinuous urban fabric was relatively large, covering more than 8.5% of the Netherlands (almost 3000 km2). Other level 3

classes of some importance (i.e. area covering) were 121, 142, forest classes, 322, 411, 511 and 512. Level 3 land cover classes covering less than 0.1% of the national land territory were 131, 132 and 324.

The last column presents the difference in land cover area between 1986 and 2000. The most obvious phenomena from this column is the increase of land area covered by artificial areas, especially discontinuous urban fabric (112), industrial and commercial units (121) and sport and leisure facilities (142). Other important aspects are the increase of deciduous forest (311), natural grasslands (321), inland marshes (411) and water bodies (512). This increase is at the expense of the agricultural areas. The decrease of land covered with pastures (231), arable land (211) and complex cultivation patterns (242) is 1050 km2 which is 95% of the total decrease. The sum of increase or decrease in area covered by the CLC classes is 1100 km2 which is approximately 3% of the entire Dutch land surface.

Table 11 the type of changes in land cover between 1986 and 2000. The total amount of changes is 1685 km2 which is 4.76% of the Dutch land surface. Due to the followed method this will be a slight overestimation of the changes (see 4.2.2). Nevertheless, the total amount of changes is comparable with the number of changes found in our national land cover database (LGN). Changes in land cover calculated between 1996 and 2000 for 41500 km2 were nearly 390 km2 (or nearly 1%) (de Wit, 2003). Extrapolation of this to the period of 1986 - 2000 shows that the figures are of similar size. A small overestimation of changes was likely to expect.

As already indicated in Table 11 the most important land cover changes are the conversion of agricultural land into artificial areas. This urbanisation process was mainly restricted to the classes 211, 231 and 242 which had changed into classes 112, 121, 133 and 142 (Figure 9 and Figure 11). Also the conversion of almost 75% of the construction areas (133) in 1986 into the classes 112, 121 and 123 were part of this urbanisation process.
A considerable part of land covered by the pastures (231) and arable land (211) was converted into deciduous forest (311), natural grasslands (321) and inland marshes (411), respectively 75, 40 and 35 km^2 (Figure 10). Also an important change was the conversion from pastures (231) into green houses which were classified in CLC as arable land (211) (Figure 11).

Table 11. Type of changes in CORINE Land Cover between 1986 and 2000 (km2)

		CLC classes 2000																													
		112	121	122	123	124	131	132	133	141	142	211	222	231	242	243	311	312	313	321	322	324	331	411	412	421	423	511	512	522	523	total
	112	0,0	6,7	0,0	0,0	0,0	0,0	0,0	0,0	0,2	0,2	0,0	0,0	0,0	0,1	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	7,4
	121	0,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,4	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,2	0,0	0,0	0,9
	122	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	123	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,2	0,0	0,4	0,0	0,0	0,0	0,1	0,0	0,8
	124	0,0	0,0	0,0	0,0	0,0	0,0	0,0	2,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,3	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	2,5
	131	0,2	0,0	0,0	0,0	0,0	0,0	0,0	0,3	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,7	0,0	0,0	1,4
	132	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,1
	133	36,5	24,0	4,4	18,8	0,0	0,0	0,0	0,0	0,4	1,9	2,3	0,0	0,0	0,2	0,0	1,9	0,0	0,0	7,2	0,0	0,0	0,0	2,3	0,0	0,0	0,0	1,4	1,3	0,5	0,0	103,3
	141	2,4	0,6	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,2	0,0	0,0	0,0	0,0	0,0	0,3	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	3,6
	142	3,5	1,0	0,0	0,0	0,0	0,0	0,0	0,3	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,3	0,0	0,0	5,2
CLC	211	112,5	63,8	1,1	0,9	0,0	3,6	1,8	33,0	6,5	33,8	0,0	9,9	18,6	4,7	18,6	53,3	0,7	4,9	27,0	1,7	8,5	0,3	11,0	1,6	0,0	0,0	0,0	7,5	0,4	0,0	426,1
classes	222	2,0	0,7	0,0	0,0	0,0	0,0	0,0	0,1	0,0	1,3	2,7	0,0	0,0	0,3	0,0	0,3	0,0	0,0	0,0	0,0	0,0	0,0	0,6	0,0	0,0	0,0	0,0	0,1	0,0	0,0	8,2
1986	231	175,8	77,4	2,5	0,7	0,0	5,2	0,0	40,2	4,7	38,1	203,3	3,4	0,0	35,8	9,9	20,7	0,1	3,1	12,6	1,4	0,0	0,9	24,8	0,6	6,2	0,0	1,0	14,6	0,0	0,0	682,9
	242	100,8	50,3	0,2	0,4	1,3	1,5	0,0	11,8	2,5	17,6	12,5	0,3	0,2	0,0	1,2	6,1	0,8	1,8	3,0	0,5	1,5	0,0	0,0	0,0	0,0	0,0	0,5	7,1	0,0	0,0	221,9
	243	10,9	5,8	0,0	0,0	0,0	0,0	0,0	1,4	0,0	3,5	0,5	0,0	0,0	0,0	0,0	0,2	0,3	0,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,2	0,0	0,0	24,1
	311	1,9	0,6	0,0	0,1	0,2	0,1	0,0	1,1	0,0	2,7	0,2	0,0	0,7	0,3	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	8,0
	312	0,4	1,6	0,0	0,0	0,0	1,3	0,0	0,5	0,0	4,8	0,2	0,0	0,0	0,2	0,0	0,2	0,0	0,2	1,6	7,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,7	0,0	0,0	19,2
	313	0,5	1,0	0,0	0,0	0,0	0,1	0,0	0,1	0,0	1,3	0,4	0,0	0,1	0,8	0,0	0,0	0,0	0,0	0,6	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,3	0,0	0,0	5,4
	321	0,0	0,8	0,0	0,0	0,1	0,0	0,0	0,0	0,0	1,3	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	2,2
	322	0,1	1,0	0,6	0,0	0,0	0,9	0,0	0,8	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,9	5,3	0,6	0,0	0,0	0,0	0,0	0,0	0,8	0,0	0,0	0,0	0,7	0,0	0,0	11,6
	324	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	3,0	2,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	5,3
	331	0,6	0,7	0,0	0,0	0,0	0,0	0,0	1,0	0,0	0,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	2,9	0,9	0,0	0,0	0,0	0,0	0,6	19,4	0,0	0,6	0,0	11,6	38,7
	411	0,2	0,0	0,0	0,0	0,0	0,0	0,0	0,8	0,0	1,6	0,8	0,0	0,0	0,0	0,0	6,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,3	0,0	0,0	9,8
	412	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,3	0,0	0,2	1,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,9
	421	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,7	0,0	5,0	0,2	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0	7,0
	423	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	7,8	0,0	0,0	10,2	6,3	0,0	1,3	0,0	0,0	12,7	0,0	7,2	45,5
	511	0,1	0,0	0,0	0,6	0,0	0,0	0,0	0,7	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0	1,5
	512	0,3	0,0	0,1	0,9	0,0	0,0	3,0	2,6	0,0	0,3	2,4	0,0	0,2	0,0	0,3	0,0	0,0	0,0	0,2	0,0	0,0	0,0	6,8	0,0	0,0	0,0	0,2	0,0	0,0	0,0	17,2
	522	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1
	523	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	4,8	0,0	0,0	0,0	14,1	0,0	2,0	0,0	0,0	22,4
	total	448,9	236,3	9,0	22,5	1,6	12,6	4,7	98,5	14,3	110,4	225,9	13,6	20,1	43,9	30,0	93,0	9,5	10,8	64,7	12,6	15,1	16,4	52,0	3,1	8,5	33,6	3,1	50,7	1,1	18,7	1685,1

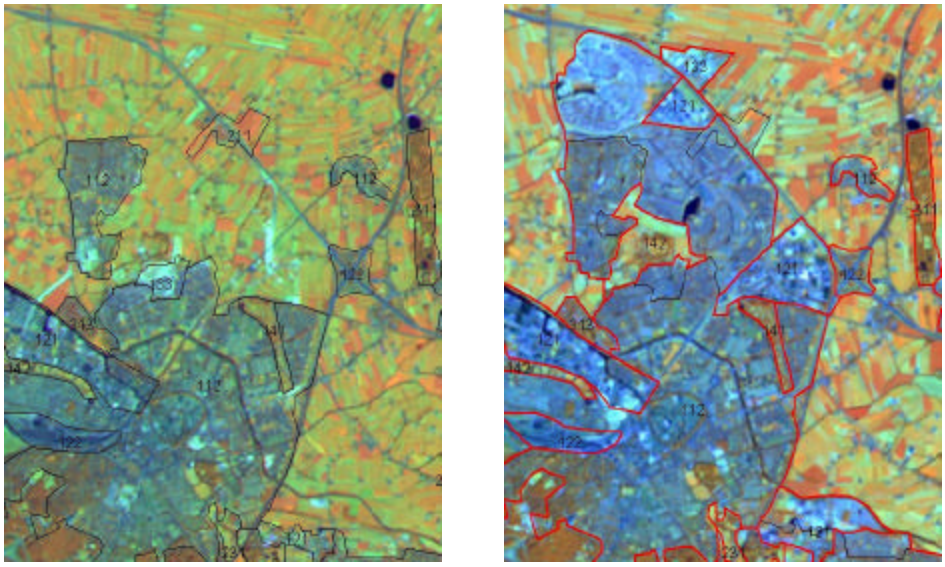


Figure 9. Agricultural areas (211, 231) changed into artificial areas (112, 121, 133 and 142) around Amersfoort (urbanisation)

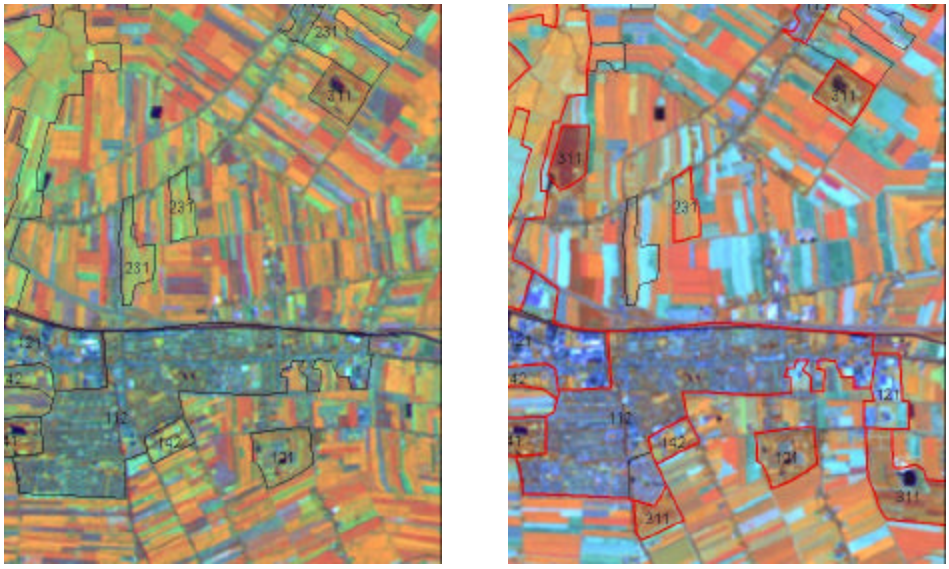


Figure 10. Changes from agricultural areas (211, 231) into deciduous forest (311) in Groningen province (afforestation)

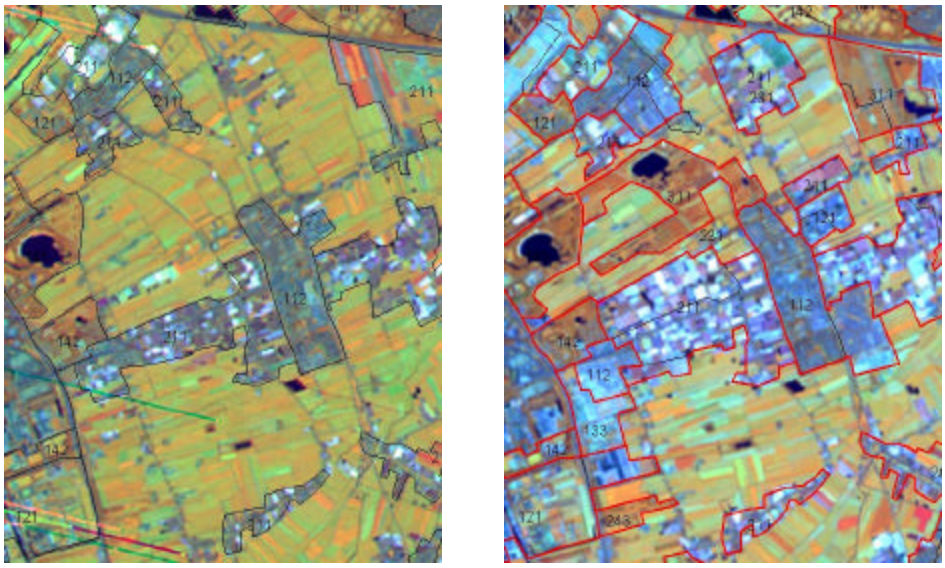


Figure 11. Changes within the agricultural areas: from pastures (231) into arable land (mainly green houses) (211) and from agricultural areas into artificial and forest areas (west of Delft)

The land cover changes of less extent can be divided into the following types:
- country specific changes
- unlikely changes due to generalisation (unreal changes)
- type of changes not important in the Dutch situation

The following important country specific changes were encountered:
- the conversion of salt marshes (421) into transitional woodland /shrub (324) and the conversion of intertidal flats (423) into 321, 331, 411 and 512 (Figure 12).
- changes from forest areas (311, 312 and 313) into moors and heathland (322) and vica versa. They are unlikely in CLC nomenclature, but they exist in the Netherlands. Forest land is converted into moors and heathland by man. The moors and heathland are man-induced climax vegetation which do not evolve into forest due to active nature management. Large clearcuts also do not exist in the Netherlands. For those reasons, the extent of transitional woodland/shrub is limited.
- the conversion of agricultural areas into natural grasslands (321) and/or transitional woodland/shrub (324). They were not yet very important but the more extensive use of agriculture areas was already sometimes reflected in the images as a different land cover.
- the change of water bodies (512) into other classes and vice versa.
- changes from sea and ocean (523) into intertidal flats (423) and vice versa. However, the identification of this type of change on basis of satellite images was nearly impossible.
- changes from intertidal flats (423) into beaches, dunes and sands (331) and vice versa. Due to the high dynamics of these areas it the thematic accuracy of these land covers will not be high. For that reason, it is advised not to give great importance to this type of changes registered in the change database (CLCchange).

Changes due to generalisation were for example the changes from 112 into 121, 141, 142 and 311. The restriction of a minimum mapping area of 25ha made it necessary

to label some areas in 1986 as 112 that were in fact industrial and commercial areas (121). These **virtual** polygons grew due to changes to an extent of > 25ha. These virtual and real changes both were mapped as a change. In 2000 the total area could be mapped as class 121 (see section 4.2.). Another cause for unlikely changes were the generalisation of **rest** polygons in the CLC2000 database with help of the priority table (Appendix 1). Both caused a slight overestimation of changes.

Enlargement of agricultural areas at the expense of other CLC classes and intensification of agriculture (321 – 2??) were nearly absent in the Netherlands. Also the conversion of CLC classes 112, 121, 141 and 142 into agricultural, forest or semi-natural areas, wetlands or water (e.g. abandonment of villages) and the change of wetlands, forest and semi-natural areas into artificial areas (level 1) were very limited (e.g. deforestation).

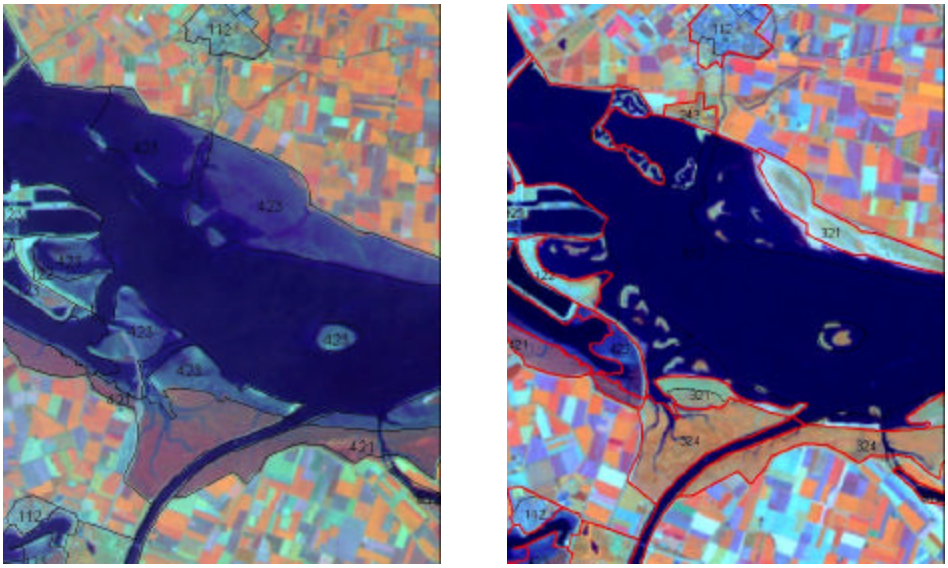


Figure 12. Country specific change in the province of Zeeland. Salt marshes (421) and intertidal flats (423) were converted into natural grasslands (321), transitional woodland shrub (324) and inland marshes (411)

Within the Netherlands you could see some regional differences concerning the most important changes between 1986 and 2000. Urbanisation (change from 133 – 121/112 and 2?? – 1??) was booming in the western part of the Netherlands (mainly the provinces Noord en Zuid-Holland, Utrecht). In other parts of the Netherlands it was more localised around already existing places. Afforestation, de-intensification of agriculture or conversion of arable land into nature areas (nature compensation) (2?? – 31, 32 or 411) were principally encountered in Groningen, Noord en Zuid-Holland), changes due to sedimentation and erosion processes (33/42 – 52 and vice versa) were difficult to delineate without appropriate ancillary data. However, these changes would be mainly localised around and in the Waddenzee and Zeeland. The shift from salt to fresh water environments through the construction of dams and canals, i.e. enclosure of former coastal waters surfaces (42-41 and 52-51, 42 -51) could be found in the province of Zeeland. Also the conversion of water environments into artificial areas could be encountered in the surroundings of Rotterdam (Europoort/Maasvlakte), Amsterdam and the Flevopolders (slufter).

6 Conclusions and recommendations

6.1 Conclusions

The CLC databases are especially suitable for integrated environmental studies at European scale (1 : 100 000). The databases were produced in a consistent way with one common methodology for all participating countries. The CLC2000 database was based on satellite images acquired within + / - 1 year around 2000.

The Dutch CORINE Land Cover project resulted in the following three databases containing land cover data of the Netherlands:
- CLC86rev, which was a revised and corrected version of the old database (CLC90_NL),
- CLC2000 representing the land cover of year 2000 (CLC00_NL) and
- CLCchange containing land cover changes between 1986 and 2000 (CHANG_NL).

Together with these three databases the metadata at country and working unit level were products of the I&CLC2000 project for the Netherlands.

The Netherlands were characterised by 30 out of 44 CORINE land cover classes. Within both CLC86rev and CLC2000 databases similar CORINE land cover classes were represented. The most extended land cover types in both databases were pastures (231), arable land (211) and complex cultivation patterns (242). Almost ¾ of the Dutch land surface was classified as agricultural land. Land classified as artificial areas or as semi-natural and forest areas occupied each around 10% of the national territory. The remainder of the Dutch land surface was classified as wetland or water bodies, rivers and / or canals.

Between 1986 and 2000 around 4.76% of the Dutch land area had changed its land cover. This percentage match with the extent of changes which could be derived from the changes detected by our national land cover database (LGN). The most typical land cover changes for the Netherlands were the conversion of agricultural land into artificial areas (112, 121, 133 and 142). The conversion of agricultural land into deciduous forest (311), natural grassland (321) and inland marshes (411) were other important changes in the Dutch situation. Furthermore, a considerable part of the registered land cover changes dealt with the conversion of pastures (231) into arable land (211) (green houses). Some country specific changes of importance were the construction of dams and canals, changes caused by erosion and sedimentation along the coast (difficult to monitor) and the conversion of salt into fresh water environments.

The total thematic accuracy of the CLC2000 database was almost 95% which amply met the European target of 85%. Only a few classes (132, 141, 142, 243 and 313) had relatively low accuracy. However, these classes occupied only small portions of the Dutch land. The thematic accuracy dropped strongly when excluding the requirements

set for CORINE in your validation (minimum mapping unit 25ha, maximum boundary displacement 100m and class definitions). For some classes more than 30%. Also the validation of the change database resulted in high total thematic accuracy of 98.7%. The accuracy percentages for the areas changed and not changed were 76.1% and 99.7%, respectively. Out of 476 points only 42 were incorrectly classified as a change, which meant 88% of the changes were correctly classified as changes.

6.2 Recommendations

The geometric corrections of the CLC86 database needed much attention. Together with some thematic corrections the correction of the original CLC86 database was of the same order as the time needed for the updating process. However, it is hard to say if a next update can be done in half time. At that moment, the databases will comply with other requirements which will need attention (changes within agricultural land, changes in dynamic environments (intertidal flats)).

Integration of LGN and CLC needs to be investigated. Differences and similarities between both databases (detail, legend, vector/raster, satellite images) need to be registered. The CLC2000 land cover mapping at European level is done on basis of a hierarchical legend with three levels which corresponds with a mapping scale of 1 : 100 000. However, in many countries the CORINE legend is extended to a fourth or even fifth level to produce a more detailed land cover map at country level. It seems appropriate to look for possibilities to develop a standardised CORINE level 4 or 5 to make detailed European environmental analysis possible. It will be important to integrate our national database (LGN) and CORINE if this will be reality. The level of detail will be similar and it will be more efficient to update only one land cover database every time step.

The method used to detect changes (CLCchange = CLC2000 – CLC86rev) is sensible to overestimate the changes. Virtual polygons (1986, < 25ha) and rest polygons (2000, < 25ha) cause unreal changes. Labelling of virtual and rest polygons different from the real changes will make it possible to separate them. This time consuming method will result in the statement that CLCchange is not equal to CLC2000 – CLC86rev. However, comparison with the changes detected with LGN/other database it shows that the extent of changes is of similar size.

The effect of spatial detail on the number and extent of changes needs to be further investigated. Several research questions can be formulated. What will be the number and extent of changes if you start with a minimum mapping unit of 5 ha for all three databases? What will be the effect of different landscape types (small scale/large scale landscape) on the number/extent of changes in this case? Is the small difference in the amount of changes between LGN and CLCchange only affected by the overestimation due to the incorporation of virtual and rest changes or have differences in mapping scale / aggregation level also an effect on the number of changes recorded?

Ancillary data is important in CORINE land cover classification as some classes are representing land use instead of land cover. Land use, which has everything to do with the function of the land, is often difficult to detect on satellite images. Spectral characteristics are not influenced by the land use. Examples are the classification of an football field as 142 and not as 231 or extraction pits (131) as water bodies (512). To delineate CLC classes representing land use (e.g. 131, 132, 142) you need ancillary data of high quality which have more or less similar class definitions. In the case of change detection, ancillary data for both time steps are required which make it even more difficult to delineate changes between these CLC classes. In inventories with a temporal component it is therefore recommended to limit the definition of land use classes.

Multi-temporal classification can be useful to separate two or more land cover classes which have the same reflection in a certain image. For example, the mixing-up of bare arable land (211) and construction sites (133) in CLC86 can be prevented. Also the separation of different agricultural classes can be facilitated with the use of multi-temporal images.

The intertidal flats were considered nearly static for the period 1986 – 2000 which is in contrast with its highly dynamic character. In CLC86 they were almost absent due to the lack of ancillary data. Remote sensing images only reflect a very temporary situation which in most cases do not reflect the 0 m tide line. Intertidal flats (423) were introduced into the CLC86rev and CLC2000 databases due to the fact ancillary data of different quality/accuracy became available. However, monitoring of changes from intertidal flats into other land cover types could not be done. Improvement of CLC and change databases can only be reached if more up-to-date and accurate ancillary data will become available. The data have to represent a kind of 'mean' situation for a certain time period.

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Appendix 1 Priority table (EEA & ETC – TE, 2003)

	111	112	121	122	123	124	131	132	133	141	142	211	212	213	221	222	223	231	241	242	243	244	311	312	313	321	322	323	324	331	332	333	334	335	411	412	421	422	423	511	512	521	522	523
111		1	1	1	1	1	1	1	1	1	1	3	3	3	3	3	3	3	2	2	3	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	5	5	5
112	1		1	1	1	1	1	1	1	1	1	3	3	3	3	3	3	3	2	2	3	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	5	5	5
121	3	3		1	1	1	2	2	2	4	4	6	6	6	6	6	6	6	5	5	6	7	7	7	7	7	7	7	7	7	7	7	7	7	8	8	8	8	8	8	8	8	8	8
122	2	2	1		1	1	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	5	5	5
123	3	3	1	1		1	2	2	2	4	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	6	6	6	6	6	6	6	6	6	6
124	3	3	1	1	1		4	4	4	2	2	6	6	6	6	6	6	6	5	6	5	6	6	6	6	6	6	6	6	6	6	6	6	6	7	7	7	7	7	7	7	7	7	7
131	3	3	2	2	3	3		1	1	4	4	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	6	6	8	8	8	8	5	8	8	8
132	3	3	2	2	3	3	3		1	4	4	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	6	6	8	8	8	8	5	8	8	8
133	1	1	1	1	1	1	2	2		2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4
141	3	2	3	3	3	3	3	3	3		1	7	7	7	7	7	7	7	7	7	5	5	4	4	4	4	4	4	4	7	7	7	7	7	7	7	7	7	7	7	6	6	7	7
142	3	2	3	3	3	3	3	3	3	1		5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	4	5	5
211	5	5	5	5	5	5	5	5	5	5	5		1	1	4	4	4	3	2	2	2	2	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	7	7	7	7	7
212	5	5	5	5	5	5	5	5	5	5	5	1		1	4	4	4	3	2	2	2	2	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	7	7	7	7	7
213	5	5	5	5	5	5	5	5	5	5	5	1	1		4	4	4	3	2	2	2	2	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	7	7	7	7	7
221	4	4	5	5	5	5	5	5	5	5	5	3	3	3		1	1	3	2	2	2	2	5	5	5	4	4	4	4	4	4	4	4	6	6	6	6	6	6	7	7	7	7	7
222	5	5	6	6	6	6	6	6	6	6	6	3	3	3	1		1	3	2	2	2	2	4	4	4	6	5	5	5	6	6	6	6	7	7	7	7	7	7	8	8	8	8	8
223	5	5	6	6	6	6	6	6	6	6	6	3	3	3	1	1		3	2	2	2	2	4	4	4	6	5	5	5	6	6	6	6	7	7	7	7	7	7	8	8	8	8	8
231	6	5	6	6	6	5	6	6	6	4	4	2	2	2	3	3	3		1	1	1	1	7	7	7	4	6	6	6	5	5	5	5	8	4	4	4	7	7	8	8	8	8	8
241	3	2	3	3	3	3	3	3	3	3	3	1	1	1	1	1	1	1		1	1	1	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	5	5	5	5	5
242	3	2	3	3	3	3	3	3	3	3	3	1	1	1	1	1	1	1	1		1	1	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	5	5	5	5	5
243	4	3	4	4	4	4	4	4	4	4	4	2	2	2	2	2	2	2	1	1		1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	3	4	4	4
244	4	3	4	4	4	4	4	4	4	4	4	2	2	2	2	2	2	2	1	1	1		3	3	3	4	4	4	4	4	4	4	4	5	5	5	5	5	5	8	6	6	6	8
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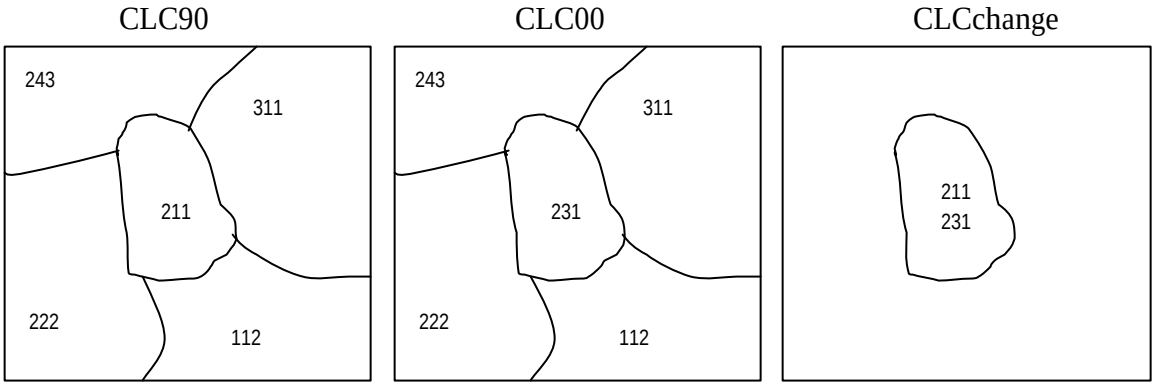
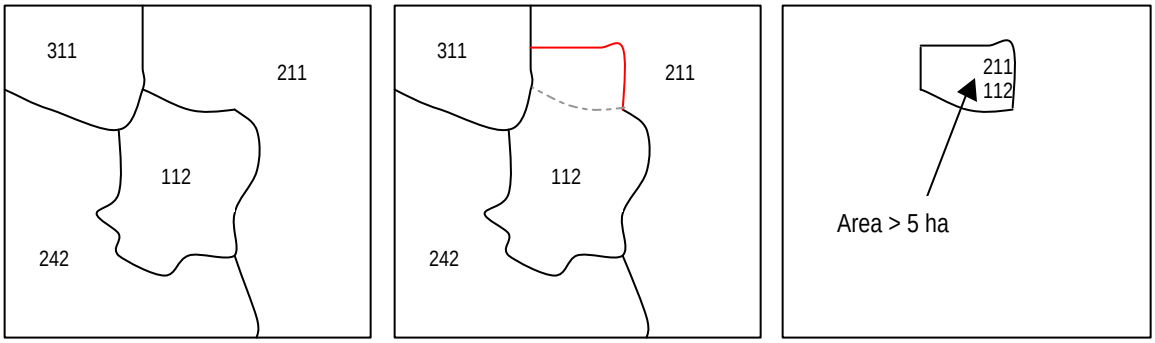
312	7	7	7	7	7	7	7	7	7	3	3	7	7	7	7	6	6	7	6	6	3	3	2		1	5	4	4	4	5	5	5	5	8	6	6	6	8	8	8	8	8	8	8
313	7	7	7	7	7	7	7	7	7	3	3	7	7	7	7	6	6	7	6	6	2	3	1	1		5	4	4	4	5	5	5	5	8	6	6	6	8	8	8	8	8	8	8
321	8	8	8	8	8	8	8	8	8	3	3	7	7	7	7	7	7	5	6	6	2	6	4	4	4		1	1	1	3	3	3	3	8	4	4	4	9	4	8	8	8	8	8
322	6	6	6	6	6	6	6	6	6	3	3	5	5	5	4	4	4	5	5	5	2	4	3	3	3	2		1	1	3	3	3	3	8	2	2	4	7	4	8	8	8	8	8
323	6	6	6	6	6	6	6	6	6	3	3	5	5	5	4	4	4	5	5	5	2	4	3	3	3	2	1		1	3	3	3	3	8	2	2	4	7	4	8	8	8	8	8
324	6	6	6	6	6	6	6	6	6	3	3	5	5	5	4	4	4	5	5	5	2	4	1	1	1	1	1	1		2	2	2	2	8	3	3	4	7	4	8	8	8	8	8
331	6	6	6	6	6	6	6	6	6	3	3	5	5	5	5	5	5	5	5	5	2	5	4	4	4	2	2	3	3		1	1	1	1	4	4	2	4	2	2	2	3	3	3
332	5	5	5	5	5	5	3	3	3	4	4	4	4	4	3	4	4	4	4	4	2	4	3	3	3	2	2	2	2	1		1	1	1	4	4	4	4	4	6	6	6	6	6
333	6	6	6	6	6	6	6	6	6	3	3	5	5	5	5	5	5	4	5	5	2	5	3	3	3	2	2	2	2	1	1		1	1	4	4	4	4	4	7	7	7	7	7
334	7	7	7	7	7	7	7	7	7	4	4	5	6	6	5	4	4	5	5	5	3	3	2	2	2	2	2	2	2	1	1	1		8	6	2	6	6	6	8	8	8	8	8
335	8	8	8	8	8	8	8	8	8	8	5	8	8	8	8	8	8	8	8	8	8	8	6	6	6	4	5	7	6	1	1	1	7		4	4	5	5	5	3	2	5	5	5
411	7	7	7	7	7	7	7	7	7	7	7	6	6	6	6	6	6	5	6	6	2	6	4	4	4	4	4	4	4	4	4	4	5	3		1	2	2	2	3	3	3	3	3
412	7	7	7	7	7	7	7	7	7	7	7	6	6	6	6	6	6	5	6	6	2	6	4	4	4	4	4	4	4	4	4	4	5	3	1		2	2	2	3	3	3	3	3
421	8	8	8	8	8	8	8	8	8	8	8	7	7	7	7	7	7	4	7	7	4	7	7	7	7	4	6	6	6	5	5	5	8	8	3	3		1	1	2	2	1	1	1
422	6	6	5	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	7	7	2	3	1		1	4	4	3	3	3
423	6	6	6	6	5	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	7	7	4	4	1	1		3	3	2	2	2
511	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	5	5	5	5	5	5	5	5	2	5	5	6	6	4	4	3	3	3		1	2	2	2
512	5	5	5	5	5	5	2	5	5	4	4	5	5	5	5	5	5	5	5	5	3	5	5	5	5	5	5	5	5	3	5	5	6	6	3	3	3	3	3	1		2	2	2
521	5	5	5	5	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	3	5	5	5	5	5	5	5	5	5	5	5	6	6	4	4	3	3	3	2	2		1	1
522	6	6	6	6	5	6	6	6	6	5	5	6	6	6	6	6	6	6	6	6	3	6	6	6	6	6	6	6	6	6	6	6	7	7	4	4	3	3	3	2	2	2		1
523	6	6	6	6	5	6	6	6	6	5	5	6	6	6	6	6	6	6	6	6	3	6	6	6	6	6	6	6	6	6	6	6	7	7	4	4	3	3	3	2	2	1	1	

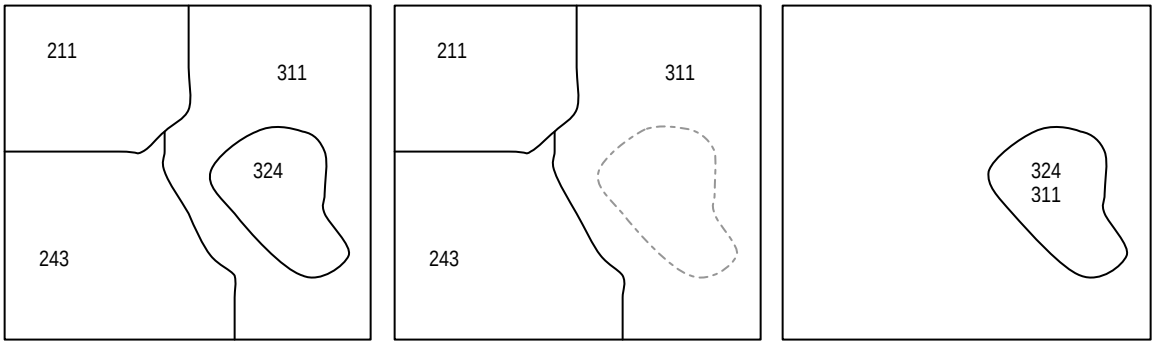
Appendix 2 Land cover changes (EEA & ETC - TE, 2003)



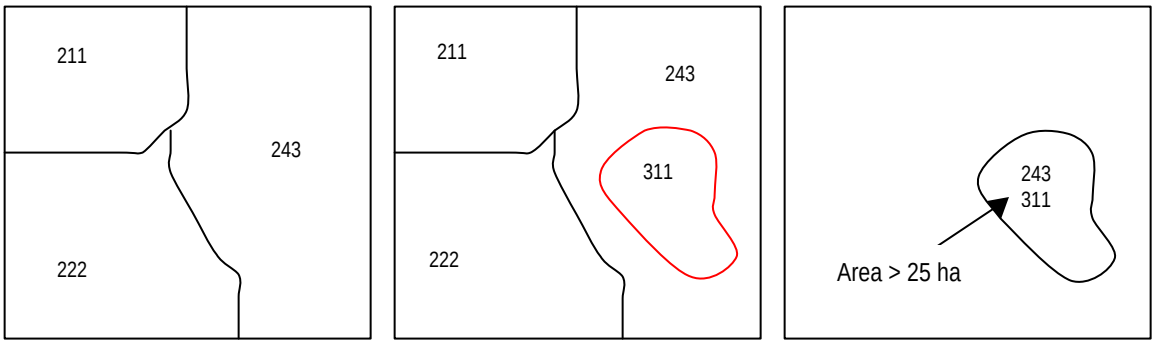
1. Change of the CLC code: the polygon with 211 code has changed into 231



2. Area exchange between two polygons: 112 has increased, 211 decreased (change > 5 ha)



3. Disappearance of a polygon: 311 has increased, 324 ceased (area became < 25 ha)



4. Appearance of a new polygon: a 311 was born inside 243 (area must be >25 ha)

Appendix 3 Area and proportions of Corine Land Cover classes for CLC86rev and CLC2000 (Dutch and EU databases)

	European database				increase/	**Dutch database**				increase/
CLC	CLC2000		CLC1986		decrease	CLC2000		CLC1986		decrease
code	km2	%	km2	%	km2	km2	%	km2	%	km2
112	3011,9	6,3	2567,9	5,3	444,0	2982,4	6,3	2540,9	5,4	441,5
121	627,4	1,3	385,4	0,8	242,0	617,7	1,3	382,3	0,8	235,4
122	61,1	0,1	52,1	0,1	9,0	61,1	0,1	52,1	0,1	9,0
123	126,9	0,3	105,2	0,2	21,7	126,9	0,3	105,2	0,2	21,7
124	62,2	0,1	63,1	0,1	-0,9	61,2	0,1	62,1	0,1	-0,9
131	26,0	0,1	15,6	0,0	10,4	23,9	0,1	12,8	0,0	11,2
132	6,9	0,0	3,3	0,0	3,6	6,9	0,0	3,3	0,0	3,6
133	134,3	0,3	138,4	0,3	-4,1	133,2	0,3	138,1	0,3	-4,9
141	114,3	0,2	103,6	0,2	10,7	112,7	0,2	102,0	0,2	10,7
142	414,3	0,9	306,3	0,6	108,0	411,1	0,9	305,9	0,6	105,2
211	8076,8	16,8	8277,6	17,2	-200,9	7775,5	16,5	7975,7	16,9	-200,2
222	81,5	0,2	75,2	0,2	6,3	78,2	0,2	72,7	0,2	5,4
231	10864,5	22,6	11533,0	24,0	-668,5	10735,7	22,8	11398,5	24,2	-662,8
242	5777,8	12,0	5964,9	12,4	-187,2	5560,5	11,8	5738,4	12,2	-178,0
243	1130,0	2,3	1124,1	2,3	5,9	1091,6	2,3	1085,7	2,3	5,9
311	600,7	1,2	515,5	1,1	85,1	583,8	1,2	498,8	1,1	85,0
312	1712,0	3,6	1722,0	3,6	-10,0	1617,6	3,4	1627,3	3,4	-9,7
313	977,3	2,0	972,0	2,0	5,3	941,6	2,0	936,2	2,0	5,4
321	322,8	0,7	260,3	0,5	62,5	322,7	0,7	260,3	0,6	62,5
322	386,4	0,8	385,6	0,8	0,9	377,0	0,8	376,0	0,8	0,9
324	15,2	0,0	5,3	0,0	10,0	15,1	0,0	5,3	0,0	9,8
331	166,7	0,3	189,0	0,4	-22,4	166,7	0,4	189,0	0,4	-22,4
411	338,7	0,7	296,5	0,6	42,3	338,7	0,7	296,4	0,6	42,3
412	83,2	0,2	80,8	0,2	2,4	77,5	0,2	76,3	0,2	1,2
421	96,4	0,2	94,9	0,2	1,5	94,3	0,2	92,9	0,2	1,5
423	2307,7	4,8	2319,6	4,8	-11,9	2306,6	4,9	2318,5	4,9	-11,9
511	467,6	1,0	466,0	1,0	1,6	459,3	1,0	457,7	1,0	1,6
512	2684,4	5,6	2649,1	5,5	35,3	2677,0	5,7	2643,5	5,6	33,5
522	229,3	0,5	228,4	0,5	1,0	227,8	0,5	226,9	0,5	1,0
523	7194,9	15,0	7198,6	15,0	-3,7	7194,9	15,3	7198,6	15,3	-3,7
Total	48099,1		48099,1			47179,4		47179,4		
total land area: 48100km2 (european database = Dutch database + 1km buffer)										
total land area: 47200km2 (dutch database)										

Appendix 4 Bias corrected confusion matrices

IV A. CLC method

		Referentie data						
	level1	1	2	3	4	5	Total	Rel.(%)
CLC data	1	0,099	0,001	0,000	0,000	0,000	0,100	99,2
	2	0,004	0,561	0,000	0,000	0,000	0,566	99,1
	3	0,002	0,001	0,088	0,000	0,000	0,091	96,3
	4	0,000	0,000	0,000	0,010	0,000	0,011	91,5
	5	0,000	0,000	0,000	0,000	0,231	0,231	100,0
	Total	0,106	0,563	0,089	0,011	0,231		
	Accuracy	93,4	99,7	99,0	97,8	99,9		
	Total accuracy (%)	99,0						

		Referentie data																
	level2	11	12	13	14	21	22	23	24	31	32	33	41	42	51	52	Total	Rel.(%)
CLC data	11	0,065	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,066	98,4
	12	0,001	0,018	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,019	93,8
	13	0,000	0,000	0,003	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,004	94,8
	14	0,000	0,000	0,000	0,010	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,012	90,8
	21	0,000	0,000	0,000	0,000	0,168	0,000	0,000	0,009	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,176	95,2
	22	0,000	0,000	0,000	0,000	0,000	0,002	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,002	91,9
	23	0,000	0,000	0,000	0,000	0,008	0,000	0,218	0,011	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,237	91,9
	24	0,002	0,000	0,000	0,002	0,000	0,000	0,002	0,144	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,151	95,7
	31	0,001	0,000	0,000	0,001	0,000	0,000	0,000	0,000	0,069	0,000	0,000	0,000	0,000	0,000	0,000	0,072	96,7
	32	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,015	0,000	0,000	0,000	0,000	0,000	0,016	95,3
	33	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,003	0,000	0,000	0,000	0,000	0,004	93,5
	41	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,008	0,000	0,000	0,000	0,009	90,3
	42	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,002	0,000	0,000	0,002	93,5
	51	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,069	0,000	0,069	100,0
	52	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,162	0,162	100,0
	Total	0,068	0,019	0,004	0,015	0,176	0,002	0,220	0,166	0,070	0,015	0,004	0,008	0,002	0,069	0,162		
	Accuracy	94,5	93,7	88,6	70,7	95,6	100,0	99,1	87,2	99,4	97,7	96,0	99,2	89,3	99,7	100,0		
	Total accuracy (%)	95,8																

		Referentie data																																								
	level3	112	121	122	123	124	131	132	133	141	142	211	222	231	242	243	311	312	313	321	322	324	331	411	412	421	423	511	512	522	523	Total	Rel.(%)
CLC data	112	0,065	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,066	98,4
	121	0,000	0,013	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,014	93,5
	122	0,000	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,001	96,8
	123	0,000	0,000	0,000	0,003	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,003	90,3
	124	0,000	0,000	0,000	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,001	98,4
	131	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,001	83,9
	132	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	80,0
	133	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,003	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,003	88,7
	141	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,002	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,002	91,9
	142	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,008	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,009	88,7
	211	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,168	0,000	0,000	0,006	0,003	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,176	95,2
	222	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,002	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,002	91,9
	231	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,008	0,000	0,218	0,011	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,237	91,9
	242	0,002	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,002	0,000	0,000	0,000	0,000	0,120	0,002	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,126	95,2
	243	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,002	0,000	0,022	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,025	88,7
	311	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,011	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,013	82,3
	312	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,032	0,004	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,037	86,9
	313	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,020	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,021	93,5
	321	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,006	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,007	91,9
	322	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,008	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,008	93,5
	324	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	100,0
	331	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,003	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,004	93,5
	411	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,007	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,007	88,7
	412	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,002	0,000	0,000	0,000	0,000	0,000	0,000	0,002	96,6
	421	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,002	0,000	0,000	0,000	0,000	0,000	0,002	93,5
	423																																
	511	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,010	0,000	0,000	0,000	0,010	100,0
	512	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,059	0,000	0,000	0,059	100,0
	522	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,005	0,000	0,005	100,0
	523	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,157	0,157	100,0
	Total	0,068	0,014	0,001	0,003	0,001	0,000	0,000	0,003	0,005	0,010	0,176	0,002	0,220	0,138	0,028	0,011	0,034	0,025	0,007	0,008	0,001	0,004	0,007	0,002	0,002		0,010	0,059	0,005	0,157		
	Accuracy	94,5	91,3	100,0	100,0	100,0	96,0	38,9	83,9	50,0	78,4	95,6	100,0	99,1	87,1	78,7	96,4	96,7	79,5	94,8	100,0	47,7	96,0	99,0	100,0	100,0		100,0	99,6	100,0	100,0		
	Total accuracy (%)	94,9																															

IV B. Point method

		Referentie data						
	level1	1	2	3	4	5	Total	Rel.(%)
	1	0,087	0,008	0,003	0,000	0,002	0,100	86,9
	2	0,045	0,496	0,018	0,004	0,003	0,566	87,6
CLC	3	0,004	0,008	0,076	0,001	0,002	0,091	83,6
data	4	0,000	0,001	0,001	0,008	0,001	0,011	69,7
	5	0,000	0,000	0,000	0,000	0,230	0,231	99,7
	Total	0,137	0,513	0,099	0,013	0,238		
	Accuracy	63,3	96,7	77,2	62,7	96,7		
	Total accuracy (%)			89,7				

		Referentie data																
	level2	11	12	13	14	21	22	23	24	31	32	33	41	42	51	52	Total	Rel.(%)
	11	0,048	0,004	0,001	0,004	0,004	0,000	0,001	0,000	0,002	0,000	0,000	0,000	0,000	0,001	0,000	0,066	72,6
	12	0,001	0,014	0,001	0,000	0,001	0,000	0,000	0,000	0,001	0,000	0,000	0,000	0,000	0,001	0,000	0,019	73,0
	13	0,000	0,000	0,003	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,004	76,5
	14	0,001	0,000	0,000	0,009	0,000	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,012	76,5
	21	0,009	0,003	0,000	0,000	0,139	0,000	0,020	0,003	0,000	0,000	0,000	0,000	0,000	0,003	0,000	0,176	79,0
	22	0,000	0,000	0,000	0,000	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,002	66,1
	23	0,019	0,004	0,000	0,000	0,046	0,004	0,157	0,000	0,004	0,000	0,000	0,004	0,000	0,000	0,000	0,237	66,1
CLC	24	0,007	0,001	0,000	0,003	0,055	0,002	0,068	0,000	0,014	0,000	0,000	0,000	0,000	0,000	0,000	0,151	0,0
data	31	0,001	0,002	0,000	0,002	0,002	0,000	0,005	0,000	0,057	0,003	0,000	0,000	0,000	0,002	0,000	0,072	78,8
	32	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,000	0,001	0,013	0,000	0,000	0,000	0,000	0,000	0,016	81,5
	33	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,003	0,000	0,000	0,000	0,000	0,004	79,0
	41	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,000	0,001	0,000	0,000	0,006	0,000	0,001	0,000	0,009	66,1
	42	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,002	0,000	0,000	0,002	82,3
	51	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,068	0,000	0,069	99,0
	52	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,162	0,162	100,0
	Total	0,086	0,028	0,005	0,019	0,249	0,007	0,254	0,003	0,079	0,016	0,004	0,010	0,002	0,076	0,162		
	Accuracy	55,8	49,7	53,9	47,7	56,0	16,7	61,7	0,0	71,4	80,9	80,4	58,6	78,8	89,8	99,9		
	Total accuracy (%)			68,1														

		Referentie data																																								
	level3	112	121	122	123	124	131	132	133	141	142	211	222	231	242	243	311	312	313	321	322	324	331	411	412	421	423	511	512	522	523	Total	Rel.(%)
	112	0,048	0,002	0,002	0,000	0,000	0,000	0,000	0,001	0,003	0,001	0,004	0,000	0,001	0,000	0,000	0,000	0,001	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,000	0,000	0,000	0,066	72,6
	121	0,001	0,009	0,001	0,000	0,000	0,000	0,000	0,001	0,000	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,014	62,9
	122	0,000	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,001	46,8
	123	0,000	0,000	0,000	0,002	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,003	66,1
	124	0,000	0,000	0,000	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,001	88,7
	131	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,001	61,3
	132	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	73,3
	133	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,002	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,003	72,6
	141	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,002	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,002	64,5
	142	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,007	0,000	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,009	72,6
	211	0,009	0,000	0,003	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,139	0,000	0,020	0,003	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,003	0,000	0,000	0,000	0,176	79,0
	222	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,002	66,1
	231	0,019	0,000	0,004	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,046	0,004	0,157	0,000	0,000	0,004	0,000	0,000	0,000	0,000	0,000	0,000	0,004	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,237	66,1
	242	0,006	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,002	0,000	0,053	0,002	0,055	0,000	0,000	0,004	0,004	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,126	0,0
CLC	243	0,001	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,002	0,000	0,013	0,000	0,000	0,004	0,000	0,002	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,025	0,0
data	311	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,002	0,000	0,000	0,007	0,000	0,002	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,013	53,2
	312	0,000	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,001	0,000	0,001	0,000	0,000	0,002	0,015	0,014	0,000	0,001	0,001	0,000	0,000	0,000	0,000	0,000	0,001	0,000	0,000	0,000	0,037	41,0
	313	0,001	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,001	0,000	0,002	0,000	0,000	0,005	0,004	0,007	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,021	33,9
	321	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,006	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,007	83,9
	322	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,000	0,000	0,006	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,008	75,8
	324	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	100,0
	331	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,003	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,004	79,0
	411	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,005	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,007	66,1
	412	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,002	66,1
	421	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,002	0,000	0,000	0,000	0,000	0,000	0,002	82,3
	423																																
	511	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,010	0,000	0,000	0,000	0,010	93,5
	512	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,059	0,000	0,000	0,059	100,0
	522	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,005	0,000	0,005	100,0
	523	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,157	0,157	100,0
	Total	0,086	0,011	0,014	0,002	0,001	0,000	0,000	0,005	0,008	0,011	0,249	0,007	0,254	0,003	0,000	0,027	0,026	0,027	0,007	0,008	0,001	0,004	0,009	0,001	0,002		0,016	0,060	0,005	0,157		
	Accuracy	55,8	76,8	4,5	100,0	100,0	100,0	36,9	46,9	20,4	61,9	56,0	16,7	61,7	0,0	0,0	26,2	58,6	27,3	85,6	81,7	27,8	80,4	53,2	100,0	88,2		61,6	97,0	100,0	99,9		
	Total accuracy (%)			65,2																													

Appendix 5 Metadata CLC2000

V A. Metadata Country level CLC 2000

1	LITERATURE, REPORTS	
1.1	List of literature.	EEA and ETC-TE, 2002. CORINE Land Cover update I&CLC2000 project. Technical Guidelines. Final Version. EEA, Denmark. Bossard, M., Feranec, J. and Otahel, J., 2000. CORINE Land Cover Technical Guide - Addendum 2000. Technical report 40, EEA, Denmark. Thunnissen, H.A.M. and Middelaar, H.J. van, 1995. The CORINE Land Cover database of the Netherlands. Final report of the CORINE Land Cover project in the Netherlands. Report 78. Alterra, the Netherlands. Feranec, J., 2002. CLC2000 Training Report of The Netherlands. Ref.: Training Report 02/2002. ETC-TE, Barcelona, Spain. Christensen, S. & Jaffrain, G., 2002. CLC2000 Verification Mission Report of The Netherlands. Ref.: Verification Mission Report 03/2002. ETC-TE, Barcelona, Spain. Buttner, G. & Jaffrain, G., 2003. CLC2000 Verification Mission Report of The Netherlands. Ref.: Verification Mission Report 01/2003. ETC-TE, Barcelona, Spain. Hazeu, G.W. in prep. CORINE Land Cover database of the Netherlands. Monitoring Land Cover Changes between 1986 and 2000. Alterra, the Netherlands
2.	**NATIONAL PROJECT DESCRIPTION**	
2.1	General Info (Objectives, Goals, National Specifics, Comments For User)	The overall aim is to produce a CLC2000 database and a change database between 1986 and 2000 for the Netherlands. Both databases need to fullfil the database specifications defined by the technical team to guarantee full coverage and maximum consistency for the European datasets.
2.2	Project Organisation, Organisation Chart	Alterra, Centrum for Geo –information
2.3	Funding	EU, Ministry of Agriculture, Nature Management and Fisheries, Ministry of Housing, Spatial Planning and Environment
2.4	National Team – List Of Subcontractors	Alterra Green World Research
2.5	Validation Team	European Topic Centre for Terrestrial Environment
2.6	Time Schedule	July 2001 – March 2003
2.7	Hardware	PC

2.8	Software	Arc Info, Arc View, Erdas imagine
3	**IMAGE 2000 (Image2000 team)**	
	Image Identification	Dataset Title <Path/row/set/type combination>
	Acquisition	Date, Path, Row, Set, Type, Scene coords
	Orthorectification	Method, Who, GCP number, RMSEx, RMSEy, overall RMSEp
	Image enhancement	Used SW, Who, Filtering, Merging, Composition
	Quality control	Procedure description, Who, Date, Results, External geometry quality
4.	**DATA DESCRIPTION**	
4.1	**Metadata Reference**	
4.1.1.	National identifier for the Dataset	CLCchange_NL
4.1.2.	Contact	Wageningen UR , Alterra, CGI – Geodesk, http://cgi.girs.wageningen-ur.nl/cgi/geodesk
4.1.3.	Last Metadata Update Date	21/3/2003
4.2	**General Information**	
4.2.1.	Dataset Title	CLCchange (Corine Land Cover Changes between 1986 – 2000)
4.2.2.	Abstract Describing Dataset	The landcover change database contains land cover changes between 1986 and 2000 for the Netherlands. The data of the land cover change database have to fulfill the standards of the EU concerning CORINE Land Cover (thematic and geometric conditions). The national database has to be integrated with other national databases and will become available for the entire EU. The EU CLCchange database will be a instrument in implementing and monitoring EU environmental policies.
4.2.3.	Dataset Topic Category	Landcover, I&CLC2000, CORINE, CLCchange, change detection, monitoring, 1986 – 2000, 1 : 100 000, 30 land cover classes
4.2.4.	Spatial Data Format	Arc Info 8.1.2.
4.2.5.	Dataset Scale	1 : 100 000 and less detailed
4.2.6.	Coordinate Reference System	RD (Amersfoort, Bessel, stereographic rijksdriehoek)
4.2.7.	National Responsible Party	WUR, Alterra, CGI, www.geo-informatie.nl
4.2.8.	Main Contractor	WUR, Alterra, CGI, g.w.hazeu@alterra.wag-ur.nl, g.j.a.nieuwenhuis@alterra.wag-ur.nl
4.3	**Data extent**	
4.3.1	Name of Spatial System	Rijks Driehoekmeting (RD)
4.3.2	West Bounding Coordinate	**Minimum X** 17614
4.3.3	South Bounding Coordinate	**Minimum Y** 306278
4.3.4	East Bounding Coordinate	**Maximum X** 278952
4.3.4	North Bounding Coordinate	**Maximum Y** 614996
4.3.5.	Period Start Date	July 2001
4.3.6.	Period End Date	March 2003

4.3.7.	Number of classes	30
4.4.	**Data Quality**	
4.4.1.	Overall Positional Accuracy (CLC2000 Technical Team)	
4.4.2.	Attribute Accuracy (CLC2000 Technical Team)	
4.4.3.	Logical Consistency	No polygons < 5ha in CLCchange, no incorrect codes, only closed polygons
4.5	**Data access / Data distribution**	
4.5.1.	Contact	http://cgi.girs.wageningen-ur.nl/cgi/geodesk
4.5.2.	Procedure	See agreement for use and dissemination of I&CLC2000 products
4.5.3.	Conditions	See agreement for use and dissemination of I&CLC2000 products

CLC Metadata – Country level CLC86 rev

1	LITERATURE, REPORTS	
1.1	List of literature.	EEA and ETC-TE, 2002. CORINE Land Cover update I&CLC2000 project. Technical Guidelines. Final Version. EEA, Denmark. Bossard, M., Feranec, J. and Otahel, J., 2000. CORINE Land Cover Technical Guide - Addendum 2000. Technical report 40, EEA, Denmark. Thunnissen, H.A.M. and Middelaar, H.J. van, 1995. The CORINE Land Cover database of the Netherlands. Final report of the CORINE Land Cover project in the Netherlands. Report 78. Alterra, the Netherlands. Feranec, J., 2002. CLC2000 Training Report of The Netherlands. Ref.: Training Report 02/2002. ETC-TE, Barcelona, Spain. Christensen, S. & Jaffrain, G., 2002. CLC2000 Verification Mission Report of The Netherlands. Ref.: Verification Mission Report 03/2002. ETC-TE, Barcelona, Spain. Buttner, G. & Jaffrain, G., 2003. CLC2000 Verification Mission Report of The Netherlands. Ref.: Verification Mission Report 01/2003. ETC-TE, Barcelona, Spain. Hazeu, G.W. in prep. CORINE Land Cover database of the Netherlands. Monitoring Land Cover Changes between 1986 and 2000. Alterra, the Netherlands

2.	NATIONAL PROJECT DESCRIPTION	
2.1	General Info (Objectives, Goals, National Specifics, Comments For User)	The overall aim is to produce a CLC2000 database and a change database between 1986 and 2000 for the Netherlands. Both databases need to fullfil the database specifications defined by the technical team to guarantee full coverage and maximum consistency for the European datasets.
2.2	Project Organisation, Organisation Chart	Alterra, Centrum for Geo –information
2.3	Funding	EU, Ministry of Agriculture, Nature Management and Fisheries, Ministry of Housing, Spatial Planning and Environment
2.4	National Team – List Of Subcontractors	Alterra Green World Research
2.5	Validation Team	European Topic Centre for Terrestrial Environment
2.6	Time Schedule	July 2001 – March 2003
2.7	Hardware	PC

2.8	Software	Arc Info, Arc View, Erdas imagine
3	**IMAGE 2000 (Image2000 team)**	
	Image Identification	Dataset Title <Path/row/set/type combination>
	Acquisition	Date, Path, Row, Set, Type, Scene coords
	Orthorectification	Method, Who, GCP number, RMSEx, RMSEy, overall RMSEp
	Image enhancement	Used SW, Who, Filtering, Merging, Composition
	Quality control	Procedure description, Who, Date, Results, External geometry quality
4.	**DATA DESCRIPTION**	
4.1	**Metadata Reference**	
4.1.1.	National identifier for the Dataset	CLC86rev_NL
4.1.2.	Contact	Wageningen UR , Alterra, CGI – Geodesk, http://cgi.girs.wageningen-ur.nl/cgi/geodesk
4.1.3.	Last Metadata Update Date	21/3/2003
4.2	**General Information**	
4.2.1.	Dataset Title	CLC1986rev (revised Corine Land Cover 1986)
4.2.2.	Abstract Describing Dataset	Landcover database CLC1986rev contains land cover data for the Netherlands in the year 1986 (+ 2 years). The data of the land cover database fulfill the standards of the EU concerning CORINE Land Cover (thematic and geometric conditions). Geometry and thematic contents of the old CLC86 database were corrected to make detection of real land cover changes between 1986 and 2000 possible.
4.2.3.	Dataset Topic Category	Landcover, I&CLC2000, CORINE, CLC86rev, change detection, monitoring, 1986 – 2000, 1 : 100 000, 30 land cover classes
4.2.4.	Spatial Data Format	Arc Info 8.1.2.
4.2.5.	Dataset Scale	1 : 100 000 and less detailed
4.2.6.	Coordinate Reference System	RD (Amersfoort, Bessel, stereographic rijksdriehoek)
4.2.7.	National Responsible Party	WUR, Alterra, CGI, www.geo-informatie.nl
4.2.8.	Main Contractor	WUR, Alterra, CGI, g.w.hazeu@alterra.wag-ur.nl, g.j.a.nieuwenhuis@alterra.wag-ur.nl
4.3	**Data extent**	
4.3.1	Name of Spatial System	Rijks Driehoekmeting (RD)
4.3.2	West Bounding Coordinate	**Minimum X 12999**
4.3.3	South Bounding Coordinate	**Minimum Y 305957**
4.3.4	East Bounding Coordinate	**Maximum X 278952**
4.3.4	North Bounding Coordinate	**Maximum Y 624996**
4.3.5.	Period Start Date	July 2001
4.3.6.	Period End Date	March 2003
4.3.7.	Number of classes	30

4.4.	**Data Quality**	
4.4.1.	Overall Positional Accuracy (CLC2000 Technical Team)	
4.4.2.	Attribute Accuracy (CLC2000 Technical Team)	
4.4.3.	Logical Consistency	No polygons < 25ha in CLC86rev, no incorrect codes, only closed polygons
4.5	**Data access / Data distribution**	
4.5.1.	Contact	http://cgi.girs.wageningen-ur.nl/cgi/geodesk
4.5.2.	Procedure	See agreement for use and dissemination of I&CLC2000 products
4.5.3.	Conditions	See agreement for use and dissemination of I&CLC2000 products

CLC Metadata – Country level CLC change

1	**LITERATURE, REPORTS**	
1.1	List of literature.	EEA and ETC-TE, 2002. CORINE Land Cover update I&CLC2000 project. Technical Guidelines. Final Version. EEA, Denmark. Bossard, M., Feranec, J. and Otahel, J., 2000. CORINE Land Cover Technical Guide - Addendum 2000. Technical report 40, EEA, Denmark. Thunnissen, H.A.M. and Middelaar, H.J. van, 1995. The CORINE Land Cover database of the Netherlands. Final report of the CORINE Land Cover project in the Netherlands. Report 78. Alterra, the Netherlands. Feranec, J., 2002. CLC2000 Training Report of The Netherlands. Ref.: Training Report 02/2002. ETC-TE, Barcelona, Spain. Christensen, S. & Jaffrain, G., 2002. CLC2000 Verification Mission Report of The Netherlands. Ref.: Verification Mission Report 03/2002. ETC-TE, Barcelona, Spain. Buttner, G. & Jaffrain, G., 2003. CLC2000 Verification Mission Report of The Netherlands. Ref.: Verification Mission Report 01/2003. ETC-TE, Barcelona, Spain. Hazeu, G.W. in prep. CORINE Land Cover database of the Netherlands. Monitoring Land Cover Changes between 1986 and 2000. Alterra, the Netherlands
2.	**NATIONAL PROJECT DESCRIPTION**	
2.1	General Info (Objectives, Goals, National Specifics, Comments For User)	The overall aim is to produce a CLC2000 database and a change database between 1986 and 2000 for the Netherlands. Both databases need to fullfil the database specifications defined by the technical team to guarantee full coverage and maximum consistency for the European datasets.
2.2	Project Organisation, Organisation Chart	Alterra, Centrum for Geo–information
2.3	Funding	EU, Ministry of Agriculture, Nature Management and Fisheries, Ministry of Housing, Spatial Planning and Environment
2.4	National Team – List Of Subcontractors	Alterra Green World Research
2.5	Validation Team	European Topic Centre for Terrestrial Environment
2.6	Time Schedule	July 2001 – March 2003
2.7	Hardware	PC
2.8	Software	Arc Info, Arc View, Erdas imagine
3	**IMAGE 2000 (Image2000 team)**	
	Image Identification	Dataset Title <Path/row/set/type combination>

	Acquisition	Date, Path, Row, Set, Type, Scene coords
	Orthorectification	Method, Who, GCP number, RMSEx, RMSEy, overall RMSEp
	Image enhancement	Used SW, Who, Filtering, Merging, Composition
	Quality control	Procedure description, Who, Date, Results, External geometry quality
4.	**DATA DESCRIPTION**	
4.1	**Metadata Reference**	
4.1.1.	National identifier for the Dataset	CLCchange_NL
4.1.2.	Contact	Wageningen UR , Alterra, CGI – Geodesk, http://cgi.girs.wageningen-ur.nl/cgi/geodesk
4.1.3.	Last Metadata Update Date	21/3/2003
4.2	**General Information**	
4.2.1.	Dataset Title	CLCchange (Corine Land Cover Changes between 1986 – 2000)
4.2.2.	Abstract Describing Dataset	The landcover change database contains land cover changes between 1986 and 2000 for the Netherlands. The data of the land cover change database have to fulfill the standards of the EU concerning CORINE Land Cover (thematic and geometric conditions). The national database has to be integrated with other national databases and will become available for the entire EU. The EU CLCchange database will be a instrument in implementing and monitoring EU environmental policies.
4.2.3.	Dataset Topic Category	Landcover, I&CLC2000, CORINE, CLCchange, change detection, monitoring, 1986 – 2000, 1 : 100 000, 30 land cover classes
4.2.4.	Spatial Data Format	Arc Info 8.1.2.
4.2.5.	Dataset Scale	1 : 100 000 and less detailed
4.2.6.	Coordinate Reference System	RD (Amersfoort, Bessel, stereographic rijksdriehoek)
4.2.7.	National Responsible Party	WUR, Alterra, CGI, www.geo-informatie.nl
4.2.8.	Main Contractor	WUR, Alterra, CGI, g.w.hazeu@alterra.wag-ur.nl, g.j.a.nieuwenhuis@alterra.wag-ur.nl
4.3	**Data extent**	
4.3.1	Name of Spatial System	Rijks Driehoekmeting (RD)
4.3.2	West Bounding Coordinate	**Minimum X** 17614
4.3.3	South Bounding Coordinate	**Minimum Y** 306278
4.3.4	East Bounding Coordinate	**Maximum X** 278952
4.3.4	North Bounding Coordinate	**Maximum Y** 614996
4.3.5.	Period Start Date	July 2001
4.3.6.	Period End Date	March 2003
4.3.7.	Number of classes	30

4.4.	**Data Quality**	
4.4.1.	Overall Positional Accuracy (CLC2000 Technical Team)	
4.4.2.	Attribute Accuracy (CLC2000 Technical Team)	
4.4.3.	Logical Consistency	No polygons < 5ha in CLCchange, no incorrect codes, only closed polygons
4.5	**Data access / Data distribution**	
4.5.1.	Contact	http://cgi.girs.wageningen-ur.nl/cgi/geodesk
4.5.2.	Procedure	See agreement for use and dissemination of I&CLC2000 products
4.5.3.	Conditions	See agreement for use and dissemination of I&CLC2000 products

CLC2000 Metadata - working unit level

Title of working unit:	1

A: GENERAL INFORMATION

Contractor:	European Environment Agency (EEA)
Address:	Kongens Nytorv 6 DK-1050 Copenhagen K Denmark
Phone:	+45 33 36 71 00
Fax:	+45 33 36 71 99
Responsible:	Chris Steenmans
E-mail:	eea@eea.eu.int

Contracted:	Alterra, Centrum for Geo-information
Address:	P.O. Box 47
Phone:	++31 317 474779 / 474707
Fax:	++ 31 317 419000
Project leader:	Gerard Hazeu
E-mail:	g.w.hazeu@alterra.wag-ur.nl

1. IMAGE2000 data used

Landsat ETM or other scene(s)				
Satellite & Sensor	**Path-**	**Row**	**Date (m/d/y)**	**Remark (e.g. clouds)**
Landsat-7 ETM+	198	23	07/30/1999	Some sporadic clouds
Landsat-7 ETM+	197	23	08/26/2000	Only used in eastern part of BWU2001

2. Topographic maps used *(indicate in remark if digital)*

Scale	**Sheet id**	**Title/Name**	**Year of production**	**Year of last revision**	**Remark**
1 : 10 000		Top10Vector	1994 - 2000		Digital – update every 4 years
1 : 50 000		Topgraphical Atlas	1980 - 1989		Analogue
1 : 50 000		Top50Vector	1990 - 2001		Digital – marking tidal flats

3. Other ancillary data used (thematic data, satellite images, aerial photos, city maps, vegetation maps)

Id	Data source/type	Title (if relevant)	Date of production (m/d/y)	Scale (spatial detail)	Remark
	Color Aerial photos		06/2000	1: 25 000	Digital
	National Land use database	LGN4	1999 / 2000	1 : 50 000	Digital

4. Photointerpreter(s)

Name	Affiliation	Phone	E-mail	Interpretation		
				start (m/d/y)	End (m/d/y)	no. of days
Gerard Hazeu	Alterra	++31 317 474779	g.w.hazeu@alterra.wag-ur.nl	07/10/2002	07/20/2002	3
Theo Jacobs	Alterra	++31 317 474441	th.jacobs@alterra.wag-ur.nl	05/15/2002	06/15/2002	10

B: DATA PREPARATION

1. Checking and systematic correction of IMAGE90 data *(optional)*

Landsat TM or any other satellite scenes used (e.g. SPOT)							
Satellite & Sensor	path-	row	Date (m/d/y)	Max. systematic geom. Error (m)	*(optional)* Checked & corrected (name)	*(optional)* Date (m/d/y)	*(optional)* Reference data
Landsat- 5 TM	198	23	08/03/1986	< 50 m			

2. Checking and systematic correction of CLC90 data

Corrections	Type of correction	Checked and Corrected by	Date (m/d/y)		Remarks
			Start	end	
Geometrical errors	Systematic correction	Theo Jacobs	05/15/2002	05/15/2002	No displacement
	Local correction	Theo Jacobs and Gerard Hazeu	05/15/2002	07/20/2002	Errors > 100 m were corrected
Thematic errors	Logical coherence*	Gerard Hazeu	07/16/2002	07/31/2002	Many small polygons were removed
	Semantic accuracy** and exhaustiveness***	Gerard Hazeu	05/15/2002	07/20/2002	systematic error between 111 – 112 was corrected

* = respectation of internal rules of CLC (100 m, 25 ha) according to Tech.Guide and Addendum
**= interpretation according to CLC nomenclature;
*** = details are appropriate

3. Verification and acceptance on national level

Date (m/d/y)	Accepted by	Signature	Remark
08/15/2002	Gerard Hazeu		Tidal flats were corrected

C: INTERPRETATION OF CHANGES AND CREATION OF CLC2000

1. Photo-interpretation and internal quality control

Date of submission (m/d/y)	Control made by	Date of control (m/d/y)	Remark (errors, corrections, etc.)
05/15/2002	Gerard Hazeu	08/07/2002	- locally unit 321 was introduced as a change from our national database LGN4 - unit 423 was introduced from Top50Vector. Only tidal flats visible on the satellite images and not marked in Top50Vector were added. Tidal variation between recording time of satellite images made it impossible to record changes in this highly dynamic environment - changes from 211 to 231 were only recorded by exception

2. Field checking (*if carried out*)

Date (m/d/y)	Itinerary (main settlements crossed on the working unit)	Problems checked and main conclusions
-		

3. Border matching with neighbour working units or countries

Working unit / Country	Controlled and corrected by	Date (m/d/y)	Remark
BWU2003	Gerard Hazeu	08/10/2002	Some small polygons were removed and some polygons were merged.
BWU2002	Gerard Hazeu	08/15/2002	Some small polygons were removed

D: FINAL TECHNICAL QUALITY CONTROL

1. Control of topology, unnecessary boundaries, 25 ha limit, invalid codes and invalid changes

	Date (m/d/y)	Controlled by	Remark
CLC2000	08/15/2002	Gerard Hazeu	A few polygons < 25 ha were generalised
CLC Changes	08/15/2002	Gerard Hazeu	A few polygons < 5 ha were generalised
CLC90	08/15/2002	Gerard Hazeu	A few polygons < 25 ha were generalised

2. Verification and acceptance

	Date (m/d/y)	Name	Signature	Remark
National level	10/24/2002	Gerard Hazeu		Separation 112 – 121
CLC2000 technical team	11/07/2002	S. Christensen & G. Jaffrain		See verification mission report

E: SOFTWARE / HARDWARE

Work phase	Software used	Hardware used
Systematic geometric correction of IMAGE90	-	-
Systematic geometric correction of CLC90	Arc Info 8.1.2.	PC
Topological and thematic corrections of CLC90	Arc Info 8.1.2.	PC
Interpretation of changes	Arc Info 8.1.2.	PC
Creation of CLC2000	Arc Info 8.1.2.	PC
Technical quality control	Arc Info 8.1.2.	PC
Database integration (border matching)	Arc Info 8.1.2.	PC

N.B.: In the case of the Netherlands CLC90 means CLC86rev

Title of working unit:	2

A: GENERAL INFORMATION

Contractor:	European Environment Agency (EEA)
Address:	Kongens Nytorv 6 DK-1050 Copenhagen K Denmark
Phone:	+45 33 36 71 00
Fax:	+45 33 36 71 99
Responsible:	Chris Steenmans
E-mail:	eea@eea.eu.int

Contracted:	Alterra, Centrum for Geo-information
Address:	P.O. Box 47
Phone:	++31 317 474779 / 474707
Fax:	++ 31 317 419000
Project leader:	Gerard Hazeu
E-mail:	g.w.hazeu@alterra.wag-ur.nl

1. IMAGE2000 data used

Landsat ETM or other scene(s)				
Satellite & Sensor	**Path-**	**Row**	**Date (m/d/y)**	**Remark (e.g. clouds)**
Landsat-7 ETM+	197	23	08/26/2000	

2. Topographic maps used *(indicate in remark if digital)*

Scale	**Sheet id**	**Title/Name**	**Year of Production**	**Year of last revision**	**Remark**
1 : 10 000		Top10Vector	1994 – 2000		Digital – update every 4 years
1 : 50 000		Topgraphical Atlas	1980 – 1989		Analogue
1: 50 000		Top50Vector	1990 – 2001		Digital – marking tidal flats

3. Other ancillary data used (thematic data, satellite images, aerial photos, city maps, vegetation maps)

Id	Data source/type	Title (if relevant)	Date of production (m/d/y)	Scale (spatial detail)	Remark
	Color Aerial photos		06/2000	1: 25 000	Digital
	National Land use database	LGN4	1999 / 2000	1 : 50 000	Digital
	Geomorfological map of the Netherlands				Digital - In production

4. Photointerpreter(s)

Name	Affiliation	Phone	E-mail	interpretation		
				start (m/d/y)	end (m/d/y)	no. of days
Gerard Hazeu	Alterra	++31 317 474779	g.w.hazeu@alterra.wag-ur.nl	02/01/2002	03/15/2002	4
Theo Jacobs	Alterra	++31 317 474441	Th.jacobs@alterra.wag-ur.nl	02/01/2002	03/15/2002	10

B: DATA PREPARATION

1. Checking and systematic correction of IMAGE90 data *(optional)*

Landsat TM or any other satellite scenes used (e.g. SPOT)							
Satellite & Sensor	path-	row	Date (m/d/y)	Max. systematic geom. error (m)	*(optional)* Checked & corrected (name)	*(optional)* Date (m/d/y)	*(optional)* Reference data
Landsat- 5 TM	198	23	08/03/86	< 50 m			Clouds in southeastern part
Landsat- 5 TM	198	23	06/16/86	< 50 m			
Landsat- 5 TM	197	23	07/14/87	< 50 m			Only used for eastern part BWU 2002

2. Checking and systematic correction of CLC90 data

Corrections	Type of correction	Checked and Corrected by	Date (m/d/y)		Remarks
			Start	end	
Geometrical errors	Systematic correction	Theo Jacobs	02/01/2002	02/01/2002	No displacement
	Local correction	Theo Jacobs and Gerard Hazeu	02/01/2002	03/15/2002	Errors > 100 m were corrected
Thematic errors	Logical coherence*	Gerard Hazeu	05/01/2002	05/14/2002	Many small polygons were removed
	Semantic accuracy** and exhaustiveness***	Gerard Hazeu	05/01/2002	05/14/2002	- systematic error between 111 – 112 was corrected - error between 322 and 412 was corrected with geomorfological map - errors between 211, 231 and 242 were corrected

* = respectation of internal rules of CLC (100 m, 25 ha) according to Tech.Guide and Addendum
**= interpretation according to CLC nomenclature;
*** = details are appropriate

3. Verification and acceptance on national level

Date (m/d/y)	Accepted by	Signature	Remark
08/20/2002	Gerard Hazeu		Tidal flats are corrected

C: INTERPRETATION OF CHANGES AND CREATION OF CLC2000

1. Photo-interpretation and internal quality control

Date of submission (m/d/y)	Control made by	Date of control (m/d/y)	Remark (errors, corrections, etc.)
02/01/2002	Gerard Hazeu	07/31/2002	- locally unit 321 was introduced as a change from our national database LGN4 - unit 423 was introduced from Top50Vector. Only tidal flats visible on the satellite images and not marked in Top50Vector were added. Tidal variation between recording time of satellite images made it impossible to record changes in this highly dynamic environment - changes from 211 to 231 were only recorded by exception - units 322 and 412 were separated on basis of LGN4 and geomorphological map

2. Field checking (*if carried out*)

Date (m/d/y)	Itinerary (main settlements crossed on the working unit)	Problems checked and main conclusions
-		

3. Border matching with neighbour working units or countries

working unit / Country	Controlled and corrected by	Date (m/d/y)	Remark
BWU2004	Gerard Hazeu	08/10/2002	Some small polygons were be removed and some polygons were merged
BWU2001	Gerard Hazeu	08/15/2002	Some small polygons were removed
Germany			A buffer zone of 1 km wide inside Germany was interpreted for border matching

D: FINAL TECHNICAL QUALITY CONTROL

1. Control of topology, unnecessary boundaries, 25 ha limit, invalid codes and invalid changes

	Date (m/d/y)	Controlled by	Remark
CLC2000	08/20/2002	Gerard Hazeu	A few polygons < 25 ha were generalised
CLC Changes	08/20/2002	Gerard Hazeu	A few polygons < 5 ha were generalised
CLC90	08/20/2002	Gerard Hazeu	A few polygons < 25 ha were generalised

2. Verification and acceptance

	Date (m/d/y)	Name	Signature	Remark
National level	10/24/2002	Gerard Hazeu		Separation of 112 – 121
CLC2000 technical team	11/07/2002	S. Christensen & G. Jaffrain		See verification mission report

E: SOFTWARE / HARDWARE

Work phase	Software used	Hardware used
Systematic geometric correction of IMAGE90	-	-
Systematic geometric correction of CLC90	Arc Info 8.1.2.	PC
Topological and thematic corrections of CLC90	Arc Info 8.1.2.	PC
Interpretation of changes	Arc Info 8.1.2.	PC
Creation of CLC2000	Arc Info 8.1.2.	PC
Technical quality control	Arc Info 8.1.2.	PC
Database integration (border matching)	Arc Info 8.1.2.	PC

Title of working unit:	3

A: GENERAL INFORMATION

Contractor:	European Environment Agency (EEA)
Address:	Kongens Nytorv 6 DK-1050 Copenhagen K Denmark
Phone:	+45 33 36 71 00
Fax:	+45 33 36 71 99
Responsible:	Chris Steenmans
E-mail:	eea@eea.eu.int

Contracted:	Alterra, Centrum for Geo-information
Address:	P.O. Box 47
Phone:	++31 317 474779 / 474707
Fax:	++ 31 317 419000
Project leader:	Gerard Hazeu
E-mail:	g.w.hazeu@alterra.wag-ur.nl

1. IMAGE2000 data used

Landsat ETM or other scene(s)				
Satellite & Sensor	**Path-**	**Row**	**Date (m/d/y)**	**Remark (e.g. clouds)**
Landsat-7 ETM+	198	23	07/30/1999	Only northern part of BWU, some clouds Flevoland
Landsat-7 ETM+	198	24	07/30/1999	

2. Topographic maps used *(indicate in remark if digital)*

Scale	**Sheet id**	**Title/Name**	**Year of production**	**Year of last revision**	**Remark**
1 : 10 000		Top10Vector	1994 – 2000		Digital – update every 4 years
1 : 50 000		Topgraphical Atlas	1980 – 1989		Analogue

3. Other ancillary data used (thematic data, satellite images, aerial photos, city maps, vegetation maps)

Id	Data source/type	Title (if relevant)	Date of production (m/d/y)	Scale (spatial detail)	Remark
	Color Aerial photos		06/2000	1: 25 000	Digital
	National Land use database	LGN4	1999 / 2000	1 : 50 000	Digital
	Geomorfological map of the Netherlands				Digital - In production

4. Photointerpreter(s)

Name	Affiliation	Phone	E-mail	interpretation		
				start (m/d/y)	end (m/d/y)	no. of days
Gerard Hazeu	Alterra	++31 317 474779	g.w.hazeu@alterra.wag-ur.nl	03/15/2002	04/15/2002	15

B: DATA PREPARATION

1. Checking and systematic correction of IMAGE90 data *(optional)*

Landsat TM or any other satellite scenes used (e.g. SPOT)							
Satellite & Sensor	path-	row	Date (m/d/y)	Max. systematic geom. error (m)	*(optional)* Checked & corrected (name)	*(optional)* Date (m/d/y)	*(optional)* Reference data
Landsat -5 TM	198	24	08/03/1986	<50 m			Area with clouds (Utrecht, Flevoland)
Landsat -5 TM	198	23	08/03/1986	<50 m			Only northern part of BWU, clouds, Flevoland
Landsat -5 TM	198	23	06/16/1986	<50 m			Only northeastern part of BWU

2. Checking and systematic correction of CLC90 data

Corrections	Type of correction	Checked and corrected by	Date (m/d/y)		Remarks
			Start	end	
Geometrical errors	Systematic correction	Gerard Hazeu	03/15/2002	03/15/2002	No displacement
	Local correction	Gerard Hazeu	03/15/2002	07/15/2002	Errors > 100 m were corrected
Thematic errors	Logical coherence*	Gerard Hazeu	07/01/2002	08/02/2002	Many small polygons were removed
	Semantic accuracy** and exhaustiveness***	Gerard Hazeu	03/15/2002	07/15/2002	- systematic error between 111 – 112 was corrected - error between 511, 123 and 121 was corrected - errors between 211, 231and 242 were corrected - correction 112 (along roads)

* = respectation of internal rules of CLC (100 m, 25 ha) according to Tech.Guide and Addendum
**= interpretation according to CLC nomenclature;
*** = details are appropriate

3. Verification and acceptance on national level

Date (m/d/y)	Accepted by	Signature	Remark
08/15/2002	Gerard Hazeu		- unit 243 delineated in more detail - separation of 512 from 511 (alongside rivers)

C: INTERPRETATION OF CHANGES AND CREATION OF CLC2000

1. Photo-interpretation and internal quality control

Date of submission (m/d/y)	Control made by	Date of control (m/d/y)	Remark (errors, corrections, etc.)
03/15/2002	Gerard Hazeu	08/02/2002	- locally unit 321 was introduced as a change from our national database LGN4 - changes from 231 to 242 at large scale (NH) - changes from 211 to 231 were only recorded by exception

2. Field checking (*if carried out*)

Date (m/d/y)	Itinerary (main settlements crossed on the working unit)	Problems checked and main conclusions
-		

3. Border matching with neighbour working units or countries

working unit / Country	Controlled and corrected by	Date (m/d/y)	Remark
BWU2001	Gerard Hazeu	08/10/2002	Some small polygons were removed and some polygons were merged.
BWU2004	Gerard Hazeu	08/15/2002	Some small polygons were removed and some polygons were merged.
BWU2005	Gerard Hazeu	10/21/2002	Some small polygons were removed and some polygons were merged.

D: FINAL TECHNICAL QUALITY CONTROL

1. Control of topology, unnecessary boundaries, 25 ha limit, invalid codes and invalid changes

	Date (m/d/y)	Controlled by	Remark
CLC2000	08/15/2002	Gerard Hazeu	A few polygons < 25 ha were generalised
CLC Changes	08/15/2002	Gerard Hazeu	A few polygons < 5 ha were generalised
CLC90	08/15/2002	Gerard Hazeu	A few polygons < 25 ha were generalised

2. Verification and acceptance

	Date (m/d/y)	Name	Signature	Remark
National level	10/24/2002	Gerard Hazeu		Separation of 112 – 121
CLC2000 technical team	01/31/2003	G. Buttner and G. Jaffrain		See verification mission report no. 2

E: SOFTWARE / HARDWARE

Work phase	Software used	Hardware used
Systematic geometric correction of IMAGE90	-	-
Systematic geometric correction of CLC90	Arc Info 8.1.2.	PC
Topological and thematic corrections of CLC90	Arc Info 8.1.2.	PC
Interpretation of changes	Arc Info 8.1.2.	PC
Creation of CLC2000	Arc Info 8.1.2.	PC
Technical quality control	Arc Info 8.1.2.	PC
Database integration (border matching)	Arc Info 8.1.2.	PC

Title of working unit:	**4**

A: GENERAL INFORMATION

Contractor:	European Environment Agency (EEA)
Address:	Kongens Nytorv 6 DK-1050 Copenhagen K Denmark
Phone:	+45 33 36 71 00
Fax:	+45 33 36 71 99
Responsible:	Chris Steenmans
E-mail:	eea@eea.eu.int

Contracted:	Alterra, Centrum for Geo-information
Address:	P.O. Box 47
Phone:	++31 317 474779 / 474707
Fax:	++ 31 317 419000
Project leader:	Gerard Hazeu
E-mail:	g.w.hazeu@alterra.wag-ur.nl

1. IMAGE2000 data used

Landsat ETM or other scene(s)				
Satellite & Sensor	**Path-**	**Row**	**Date (m/d/y)**	**Remark (e.g. clouds)**
Landsat-7 ETM+	197	24	09/09/1999	Band of clouds in western part of BWU
Landsat-7 ETM+	198	24	08/26/2000	Northern part of BWU
Landsat-7 ETM+	198	23	07/30/1999	Only northwestern part of BWU
Landsat-7 ETM+	198	24	07/30/1999	Only southwestrn part of BWU

2. Topographic maps used *(indicate in remark if digital)*

Scale	**Sheet id**	**Title/Name**	**Year of production**	**Year of last revision**	**Remark**
1 : 10 000		Top10Vector	1994 – 2000		Digital – update every 4 years
1 : 50 000		Topgraphical Atlas	1980 – 1989		Analogue

3. Other ancillary data used (thematic data, satellite images, aerial photos, city maps, vegetation maps)

Id	Data source/type	Title (if relevant)	Date of production (m/d/y)	Scale (spatial detail)	Remark
	Color Aerial photos		06/2000	1: 25 000	Digital
	National Land use database	LGN4	1999 / 2000	1 : 50 000	Digital
	Geomorfological map of the Netherlands				Dgital - In production

4. Photointerpreter(s)

Name	Affiliation	Phone	E-mail	interpretation		
				start (m/d/y)	end (m/d/y)	no. of days
Gerard Hazeu	Alterra	++31 317 474779	g.w.hazeu@alterra.wag-ur.nl	06/250/2002	08/05/2002	15

B: DATA PREPARATION

1. Checking and systematic correction of IMAGE90 data *(optional)*

Landsat TM or any other satellite scenes used (e.g. SPOT)							
Satellite & Sensor	path-	row	Date (m/d/y)	Max. systematic geom. Error (m)	*(optional)* Checked & corrected (name)	*(optional)* Date (m/d/y)	*(optional)* Reference data
Landsat -5 TM	197	24	08/12/1986	<50 m			Southeastern part of BWU
Landsat -5 TM	197	23	07/14/1987	<50 m			Clouds in the western part Northeastern part of BWU
Landsat -5 TM	198	23	06/16/1986	<50 m			Northwestern part of BWU
Landsat -5 TM	198	24	06/16/1986	<50 m			Southwestern part of BWU
Landsat -5 TM	198	23	08/03/1986	<50 m			Northwestern part of BWU

Landsat -5 TM	198	24	08/03/1986	<50 m			Southwestern part of BWU

2. Checking and systematic correction of CLC90 data

Corrections	Type of correction	Checked and Corrected by	Date (m/d/y) Start	end	Remarks
Geometrical errors	Systematic correction	Theo Jacobs	06/25/2002	06/30/2002	Bands of 1 –4 km width from west to east were corrected
	Local correction	Gerard Hazeu	07/15/2002	08/01/2002	Errors > 100 m were corrected
Thematic errors	Logical coherence*	Gerard Hazeu	07/15/2002	08/05/2002	Many small polygons were removed
	Semantic accuracy** and exhaustiveness***	Gerard Hazeu	07/15/2002	08/01/2002	- systematic error between 111 – 112 was corrected - error between 322 and 412 was corrected - local error between 243 and 313 - correction agriculture (211, 231, 242, 243)

* = respectation of internal rules of CLC (100 m, 25 ha) according to Tech.Guide and Addendum
**= interpretation according to CLC nomenclature;
*** = details are appropriate

3. Verification and acceptance on national level

Date (m/d/y)	Accepted by	Signature	Remark
08/20/2002	Gerard Hazeu		- unit 243 delineated in more detail - separation of 512 from 511 (alongside rivers)

C: INTERPRETATION OF CHANGES AND CREATION OF CLC2000

1. Photo-interpretation and internal quality control

Date of submission (m/d/y)	Control made by	Date of control (m/d/y)	Remark (errors, corrections, etc.)
07/10/2002	Gerard Hazeu	08/05/2002	- locally unit 321 was introduced as a change from our national database LGN4 - changes from 211 to 231 were only recorded by exception - units 322 and 412 were separated on basis of LGN4 and geomorphological map

2. Field checking (*if carried out*)

Date (m/d/y)	Itinerary (main settlements crossed on the working unit)	Problems checked and main conclusions
-		

3. Border matching with neighbour working units or countries

working unit / Country	Controlled and corrected by	Date (m/d/y)	Remark
BWU2002	Gerard Hazeu	08/10/2002	Some small polygons were removed and some polygons were merged
BWU2003	Gerard Hazeu	08/15/2002	Some small polygons were removed and some polygons were merged
BWU2006	Gerard Hazeu	10/21/2002	Some small polygons were removed
Germany	Gerard Hazeu		A buffer zone of 1 km wide inside Germany was interpreted for border matching

D: FINAL TECHNICAL QUALITY CONTROL

1. Control of topology, unnecessary boundaries, 25 ha limit, invalid codes and invalid changes

	Date (m/d/y)	Controlled by	Remark
CLC2000	08/20/2002	Gerard Hazeu	A few polygons < 25 ha were generalised
CLC Changes	08/20/2002	Gerard Hazeu	A few polygons < 5 ha were generalised
CLC90	08/20/2002	Gerard Hazeu	A few polygons < 25 ha were generalised

2. Verification and acceptance

	Date (m/d/y)	Name	Signature	Remark
National level	10/24/2002	Gerard Hazeu		Separation of 112 –121
CLC2000 technical team	11/07/2002	S. Christensen & G. Jaffrain		See verification mission report

E: SOFTWARE / HARDWARE

Work phase	Software used	Hardware used
Systematic geometric correction of IMAGE90	-	-
Systematic geometric correction of CLC90	Arc Info 8.1.2.	PC
Topological and thematic corrections of CLC90	Arc Info 8.1.2.	PC
Interpretation of changes	Arc Info 8.1.2.	PC
Creation of CLC2000	Arc Info 8.1.2.	PC
Technical quality control	Arc Info 8.1.2.	PC
Database integration (border matching)	Arc Info 8.1.2.	PC

Title of working unit:	**5**

A: GENERAL INFORMATION

Contractor:	European Environment Agency (EEA)
Address:	Kongens Nytorv 6 DK-1050 Copenhagen K Denmark
Phone:	+45 33 36 71 00
Fax:	+45 33 36 71 99
Responsible:	Chris Steenmans
E-mail:	eea@eea.eu.int

Contracted:	Alterra, Centrum for Geo-information
Address:	P.O. Box 47
Phone:	++31 317 474779 / 474707
Fax:	++ 31 317 419000
Project leader:	Gerard Hazeu
E-mail:	g.w.hazeu@alterra.wag-ur.nl

1. IMAGE2000 data used

Landsat ETM or other scene(s)				
Satellite & Sensor	**Path-**	**Row**	**Date (m/d/y)**	**Remark (e.g. clouds)**
Landsat-7 ETM+	198	24	07/30/1999	
Landsat-7 ETM+	199	24	08/24/2000	

2. Topographic maps used *(indicate in remark if digital)*

Scale	**Sheet id**	**Title/Name**	**Year of production**	**Year of last revision**	**Remark**
1 : 10 000		Top10Vector	1994 – 2000		Digital – update every 4 years
1 : 50 000		Topgraphical Atlas	1980 – 1989		Analogue

3. Other ancillary data used (thematic data, satellite images, aerial photos, city maps, vegetation maps)

Id	Data source/type	Title (if relevant)	Date of production (m/d/y)	Scale (spatial detail)	Remark
	Color Aerial photos		06/2000	1: 25 000	Digital
	National Land use database	LGN4	1999 / 2000	1 : 50 000	Digital
	Geomorfological map of the Netherlands				Digital - In production

4. Photointerpreter(s)

Name	Affiliation	Phone	E-mail	interpretation		
				start (m/d/y)	end (m/d/y)	no. of days
Gerard Hazeu	Alterra	++31 317 474779	g.w.hazeu@alterra.wag-ur.nl	04/26/2002	10/14/2002	12

B: DATA PREPARATION

1. Checking and systematic correction of IMAGE90 data *(optional)*

Landsat TM or any other satellite scenes used (e.g.SPOT)							
Satellite & Sensor	path-	row	Date (m/d/y)	Max. systematic geom. error (m)	*(optional)* Checked & corrected (name)	*(optional)* Date (m/d/y)	*(optional)* Reference data
Landsat -5 TM	198	24	08/03/1986	<50 m			Missing coverage on farwestern side of BWU

2. Checking and systematic correction of CLC90 data

Corrections	Type of correction	Checked and corrected by	Date (m/d/y)		Remarks
			Start	end	
Geometrical errors	Systematic correction	Gerard Hazeu	04/26/2002	04/30/2002	Entire islands were systematically corrected
	Local correction	Gerard Hazeu	04/26/2002	05/23/2002	Errors > 100 m were corrected
Thematic errors	Logical coherence*	Gerard Hazeu	07/05/2002	05/23/2002	Many small polygons were removed
	Semantic accuracy** and exhaustiveness***	Gerard Hazeu	04/26/2002	10/14/2002	- Systematic error between 111 – 112 was corrected - Correction agriculture (211, 231, 242) - Separation 112 and 121

* = respectation of internal rules of CLC (100 m, 25 ha) according to Tech.Guide and Addendum
**= interpretation according to CLC nomenclature;
*** = details are appropriate

3. Verification and acceptance on national level

Date (m/d/y)	Accepted by	Signature	Remark
10/24/2002	Gerard Hazeu		Separation of 112 – 121 and tidal flats were corrected

C: INTERPRETATION OF CHANGES AND CREATION OF CLC2000

1. Photo-interpretation and internal quality control

Date of submission (m/d/y)	Control made by	Date of control (m/d/y)	Remark (errors, corrections, etc.)
04/26/2002	Gerard Hazeu	10/14/2002	- locally unit 321 was introduced as a change from our national database LGN4 - Changes from 211 to 231 were only recorded by exception - Unit 423 was introduced from Top10Vector. Tidal variation between recording time of satellite images made it impossible to record changes in this highly dynamic environment - separation of 112 and 121 on basis of aerial photographs

2. Field checking (*if carried out*)

Date (m/d/y)	**Itinerary** (main settlements crossed on the working unit)	**Problems checked and main conclusions**
-		

3. Border matching with neighbour working units or countries

working unit / Country	**Controlled and corrected by**	**Date (m/d/y)**	**Remark**
BWU2003	Gerard Hazeu	10/21/2002	Some small polygons were removed and some polygons were merged
BWU2006	Gerard Hazeu	10/14/2002	Some small polygons were removed and some polygons were merged
Belgium	Gerard Hazeu	10/14/2002	A buffer zone of 1 km wide inside Belgium was interpreted for border matching

D: FINAL TECHNICAL QUALITY CONTROL

1. Control of topology, unnecessary boundaries, 25 ha limit, invalid codes and invalid changes

	Date (m/d/y)	**Controlled by**	**Remark**
CLC2000	10/21/2002	Gerard Hazeu	A few polygons < 25 ha were generalised
CLC Changes	10/21/2002	Gerard Hazeu	A few polygons < 5 ha were generalised
CLC90	10/21/2002	Gerard Hazeu	A few polygons < 25 ha were generalised

2. Verification and acceptance

	Date (m/d/y)	**Name**	**Signature**	**Remark**
National level	10/24/2002	Gerard Hazeu		
CLC2000 technical team	01/31/2003	G. Buttner and G. Jaffrain		See verification mission report no. 2

E: SOFTWARE / HARDWARE

Work phase	Software used	Hardware used
Systematic geometric correction of IMAGE90	-	-
Systematic geometric correction of CLC90	Arc Info 8.1.2.	PC
Topological and thematic corrections of CLC90	Arc Info 8.1.2.	PC
Interpretation of changes	Arc Info 8.1.2.	PC
Creation of CLC2000	Arc Info 8.1.2.	PC
Technical quality control	Arc Info 8.1.2.	PC
Database integration (border matching)	Arc Info 8.1.2.	PC

Title of working unit:	**6**

A: GENERAL INFORMATION

Contractor:	European Environment Agency (EEA)
Address:	Kongens Nytorv 6 DK-1050 Copenhagen K Denmark
Phone:	+45 33 36 71 00
Fax:	+45 33 36 71 99
Responsible:	Chris Steenmans
E-mail:	eea@eea.eu.int

Contracted:	Alterra, Centrum for Geo-information
Address:	P.O. Box 47
Phone:	++31 317 474779 / 474707
Fax:	++ 31 317 419000
Project leader:	Gerard Hazeu
E-mail:	g.w.hazeu@alterra.wag-ur.nl

1. IMAGE2000 data used

Landsat ETM or other scene(s)				
Satellite & Sensor	**Path-**	**Row**	**Date (m/d/y)**	**Remark (e.g. clouds)**
Landsat-7 ETM+	197	24	09/09/1999	Western part with clouds
Landsat-7 ETM+	197	25	09/11/2000	Southern part of BWU
Landsat-7 ETM+	198	24	07/30/1999	

2. Topographic maps used *(indicate in remark if digital)*

Scale	**Sheet id**	**Title/Name**	**Year of Production**	**Year of last revision**	**Remark**
1 : 10 000		Top10Vector	1994 – 2000		Digital – update every 4 years
1 : 50 000		Topgraphical Atlas	1980 – 1989		Analogue

3. Other ancillary data used (thematic data, satellite images, aerial photos, city maps, vegetation maps)

Id	Data source/type	Title (if relevant)	Date of production (m/d/y)	Scale (spatial detail)	Remark
	Color Aerial photos		06/2000	1: 25 000	Digital
	National Land use database	LGN4	1999 / 2000	1 : 50 000	Digital
	Geomorfological map of the Netherlands				Digital - In production

4. Photointerpreter(s)

Name	Affiliation	Phone	E-mail	interpretation		
				start (m/d/y)	end (m/d/y)	no. of days
Gerard Hazeu	Alterra	++31 317 474779	g.w.hazeu@alterra.wag-ur.nl	04/01/2002	10/14/2002	15

B: DATA PREPARATION

1. Checking and systematic correction of IMAGE90 data *(optional)*

Landsat TM or any other satellite scenes used (e.g. SPOT)							
Satellite & Sensor	path-	row	Date (m/d/y)	Max. systematic geom. error (m)	*(optional)* Checked & corrected (name)	*(optional)* Date (m/d/y)	*(optional)* Reference data
Landsat -5 TM	197	24	06/14/1988	<50 m			Southeastern part of BWU
Landsat -5 TM	197	23	08/03/1986	<50 m			

2. Checking and systematic correction of CLC90 data

Corrections	Type of correction	Checked and Corrected by	Date (m/d/y)		Remarks
			Start	end	
Geometrical errors	Systematic correction	Gerard Hazeu	04/01/2002	04/08/2002	Bands of 1-3 width from west to east were corrected
	Local correction	Gerard Hazeu	04/01/2002	10/14/2002	Errors > 100 m were corrected
Thematic errors	Logical coherence*	Gerard Hazeu	05/15/2002	10/14/2002	Many small polygons were removed
	Semantic accuracy** and exhaustiveness***	Gerard Hazeu	04/01/2002	10/14/2002	- systematic error between 111 – 112 was corrected - correction 512, 123 and 142 - correction agriculture (211, 231, 242, 243) - separtion of 112 - 121

* = respectation of internal rules of CLC (100 m, 25 ha) according to Tech.Guide and Addendum
**= interpretation according to CLC nomenclature;
*** = details are appropriate

3. Verification and acceptance on national level

Date (m/d/y)	Accepted by	Signature	Remark
10/24/2002	Gerard Hazeu		Separation of 112 and 121 was corrected

C: INTERPRETATION OF CHANGES AND CREATION OF CLC2000

1. Photo-interpretation and internal quality control

Date of submission (m/d/y)	Control made by	Date of control (m/d/y)	Remark (errors, corrections, etc.)
04/01/2002	Gerard Hazeu	10/24/2002	- locally unit 321 was introduced as a change from our national database LGN4 - changes from 211 to 231 were only recorded by exception - separation of 112 and 121 on basis of aerial photographs

2. Field checking (*if carried out*)

Date (m/d/y)	**Itinerary** (main settlements crossed on the working unit)	**Problems checked and main conclusions**
-		

3. Border matching with neighbour working units or countries

working unit / Country	**Controlled and corrected by**	**Date (m/d/y)**	**Remark**
BWU2004	Gerard Hazeu	10/21/2002	Some small polygons were removed and some polygons were merged
BWU2005	Gerard Hazeu	10/14/2002	Some small polygons were removed and some polygons were merged
Germany	Gerard Hazeu	10/14/2002	A buffer zone of 1 km wide inside Germany is interpreted for border matching
Belgium	Gerard Hazeu	10/14/2002	A buffer zone of 1 km wide inside Belgium was interpreted for border matching

D: FINAL TECHNICAL QUALITY CONTROL

1. Control of topology, unnecessary boundaries, 25 ha limit, invalid codes and invalid changes

	Date (m/d/y)	**Controlled by**	**Remark**
CLC2000	10/21/2002	Gerard Hazeu	A few polygons < 25 ha were generalised
CLC Changes	10/21/2002	Gerard Hazeu	A few polygons < 5 ha were generalised
CLC90	10/21/2002	Gerard Hazeu	A few polygons < 25 ha were generalised

2. Verification and acceptance

	Date (m/d/y)	**Name**	**Signature**	**Remark**
National level	10/24/2002	Gerard Hazeu		- separation of 512 from 511 (alongside rivers)
CLC2000 technical team	01/31/2003	G. Buttner and G. Jaffrain		See verification mission report no. 2

E: SOFTWARE / HARDWARE

Work phase	Software used	Hardware used
Systematic geometric correction of IMAGE90	-	-
Systematic geometric correction of CLC90	Arc Info 8.1.2.	PC
Topological and thematic corrections of CLC90	Arc Info 8.1.2.	PC
Interpretation of changes	Arc Info 8.1.2.	PC
Creation of CLC2000	Arc Info 8.1.2.	PC
Technical quality control	Arc Info 8.1.2.	PC
Database integration (border matching)	Arc Info 8.1.2.	PC

Appendix 6 Time schedule

Time-period	Activities	Executed by
2nd part 2001	Preparation (acquisition satellite images, ancillary data)	National team
2nd part 2001	Case study (methodology testing)	National team
February 2002	Training of national team	ETC-TE / National Team
January – December 2002	Interpretation (correction and updating)	National Team
November 2002	1st Verification	ETC-TE / National Team
December 2002-January 2003	Improvements database	National Team
January 2003	2nd Verification	ETC-TE / National Team
February – March 2003	Improvements database	National Team
April 2003	Final delivery database ETC-TE	National Team / ETC-TE / GISAT
May-June 2003	Report and databases delivery EEA / EU	National Team / ETC-TE / EEA / EU