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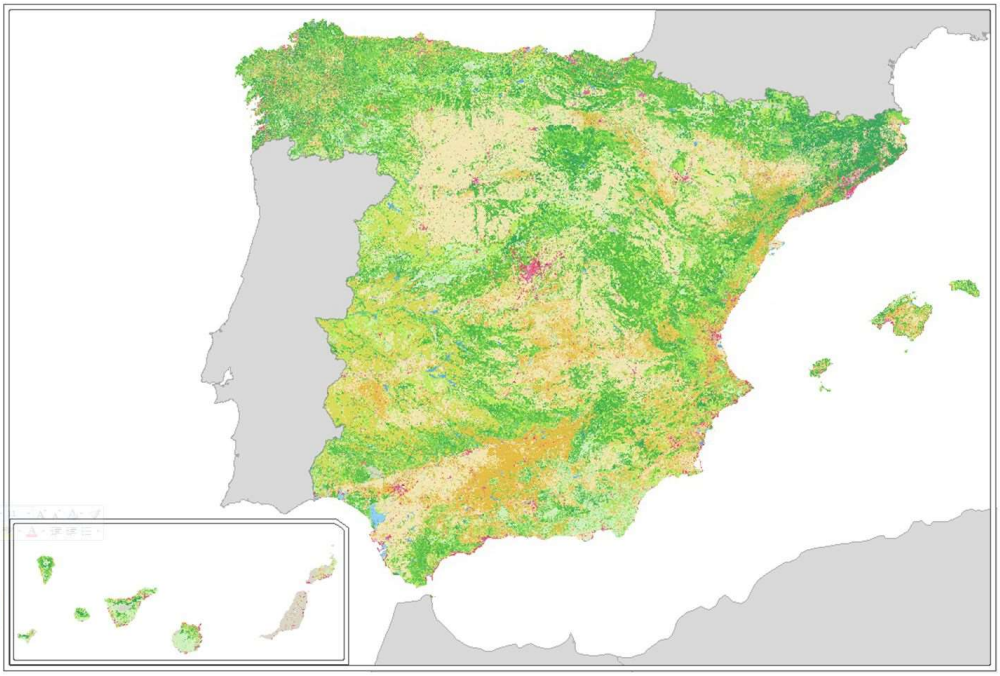

Spanish Land Cover / Land Use Information System
- SIOSE2005 -

National Geographic Institute of Spain

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ACRONYMS

Acronym	Definition
AGE	Spanish National Administration (Administración General del Estado)
BCN	National Topographic Database (Base Cartográfica Nacional)
CCAA	Autonomous Regions (Comunidades Autónomas)
CORINE	Coordination of Information of the Environment
CLC	CORINE Land Cover
CNIG	Geographic Information National Centre of Spain (Centro Nacional de Información Geográfica)
NRC-LC/LU	National Reference Centre on Land cover and on Land use & spatial planning
EEA	European Environment Agency
EIONET	European Environment Information and Observation Network
ETRS89	European Terrestrial Reference System 1989
GEO	Group on Earth Observations
GEOSS	Global Earth Observation System of Systems
GIS	Geographic Information System
GMES	Global Monitoring for Environment and Security
IGN	National Geographic Institute of Spain (Instituto Geográfico Nacional)
INSPIRE	Infrastructure for Spatial Information in Europe
LC	Land Cover
LU	Land Use
NEM	Spanish Metadata Core (Núcleo Español de Metadatos)
PNOA	National Plan for Aerial Orthophotography (Plan Nacional de Ortofotografía Aérea)
PNOT	Spanish Land Observation Programme (Plan Nacional de Observación del Territorio)
SIOSE	Land Cover/Land Use Information System of Spain (Sistema de Información de Ocupación del Suelo en España)
UTM	Universal Transverse Mercator

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1. INTRODUCTION

The National Geographic Institute and the Geographic Information National Centre of Spain (IGN-CNIG), both part of the Spanish Ministry of Public Works and Transport, are the National Reference Centre on Land cover and on Land use & spatial planning (NRC-LC/LU) within the European Environment Agency (EEA). Hence, one of their main objectives is the production, in coordination with regional governments, of land cover and land use (LC/LU) information in Spain and its dissemination throughout the European EIONET network.

The SIOSE project began at the end of 2004, taking into account the success of a previous collaborative experience between the Spanish National Administration (AGE) and the autonomous regions (CCAA) in the decentralized production of the Spanish CORINE Land Cover 2000 database (CLC2000).

SIOSE, which stands for Land Cover / Land Use Information System of Spain (Sistema de Información de Ocupación del Suelo en España, www.siose.es), is carried out by the CCAA under the coordination of IGN-CNIG as technical manager of the project.

Part of the Spanish Land Observation Programme (PNOT), SIOSE integrates the information stored in other already existing national and regional LC/LU databases at 1:25.000 scale with the following objectives:

- To produce, in a coordinated way between AGE and CCAA, objective, homogeneous, quantitative and comparable LC/LU territorial data for the whole country.
- To avoid duplicities and to reduce costs in the production of LC/LU information in Spain.
- To meet the requirements of the European Union and other public administrations in terms of LC/LU information.

The first production of SIOSE, SIOSE2005, finished successfully in 2009. In 2010, the integration and final validation of the SIOSE2005 database was also completed, obtaining the first homogeneous LC/LU database for the whole country with 2005 as reference date. Nowadays, SIOSE2009's production, with 2009 as reference date, has already begun and next updates of SIOSE are expected to take place every two years.

SIOSE has become a world reference in geographic information, not only technically, due to the high-quality products generated, but also for being economically sustainable and normalized on its procedures. SIOSE produces high spatial and temporal resolution LC/LU data (1:25.000, updated every two years) of the Spanish territory, improving the information provided by the CORINE Land Cover (CLC) database in Spain.

LC/LU information allows the understanding of natural, agricultural and urban dynamic changes in our country as well as the performance of many studies and analysis from multiple points of view. Therefore, SIOSE is an essential tool for spatial planning and environmental policies, not only for the Spanish administrations and users but also for European institutions and international organizations (EEA, the European Commission and its GMES programme, the INSPIRE Directive, GEO with its programme GEOSS) or even providing essential data for assessment of absorption and emission of greenhouse gases according to the United Nations Framework Convention on Climate Change and Kyoto Protocol.

1.2 Project organization and budget

The project organization arises from the premise of involving public administrations in it, assessing their needs in LC/LU information and defining technical specifications to fulfill their requirements as users of this type of information. For this reason, the AGE (through the Ministries of Public Works and Transport, Environment and Rural and Marine Affairs, Defence and Science and Innovation) and the regional administrations have been involved in the management and production of the project.

The project's national management was assumed jointly by the IGN-CNIG and the former General Secretariat for Territory and Biodiversity (Ministry of the Environment and Rural and Marine Affairs). In order to coordinate the production on all regions a National Technical Team was established, formed by experts from AGE and CCAA. In addition, each regional production team had its own coordinator. The definition of technical specifications was made by agreement through several thematic working group meetings held at the beginning of the project (*Figure 1*).

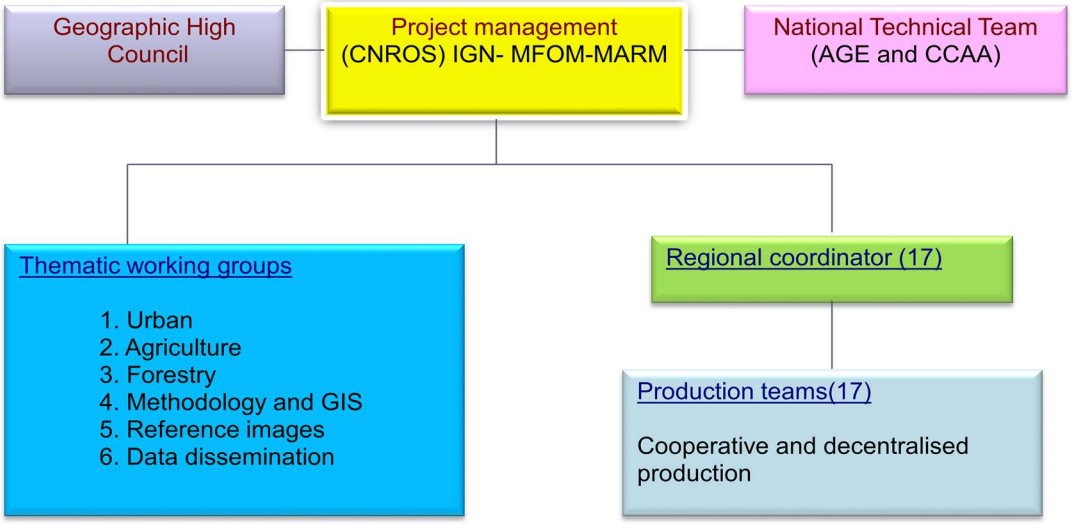


Figure 1: Project organization.

During SIOSE's production, especially at the beginning of the project, visits were made to the regional teams in order to meet them and verify the methodology they were applying. Since 2006 several general meetings have taken place in order to inform about the progress, current situation and future of the project.

The budget for SIOSE2005, co-financed by CCAA and AGE, is described in the table below:

	CCAA		A.G.E	
	Contribution	Total (€)	Contribution	Total (€)
Project management	50%	271.207 €	50%	271.207 €
Production	34%	4.301.914 €	66%	8.350.774 €
Data integration	0%	0	100%	1.084.827 €
Quality control and validation	34%	368.841 €	66%	715.986 €
TOTAL	**4.941.962 €**		**10.422.793 €**	

Table 1: Budget.

2. TECHNICAL SPECIFICATIONS

SIOSE was produced in a decentralized way by 17 regional teams who took into account some technical rules and specifications set to ensure the quality and compliance of the data for the whole country.

Recommendations given by the Geographic High Council (Royal Decree 1071/2007, regulating the official geodetic system of Spain) and requirements set by the European INSPIRE Directive (2007/2/CE) were followed:

- **Geodetic Reference System**: European Terrestrial Reference System 1989 (ETRS89).
- **Cartographic Projection**: Universal Transverse Mercator (UTM) in the following zones: 28 (Canarias), 29 (Galicia), 31 (Cataluña and Illes Balears) and 30 for the rest of the country.
- **Scale**: 1:25.000, with 5 meters of planimetric accuracy.

The **spatial unit** in SIOSE is the polygon. SIOSE divides geometrically the whole territory in a continuous network of polygons, in which every polygon is assigned the land cover type, or a combination thereof, that is enclosed in it. The minimum polygon size depends on its type of land cover:

- Artificial surfaces and water bodies: **1 ha**.
- Forced crops, wetlands, beaches, riparian vegetation and sea cliffs: **0,5 ha.**
- Crops and other areas of natural vegetation: **2 ha.**

The most innovative feature of SIOSE is the technique used to assign the land cover information to the polygons. SIOSE uses an object oriented data model that describes the objects, attributes, consistency relations, structure and philosophy of SIOSE data. It has two main entities: polygons and land covers associated with them.

SIOSE is not only a classification of polygons by a defined nomenclature. SIOSE allows the assignment of one or more land covers to the same polygon, specifying the percentage occupied by each land cover within the polygon as well as its attributes.

SIOSE stores in its geodatabases more information than traditional classifications or thematic maps do and its information is also more versatile. SIOSE allows, for example, the identification of the polygons with a specific coverage or with a specific percentage of a certain land cover, producing as many queries and thematic maps as needed by the user requirements.

3. METHODOLOGY

For the production of SIOSE2005 Spain was divided into areas with homogeneous land occupation in terms of land cover according to the SIOSE2005 data model previously established. These areas were graphically represented through polygons drawn by **photo interpretation of the 2005 SPOT5 satellite images** (geometrical and temporal reference). Other reference sources used in SIOSE's production were:

- Orthophotographs of the National Plan for Aerial Orthophotography (PNOA).
- Official database of boundary lines between CCAA.
- Large-scale LC/LU databases, when available, provided by the CCAA (multi-scale integration).

Other support information was also used for the photo interpretation. However, this information never had prevalence over the above information:

- Landsat 5 TM images.
- Orthophotographs and/or satellite images provided by the CCAA, previously approved by the National Technical Team of the project.
- National Topographic Database, scale 1:25.000 (BCN25).
- Cadastre.
- Forest Map of Spain (MFE) and Crop & Land Use Map of Spain (MCA).
- National Geological Map (MAGNA) of the Canary Islands produced by the Geological and Mining Institute of Spain (IGME, Ministry of Science and Innovation).
- Regional databases and thematic maps provided by the CCAA concerning LC information.

3.1. Data production

Once both reference and support information were collected and integrated, the **geometric edition of SIOSE polygons and its thematic LC assignment** was carried out, storing in the database the percentage of coverage/s and the attributes which better described the LC information of each polygon.

The geometric edition was achieved by digitizing SIOSE polygons over the 2005 SPOT5 images with the help of GIS software and tools. The thematic assignment of land cover classes, percentages and attributes to each polygon was made possible by using an external tool connected to the GIS, called AppSIOSE, which was provided to the production teams by the technical management of the project.

Simultaneously, **metadata** for the SIOSE2005 products were created following the standards and recommendations of the Spanish Metadata Core (NEM).

In addition to the production of the SIOSE database, **field work** was carried out in order to check the land cover information on-site and to resolve doubts arisen during the photo interpretation task. The result of this work was the creation of a database with more than 300.000 georeferenced photographs uniformly distributed throughout the national territory (an average of 16 photos per sheet of the Spanish National Topographic Map 1:25.000).

In some autonomous regions 360º panoramas were generated.

Figure 2: Panorama in Castilla y León.

3.2 Quality control

For data validation and in order to guarantee compliance with technical specifications in all the databases produced by each CCAA, an exhaustive quality control was carried out during the production phase of the project. The procedure followed is described in detail in the technical documentation of the SIOSE2005 project.

The quality control was implemented in two phases: an **internal quality control** carried out by each regional team and an **external quality control** conducted by the project's national managers. Both quality controls have ensured the consistency and expected accuracy of the SIOSE2005 databases and products.

During the internal quality control regional teams checked that data had the geometric and topological quality required by the project's technical specifications, what was also verified again during the external quality control. Moreover, general aspects such as delivery format and naming of the files, or the thematic quality of the photo interpretation were also validated in this external control, ensuring uniformity in the thematic assigning criteria among different regional teams.

While **control of general and topological aspects** was carried out for the whole database (existence of not desired gaps and overlaps in the geometry, contiguous polygons with the same cover, etc.), the **geometric control** was conducted on a representative sample of points (not random) of the database, throughout an algorithm that allowed the selection of the points with maximum curvature in the perimeter of each polygon, which is an objective way to choose representative points in the database.

The **semantic control** was accomplished in order to determine the quality and reliability of the photo interpretation of delivered databases. It consisted in a general analysis to detect coarse errors and to check, in a more detailed way, those types of covers susceptible of misinterpretation. These types of covers were mostly identified during visits to the regional production teams and by the continuous consultation, clarification and solution of doubts of photo interpretation concepts that usually took place at the beginning of the project.

3.3 National data integration

After the production of SIOSE2005 by the regional production teams, and once the corresponding quality controls were completed, the national management of the project was responsible for the merging of the regional databases. A single cartographic database, continuous and uniform for the whole country, was generated without geometric or semantic mismatches between neighboring regions.

The final SIOSE2005 database was obtained, a LC continuous geodatabase for the whole country at 1:25.000 scale and with 2005 as reference date.

4. SIOSE PRODUCTS

The final products of SIOSE2005 project are:

- Spanish 2005 LC/LU database, continuous and homogeneous for the whole country at 1:25.000 scale.
- Metadata at regional and national level.
- Digital album of field photographs, GPS georeferenced and evenly distributed throughout the country (over 300.000 photos).
- SIOSE2005 statistics and comparison with the results of the CORINE Land Cover 2006 (CLC2006) project.

5. RESULTS

5.1 SIOSE database utilization

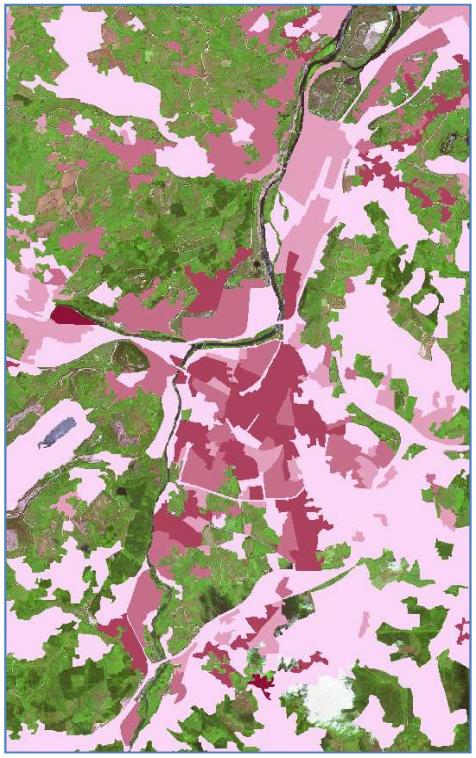
Most of traditional LC/LU information systems are based on hierarchical classifications, i.e., they assign to each polygon only one class, the one that occupies the largest area within the polygon. However, other classes that are also present in the polygon are not incorporated to the database due to their small area within the polygon and to the scale and minimum mapping unit of the project.

The SIOSE project, due to its object oriented data model, goes one step further storing in each polygon every present and displayable class in the territory. In SIOSE2005 any coverage found in a polygon with an area equal or greater to 5% of the surface of the polygon must be collected. In addition, attributes and percentage of occupation of land covers inside the polygon are also collected. This implies a substantial improvement in the description of the territory. In this way LC data can be analyzed from multiple points of view depending on the user's needs and there are many possible ways to show the results, either graphically or numerically.

For example, if you would like to know the percentage of occupation of the 'Buildings' coverage, polygons that have within them any percentage of buildings can be selected and grouped by this parameter and depicted through a map:

% Occupation.'Buildings'		
PERCENTAGES		LEGEND
0%		
> 0%	20%	
> 20%	40%	
> 40%	60%	
> 60%	80%	
> 80%	100%	

Table 2 and figure 3: Example of map legend and portrayal of LC polygons by percentage of buildings coverage.



In the same way as in the above example, many map legends and portrayals of the SIOSE polygons can be created based on any other land cover of the polygons, its percentage of occupation, its attributes or a combination of all of them. For example, information can be got about the rate of occupancy of forest trees (canopy cover), the majority type of buildings in urban expansion areas, the existence of water in areas of cultivation, etc.

Another example of how to work with the information contained in the SIOSE2005 database is to develop **nomenclatures** based on criteria which meet end user needs. Thereby each user can design the nomenclature that best suits his needs with SIOSE data.

As an example, the nomenclature designed for SIOSE data visualization in 'IBERPIX', the IGN image viewer, is shown below. The aim of this nomenclature is to show visually the majority coverage of the polygons through a color legend:

Herbaceous crops
Woody crops
Pastures
Dehesas
Crop combinations
Crops and natural vegetation combinations
Grasslands
Shrubs
Grassland, shrub and forest combinations
Forest
Sparsely vegetated areas
Non-vegetated land
Wetlands
Waters
Waters and riparian vegetation
Urban fabric
Primary
Industrial area
Tertiary
Facilities
Transport infrastructures
Waste management infrastructures
Supply infrastructures

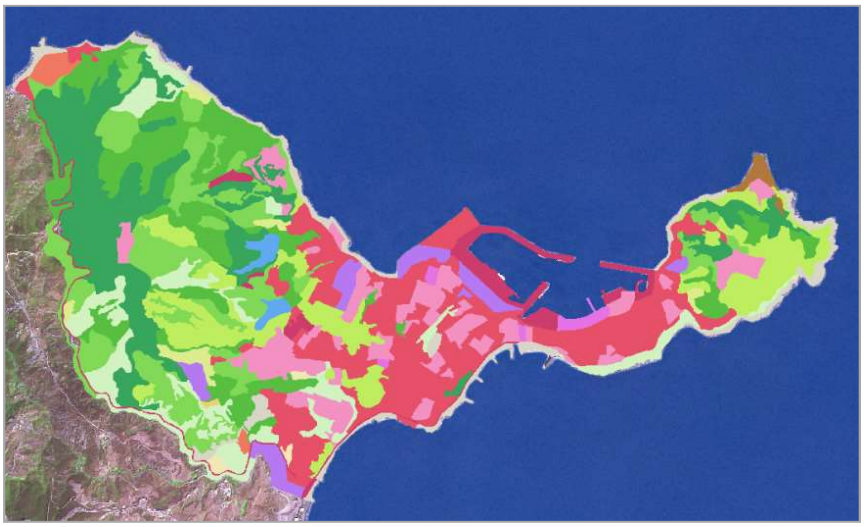


Table 3 and figure 4: Example of the nomenclature applied in 'IBERPIX' in the city of Ceuta.

5.2 SIOSE2005 statistics

SIOSE2005 statistical results presented in this document refer to area occupied in Spain by each of the coverages of the SIOSE2005 data model. This calculation has been done in the geodetic system, projection and geographic zone in which SIOSE databases were generated (Section 2), giving the results in square kilometers (km^2).

Note: UTM projection does not preserve surfaces, but the discrepancies that could be found in calculated values were considered negligible taking into account the accuracy of the results presented.

5.2.1 Simple coverages

The following table shows the results for the area covered in Spain by each of the SIOSE2005 simple coverages. The sum of the areas occupied by all simple coverages provides the total area of Spain.

ID	Simple coverages	Area (km^2)
101	Buildings	5.651
102	Green urban area	1.633
103	Artificial water bodies	731
104	Roads, parking lots and other artificial surfaces	4.626
111	Other constructions	817
121	Non-built soil	3.921
131	Extraction and dumping	1.323
211	Rice	1.338
212	Herbaceous crops (other than rice)	132.660
222	Citrus fruit trees	3.404
223	Non-citrus fruit trees	10.054
231	Vineyards	10.771
232	Olive groves	24.330
241	Other woody crops	1.161
290	Pastures	6.904
300	Grasslands	89.716
312	Deciduous broad-leaved forest trees	23.012
313	Evergreen broad-leaved forest trees	27.860
316	Coniferous forest trees	40.907
320	Shrubs	85.455
331	Beaches, dunes and sand plains	354
333	Bare soil	15.764
334	Burnt areas	873
335	Glaciers and perpetual snow	5
336	Dry riverbeds	378
351	Sea cliffs	162
352	Outcrops	6.706
353	Scree	698
354	Quaternary lava flows	362
411	Marshes	74
412	Peat bogs	25
413	Inland salines	11
421	Coastal marshes	740
422	Coastal salines	144
511	Water courses	874
513	Lakes and lagoons	217
514	Reservoirs	2.221
521	Coastal lagoons	85
522	Estuaries	73
523	Sea and ocean	0
	TOTAL	**506.041**

Table 4: Area occupied in Spain by SIOSE2005 simple coverages.

The area occupied in Spain by the main groups of SIOSE2005 simple coverages is presented in the next table:

ID	Simple coverages (grouped in 8 classes)	Area (km²)
100	Artificial elements	18.701
200	Crops	190.623
300	Grassland	89.716
310	Forest trees	91.779
320	Shrub	85.455
330	Non-vegetated land	25.302
400	Wetlands	994
500	Waters	3.470
	TOTAL	**506.041**

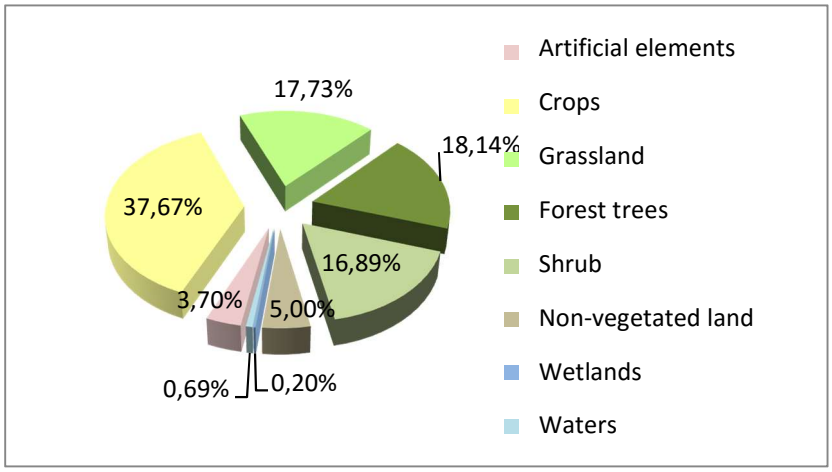


Table 5 and figure 5: Area occupied by the principal groups of SIOSE's simple coverages in Spain.

5.2.2 Predefined compound coverages

According to SIOSE2005 data model, simple coverages can be part of compound coverages or 'predefined compound coverages', a special type of compound coverage which has been given an identifying name due to its importance in our country.

The following table shows the area occupied in Spain by the SISOE2005's predefined compound coverages, which, by definition, don't necessarily add up to the total surface of Spain.

ID	Predefined compound coverages	Area (km²)
701	Dehesas	24.373
702	Olive groves/Vineyards	247
703	Agricultural settlements	1.765
704	Home orchards	393
800	Artificial compound coverages	14.555

Tabla 6: Area occupied by the main groups of SIOSE2005 predefined compound coverages in Spain.

All predefined coverages inside the group of 'Artificial compound coverages' in the SIOSE2005 data model are break down in the following table:

ID	Predefined Artificial compound coverages	Area (km^2)
811	Town centre	1.629
812	Urban expansion area	2.643
813	Discontinuous	2.051
821	Planned industrial park	949
822	Non-planned industrial park	330
823	Isolated industry	520
831	Farming	727
832	Logging	22
833	Mining	859
834	Fish farming	9
841	Commercial and business park	144
842	Hotel resort	51
843	Amusement park	27
844	Campsite	44
851	Government	128
852	Health	43
853	Cemetery	54
854	Educational	174
855	Penitentiary	11
856	Religious	37
857	Cultural	47
858	Sports	280
859	Golf course	230
860	Urban park	234
881	Road network	2.256
882	Rail network	337
883	Port	68
884	Airport	154
891	Wind power	69
892	Solar	7
893	Nuclear	8
894	Electric	21
895	Thermal	18
896	Hydroelectric	7
897	Pipeline	7
900	Telecommunications	5
911	Water treatment plant	35
912	Water supply network	242
913	Desalination plant	3
921	Dump site	63
922	Waste treatment plant	13

Table 7: Area occupied by SIOSE2005 predefined compound coverages belonging to the 'Artificial compound' group in Spain.

6. FUTURE OF LAND COVER / LAND USE IN SPAIN

6.1 CORINE Land Cover and GMES

On 27th June 1985 the Council, on a proposal from the Commission, adopted a decision on the CORINE programme. This Commission's work programme concerns an 'experimental project for gathering, coordinating and ensuring the consistency of information on the state of the environment and natural resources in the Community'.

Within the CORINE programme is the CORINE Land Cover project, whose purpose is to obtain a 1:100.000 scale European land cover hierarchical database. Since 1995 the EEA is responsible for this project with the aim of being useful for spatial analysis and the assessment of European policies.

Currently there are three editions of the CORINE Land Cover database, with reference dates of 1990 (CLC90), 2000 (CLC2000) and 2006 (CLC2006).

A new update of CLC is scheduled with reference date of 2012 in the frame of the GMES (Global Monitoring for Environment and Security) programme, an initiative of the European Union to develop its own operational earth observation capacity. Following SIOSE's philosophy and in line with the INSPIRE European Directive, CLC2012 aims to improve the current hierarchical CLC data model, based on classifications, through the parameterization of its classes and attributes. The 'EAGLE' Working Group of the EIONET network (European Environment Agency) was created to accomplish this goal and Spain is involved in it with the participation of its National Reference Centre in Land cover and on Land use & spatial planning (NRC-LC/LU).

Thanks to the coordination raised from the beginning between SIOSE and CORINE Land Cover and through an appropriate planning of the production schedule and acquisition of the reference images, it is possible to ensure the provision of LC data of Spain for future editions of CLC using SIOSE as source of information. In fact, **SIOSE update with reference date of 2009 is already in course,** in agreement with the autonomous regions, and it is planned to be updated again in 2012 (±1 year). The idea is to produce the next CLC2012 from SIOSE updated to 2012.

SIOSE allows to address not only the future CLC databases but also the High Resolution Layers of GMES, a series of raster layers obtained by automatic classification of images, in order to obtain the major classes of land cover: sealed soil (level of permeability and infiltration of water in the soil), forest (according to a certain percentage of presence of forest trees), grasslands, wetlands and water.

This approach, presented to the European Commission and to the European Environment Agency, is focused on generating LC/LU information of Spain from a more detailed level to a less detailed level (bottom-up approach). Working this way, according to the INSPIRE European Directive, data will be collected only once, at the most efficient level and will be used at regional, national, European and even global levels through the appropriate processes of thematic and geometrical aggregation and generalization.

This decentralization and coordination of the national needs with the European requirements ensures a future provision of sustainable and efficient 'Terrestrial Surveillance' services.

6.2 INSPIRE

The European Directive 2007/2/EC establishes an Infrastructure for Spatial Information in the European Community (INSPIRE) in order to coordinate the geographic information in Europe, with the instruction of collecting the information only once and at the most appropriate level for the utilization by all users.

INSPIRE includes in three annexes the themes of geographic information which must have common specifications (Data Specifications) agreed by coordinated working groups composed of experts in each field.

The period between 2010 and 2012 has been fixed to establish the working groups and to define the specifications of the 'Land cover' (belonging to Annex II) and 'Land use' (Annex III) themes. Spain is involved in these two groups with two experts from the IGN's SIOSE team. Both contribute with the experience and work already done in SIOSE and especially with a new approach about the land cover **parameterization** (to give numeric values to the variables, e.g., value of percentage of coverage or attributes as irrigated or non-irrigated). This approach, based on the philosophy of the SIOSE parametric and object-oriented data model, is being taken into account in the INSPIRE specifications and ensures an easy adaptation of the national LC/LU data to INSPIRE specifications.

ANNEX I: COMPARISON OF RESULTS SIOSE2005 - CLC2006

SIOSE2005 and CORINE Land Cover 2006 (CLC2006) are two land cover databases that, in the case of Spain, can be compared since they have been produced using the same reference images: the SPOT5 satellite images of 2005.

However, in order to compare the data obtained by both projects, it is important to take into account the main characteristics that differentiate them. They are shown in the following table:

	CLC2006	SIOSE2005
Cartographic scale	1:100.0000	1:25.000
Minimum mapping unit	25 ha	- 0,5 ha: forced crops, wetlands, beaches, riparian vegetation and sea cliffs. - 1 ha: urban areas and water bodies. - 2 ha: agricultural, forests and natural areas.
Minimum width of linear elements	100 m	15 m
Data model	Hierarchical (44 classes)	Object oriented (40 simple classes and 46 predefined compound classes)
Geodetic reference system	ETRS89	ETRS89 (except in Canary Islands: WGS84)
Cartographic projection	UTM, extended zone 30	UTM, each autonomous region in its corresponding zone

Table 8: Comparative table between SIOSE2005 and CLC2006 projects.

The CLC2006 statistics were obtained for the whole country and were calculated in the geodetic reference system ETRS89 and UTM projection (extended zone 30).

In order to carry out the analysis, the information of both databases was spatially compared, so that for each CLC2006 polygon is known the percentage of each SIOSE2005 simple coverage that composes it.

Due to the differences in the technical specifications of both projects - which have been described in the table above - the information collected by CLC2006 has less detail than that in SIOSE2005:

- CLC2006 has less geometric detail than SIOSE2005 due to the minimum polygon size (25 ha in CLC2006 comparing to 0,5 ha - 2ha in SIOSE2005 depending on the type of coverage).
- CLC2006 has less semantic detail than SIOSE2005 because of the type of data model used. CLC uses a nomenclature of 44 classes and each CLC polygon can only be assigned one class. On the contrary, SIOSE uses an object-oriented data model which allows the assignment of more than one coverage to every polygon, each one with its percentage of occupation and its attributes.

For these reasons, the generation of the CLC2006 database requires a greater generalization of the land cover information than the one needed in SIOSE2005 as it is necessary to assign to each polygon, of at least 25 ha, the most representative class (among 44 CLC classes). In this process, information of other minority, but existing, coverages is lost. However, SIOSE keeps it on its database.

The following table lists the areas covered in Spain by the five major groups of CLC2006 classes and the percentage of this areas occupied by each main SIOSE2005 simple coverage.

CLC2006 - LEVEL 1		**SIOSE2005 (%)**							
DESCRIPTION	Area (km^2)	Artificial coverages	Crops	Grasslands	Forest trees	Shrubs	Non-vegetated land	Wetland coverages	Water coverages
Artificial areas	10.174	79	7	4	3	4	2	0	1
Agricultural areas	253.642	3	72	10	5	8	2	0	0
Forest areas with natural vegetation and open spaces	238.521	1	6	24	31	29	9	0	0
Wetlands	1.111	2	8	8	1	4	3	64	10
Water surfaces	3.282	2	3	4	4	4	2	4	77
TOTAL	506.730								

Table 9: CLC2006 class composition by SIOSE2005 main groups of simple classes.

Artificial areas

It can be seen from the data presented in the previous table - Table 9 – that, according to CLC2006 data, there are 10.174 km^2 of 'Artificial areas' in Spain. However, according to SIOSE2005, only a 79% of this surface corresponds to artificial coverages. The remaining 21% goes to other types of coverages such as crops, grasslands, shrubs, etc.

This is mainly due to the difference in both projects in the minimum mapping size of the polygons (25 ha for CLC2006 and 1 ha in SIOSE2005).

An example of this difference is the case of small and dispersed rural settlements which appear in CLC2006 as *111-Continous urban fabric* within polygons of, at least, 25 ha of size. The same area in SIOSE2005 will have an urban polygon that will fit better with the real settlement (minimum mapping unit 1 ha) and the rest of the area will be codified, in different polygons, as crops, trees or other corresponding coverage.

This is shown in the following image. The CLC2006 polygon, in yellow, is classified as *111-Continous urban fabric*. SIOSE2005 polygons are drawn in red. Three of the SIOSE polygons within the CLC polygon have been highlighted with a thicker line because their coverage is not entirely artificial. The polygon (1) has 70% of *herbaceous crops* and 20% of *deciduous broadleaved trees*. Polygons (2) and (3) have 15% of *herbaceous crops* within them. Therefore, part of the surface classified as artificial in CLC2006 goes in SIOSE2005 to other types of coverages such as crops and forest trees, due to the difference in the minimum mapping size between both projects.

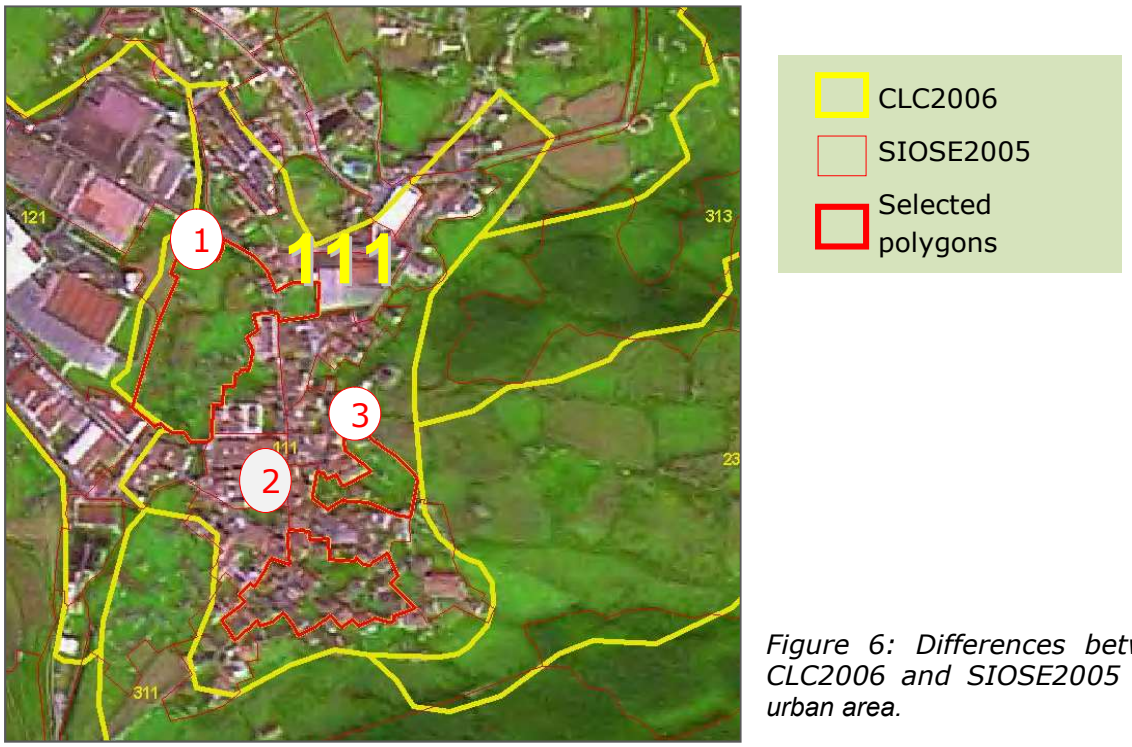


Figure 6: Differences between CLC2006 and SIOSE2005 in an urban area.

Agricultural areas

According to Table 9, the areas classified as 'Agricultural areas' in CLC2006 correspond in SIOSE2005 with 72% of crop areas, while the remaining 28% is the sum of other coverages such as grassland, shrub, forest trees, etc.

These results are mainly due to two reasons. First of all, the difference in the minimum mapping sizes between CLC2006 and SIOSE2005. Artificial and forest areas among crops with less than 25 ha are represented in SIOSE2005 but not in CLC2006.

Secondly, inside the 'Agricultural areas' group CLC2006 includes the classes: *243 – Land principally occupied by agriculture, with significant areas of natural vegetation* and *244 – Agro-forestry areas*, this last one including, in the case of Spain, the 'dehesas'. However, in Spain, the 'dehesas' have a very important composition of forest coverage that would explain, in part, these percentages of 10% of grasslands, 5% of forest trees and 8% of shrubs that appear in Table 9.

The following image shows an example of the differences in the minimum polygon size between both databases. SIOSE2005 polygons are drawn in blue.

A CLC2006 polygon, in yellow, is classified as *211 - Arable land*. Within it there are several SIOSE2005 polygons less than 25 ha with natural coverages of forest trees, grassland, shrubs, etc. and artificial coverage percentages (such as buildings, roads, etc.). Due to the greater minimum mapping unit in CLC2006 these areas cannot be collected and labeled with their real coverage and they are classified as the area around as 'Arable land'.

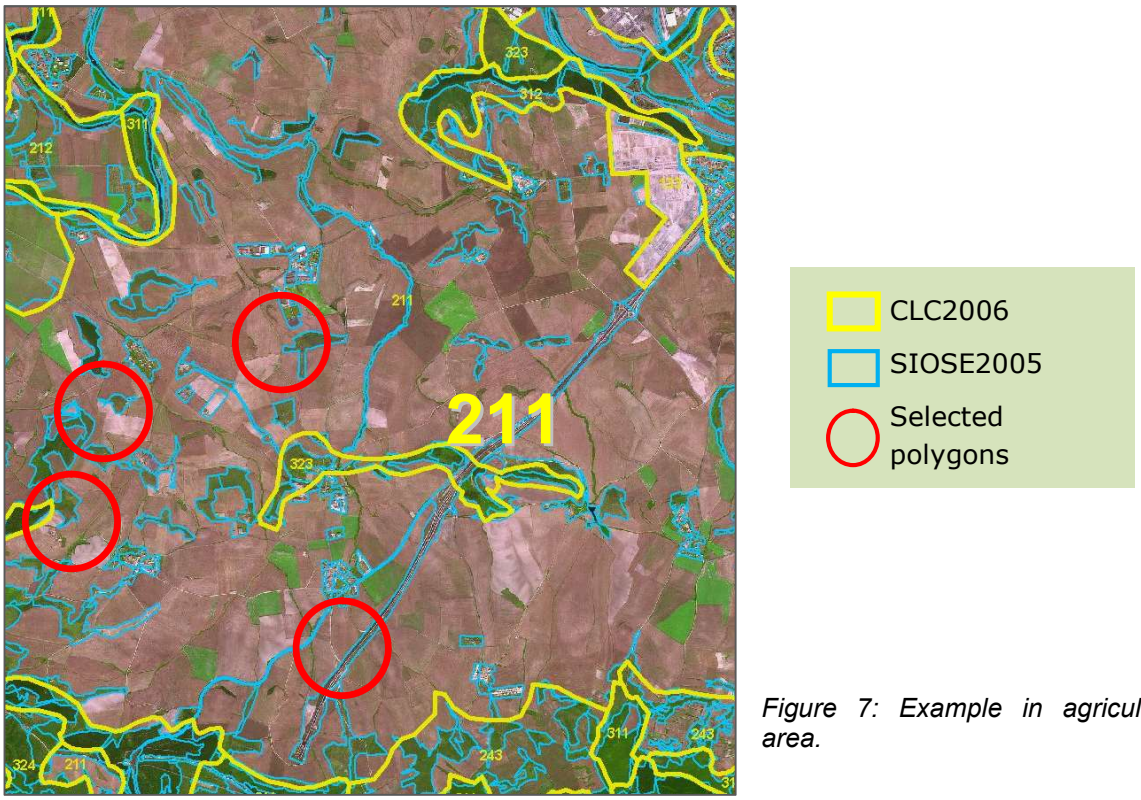


Figure 7: Example in agricultural area.

Forest areas with natural vegetation and open spaces

In the case of the CLC group 'Forest areas with natural vegetation and open spaces', the surface that is classified as such in CLC2006 corresponds in SIOSE2005 to grasslands, forest trees, shrubs and non-vegetated areas in a 93%. The remaining 7% goes mainly to crops, with a small percentage of artificial coverages.

This percentage that does not correspond with forest and natural areas is explained in the same way than in the previous cases. Small areas of crops may exist within forest areas but will not be represented in CLC due to the minimum polygon size (25 ha) and, therefore, these areas are all classified as forest areas. However, this case is less common than the previous ones.

The following image shows an example of this case. The CLC2006 polygon in yellow is classified as *323 - Sclerophyllous vegetation* (shrubs), which belongs to the group 'Forest areas with natural vegetation and open spaces'. SIOSE2005 polygons are drawn in red but some of them have been highlighted in black because they are classified as crops. These crops are not classified in CLC2006 due to its small size.

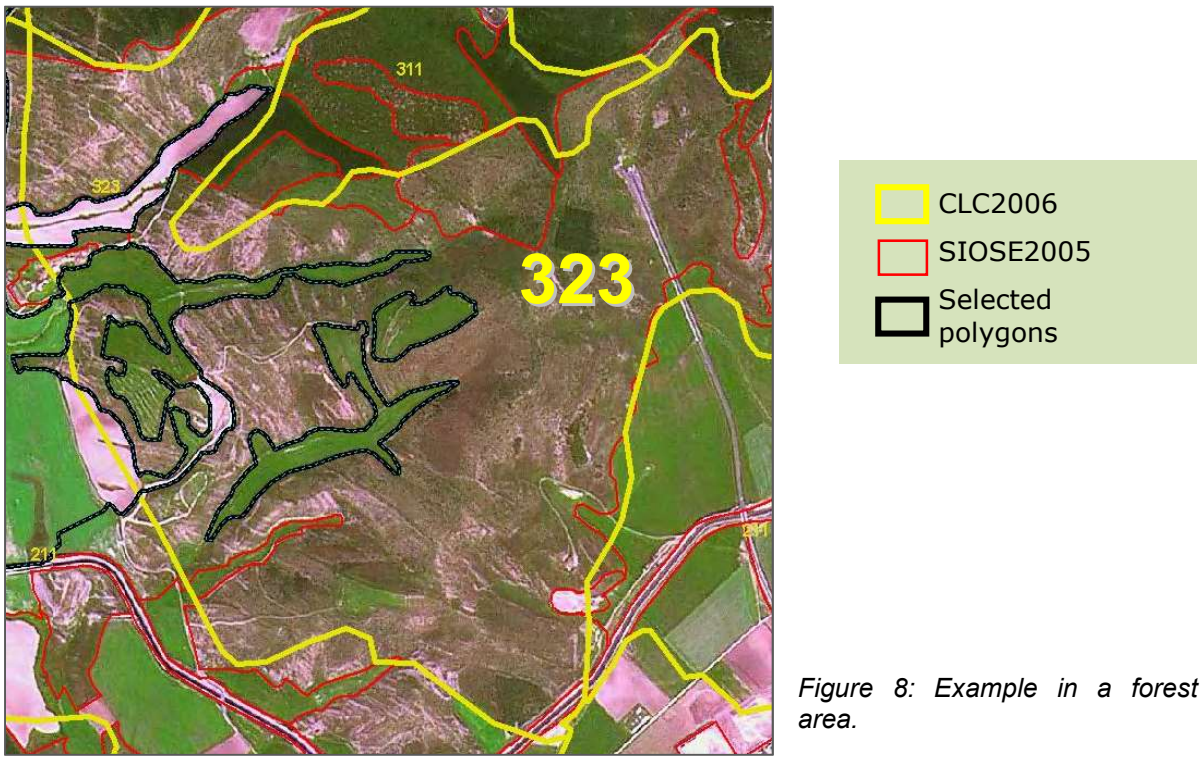


Figure 8: Example in a forest area.

Wetlands and water surfaces

The surface classified as 'Wetlands' in CLC2006 corresponds in a 64% to wetlands in SIOSE2005, whereas the remaining 36% corresponds to the sum of the rest of simple coverages.

Moreover, the surface that is classified in CLC2006 as 'Water surfaces' corresponds with a 77% of water coverages in SIOSE2005. The remaining 23% goes to the sum of the rest of simple coverages.

In most of the cases, these results can be explained by the difference in the minimum mapping unit used in SIOSE2005 and CLC2006.

These two classes, 'Wetlands' and 'Water surfaces', take up a small area compared to the total area of our country but their environmental value is enormous. This is the reason why CLC2006, in an attempt to collect these areas, forces their polygons to have the minimum mapping size (25 ha) adding to these polygons other areas adjacent to the wetlands and water surfaces. This does not happen in SIOSE2005 since the minimum polygon size is 0,5 ha for 'Wetlands' and 1 ha for 'Water coverages' and, therefore, these areas are easily collected.

Conclusions

Based on the comparative study between SIOSE2005 and CLC2006, it can be concluded that:

1. CORINE Land Cover has been, and is, the first comparable land cover database for all Europe and has allowed the study of the evolution of the European land cover in the last 20 years. Its future feasibility is guaranteed for the next few years in the frame of European initiatives as INSPIRE and GMES.
2. SIOSE2005 improves the spatial and thematic resolution of the land cover information in our country regarding the one provided by CLC. In addition, SIOSE keeps the compatibility with CLC.

   The improvement on spatial resolution can be quantified by the number of polygons in SIOSE2005, 2.477.593, comparing to this figure in CLC2006, 155.801. Moreover, the average size polygon goes from 3,24 km^2 in CLC2006 to 0,20 km^2 in SIOSE2005.

   Improvement in thematic resolution can be quantified by the number of different coverages that appear in the databases. SIOSE2005 has 820.632 different class combinations, whereas CLC2006 only has 44 different classes. This result indicates a significant improvement in SIOSE2005 in regard to the description of the territory.
3. Differences in mapping scale, minimum mapping unit and data model between SIOSE2005 and CLC2006 make the information collected in SIOSE2005 much more detailed than the one provided by CLC2006 in terms of structure and features of the territory.
4. It is proved that the correspondence between information provided by CLC2006 and SIOSE2005 is significant and that the differences between them are the expected due to the differences of scale and data model between both projects.
5. Coexistence and coordination of both projects ensure the availability of land cover information in our country, ensuring compliance of national, European and global requirements.