

# **SIOSE, A SUCCESSFUL TEST BENCH TOWARDS HARMONIZATION AND INTEGRATION OF LAND COVER /USE INFORMATION AS ENVIRONMENTAL REFERENCE DATA**

N. Valcarcel, G. Villa, A. Arozarena, L. Garcia-Asensio, M. E. Caballero, A. Porcuna, , E. Domenech, J.J. Peces

National Geographic Institute of Spain. Cartographic Production Department. General Ibáñez Ibero, 3. 28003 Madrid. Spain-(nvalcarcel, gmvilla, aarozarena, lgasensio, mecaballero, ign\_teledeteccion, edomenech, jjpeces)@fomento.es

**KEY WORDS:** Land Cover, Land Use, Reference Data, Interoperability, Integration, Modelling

## **ABSTRACT:**

The National Geographic Institute of Spain (IGN) is the National Reference Centre in Land Cover and Use (EIONET's National Reference Centre for Soil, by mandate of the National Focal Point, the Spanish Environment Ministry); according to this mandate, IGN must coordinate the information in Spain related to Land Cover and Use. This new Land Cover and Use Information System of Spain (SIOSE), able to integrate different data of regional and national administrations, is a very ambitious project destined for being a Spanish and European reference as regards geographic information. SIOSE is part of the National Land Monitoring Plan, managed and coordinated by the IGN, which hopes to achieve a multidisciplinary spatial data infrastructure, periodically updated, for the Spanish national and regional administrations. SIOSE is being produced between 2006-2009, in a decentralized and cooperative production model by Spanish National and Regional administrations. This projects has been designed according to the main INSPIRE principles, and ISO TC/211 standards, moving from previous hierarchical land cover databases towards a land cover feature data model, able to describe the different land cover classes in the territory, but also their environmental parameters. This complex and strong description of each land cover occurrence will allow obtaining environmental key indicator from SIOSE data.

## **1. INTRODUCTION**

Land cover information at national and regional level has been historically recorded in many UE Member States (MS) because of their environmental and territorial management's needs and requirements. In addition to Corine Land Cover (CLC) 1990 and 2000 databases, many Member Countries (MC) have been producing Land Cover (LC) databases to manage and satisfy their own requirements on environmental, agricultural, forest and territory planning issues, with what happened in consequence several regional and national LC inventories with very different scales, nomenclatures and Minimum Mapping Units (MMU), and different production and update intervals. These inventories, however, do not respond to these national requirements. So, the task now is to harmonize and homogenize the LC information production and update at European, national and if necessary regional level, in a double bottom-up & top-down approach, according to the INSPIRE Directive principles. According to this, the National Geographic Institute of Spain (IGN), which is the National Reference Centre in Land Cover and Use (EIONET's National Reference Centre for Soil, by mandate of the National Focal Point, the Spanish Environment Ministry), must coordinate the information in Spain related to Land Cover and Use. This new Land Cover and Use Information System of Spain (SIOSE), which is being produced from 2006 to 2009, is a very ambitious project destined for being a Spanish and European reference as regards geographic information, able to integrate different data of regional and national administrations. SIOSE is part of the National Land

Monitoring Plan, managed and coordinated by the IGN, which hopes to achieve a multidisciplinary spatial data infrastructure, periodically updated, for the Spanish national and regional administrations.

## **2. SIOSE MAIN TECHNICAL FEATURES**

### **2.1 Objectives**

The main SIOSE objectives are:

- Avoid duplicity of data and reduce costs of Geographic Information.
- Production and Quality model based in cooperation between national and regional administrations.
- Satisfy Spanish National and Regional Administration requirements on Land Cover and Use information.
- Integrate Regional Administrations in the management, quality control and productions of the land cover and use national database and information system.
- Satisfy EEA's and EU requirements in future Corine Land Cover versions and on Land Cover and Use information.
- Integrate land cover and use databases and information of the Spanish national institutions

### **2.2 Project organization**

The following diagram (Figure 1) resumes the main Spanish Institutions collaborating in SIOSE.

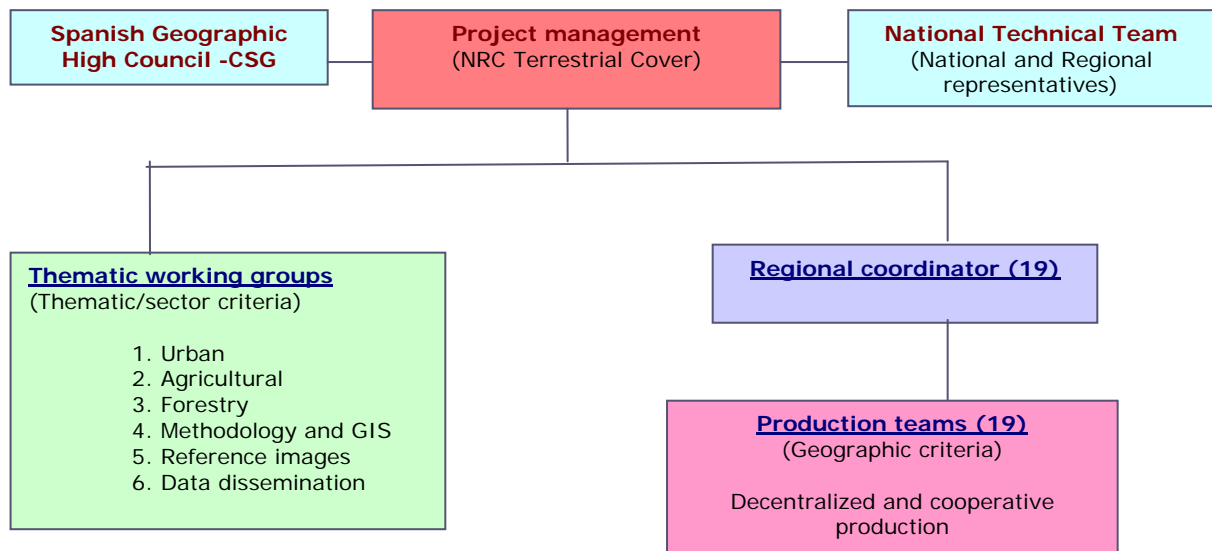


Figure 1. SIOSE Organization

### 2.3 Summary of technical features

- Geodetic Reference System: ETRS89, according to INSPIRE and Spanish Geographical High Council.
- Cartographic Projection: UTM, zones 28, 29, 30 y 31
- Different surface minimum unit, according to the cover class in the land.
  - Urban Fabric and Water bodies: 1 ha.
  - Agricultural land: 2 ha.
  - Forest and Natural Areas: 2 ha.
  - Wetlands, Beaches, greenhouses, riverside vegetation: 0,5 ha.
- Cartographic scale: 1:25.000. According to final geometric accuracy: quadratic mean error (X,Y) ≤ 5 m. Screen resolution: ≈ 90 pixels/inch
- Harmonized Object Oriented Data Model, UML notation.

### 2.4 SIOSE Data model: using object oriented concepts

The hierarchical nomenclature system, used in CLC and other LC databases, has shown its incapacity to store in an efficient way the diversity of LC occurrences in the European territory. Furthermore, hierarchical classification data models were an efficient way to store information many years ago, but now rarely are the most efficient way to store and analyse information in a database. Queries based on parameters are not possible, for example. Nowadays, conceptual data models, designed using object-oriented methodology, and its conversion in relational or object-oriented databases, are best and common practices to build Information systems. Considering this, Land cover should be described using a harmonized conceptual parametric data model, based on ISO 19109 (Rules for application schemas, ISO TC 211 standards), which classes must be defined and kept in time in order to identify land cover changes within time series. Using this data model, standard European and international nomenclatures could be automatically obtained, shaped like thematic queries

For the SIOSE project, an OODM (SIOSE data model) has been designed, in collaboration with more than 25 institutions interested in LU/LC, organized in “Thematic Working Groups”. This community of producers/users of LU/LC information is registered as a SDIC (“Spatial Data Interest Community”) for

INSPIRE initiative. From this OODM, it is possible to derive as many ‘views’ as necessary. Standard CLC or Murbandy/Moland Nomenclatures would be “predefined views” of the OODM database. SIOSE database is been produced with the OODM concept described here, but when any SIOSE user (local, national or international institutions) has the need to input additional information of a specialized field. E.g.: agricultural, forestry, infrastructures, etc., it is easy to “extend” the Data Model, using one or more of these techniques:

- Subdivide one UML class into multiple classes
- Add more UML classes
- Add values to controlled list text parameters
- Add more parameters to some classes.
- Add “conditions” that parameters should comply.
- etc.

One of the premises of the Data Model proposed is that it must be possible to obtain automatically a standard Corine Nomenclature database, and also a standard Moland Nomenclature database from the OODM database. This assures backward compatibility and comparability with preexistent databases, as CLC90, CLC00, Murbandy, etc, and UN FAO LCCS. As said before, standard CLC or Murbandy/Moland Nomenclatures would be “predefined views” of the OODM database.

### 2.5 Use of bio-physical parameters derived by remote sensing

In SIOSE one of the main premises is the use of bio-physical parameters derived by Remote Sensing during the production phase. There are many bio-physical parameters (vegetation indexes -NDVI, etc., Leaf Area Index -LAI-, FAPAR, etc...) that can be semi-automatically derived from multispectral images by remote sensing techniques or in other cases by field work. The mean of these continuous value variables for each polygon can then be input and stored in the OODM database as a parameter that qualifies each polygon. This improves greatly the “synergies” between Remote Sensing and GIS technologies in Land Use/Land Cover information.

### 3. SIOSE PRODUCTION IN SPAIN: DATA HARMONIZATION AND INTEGRATION

#### 3.1 First SIOSE Production: 2005-2009

**Integrating reference and thematic information:** First a previous work was made by the NRC to include any topographic and environmental spatial information to be integrated as reference data for the production of SIOSE. The following spatial databases were selected:

Reference topographic data: BCN (hydrography, roads, railway network), Cadastre (urban limits, street axes)

- Agricultural (National Crop Map -MCA) and Forest (National Forest Map - MFE) thematic reference data
- Thematic LC/LU databases in the Spanish Autonomous Communities (if existing).

After several geoprocessing phases, a reference SIOSE “skeleton” was built, using reference integrated topographic and thematic information.

**3.1.1 Photointerpretation:** Using the SIOSE ‘skeleton’ as initial geometric and thematic information, photointerpretation is being made by the Autonomous Production Teams using SPOT5 2005 coverage (2.5 m pixel) as geometric and temporal reference. The geometry and land cover information is reviewed considering the SPOT 5 reference, and is updated when necessary. After the photointerpretation phase, two detailed quality control processes are made, one by the Autonomous team, and the final one by the NRC, to ensure the adequate homogenization of data considering the whole Spanish territory.

#### 3.2 SIOSE Update

After the first SIOSE production, to be ended by 2009, SIOSE Update will be produced again in a coordinated way based on common methodology and data model. This will apply again one of the main INSPIRE principles: information is produced at the most efficient level.

#### 3.3 Summary

Figure 2 resumes the main characteristics of the SIOSE production and update.

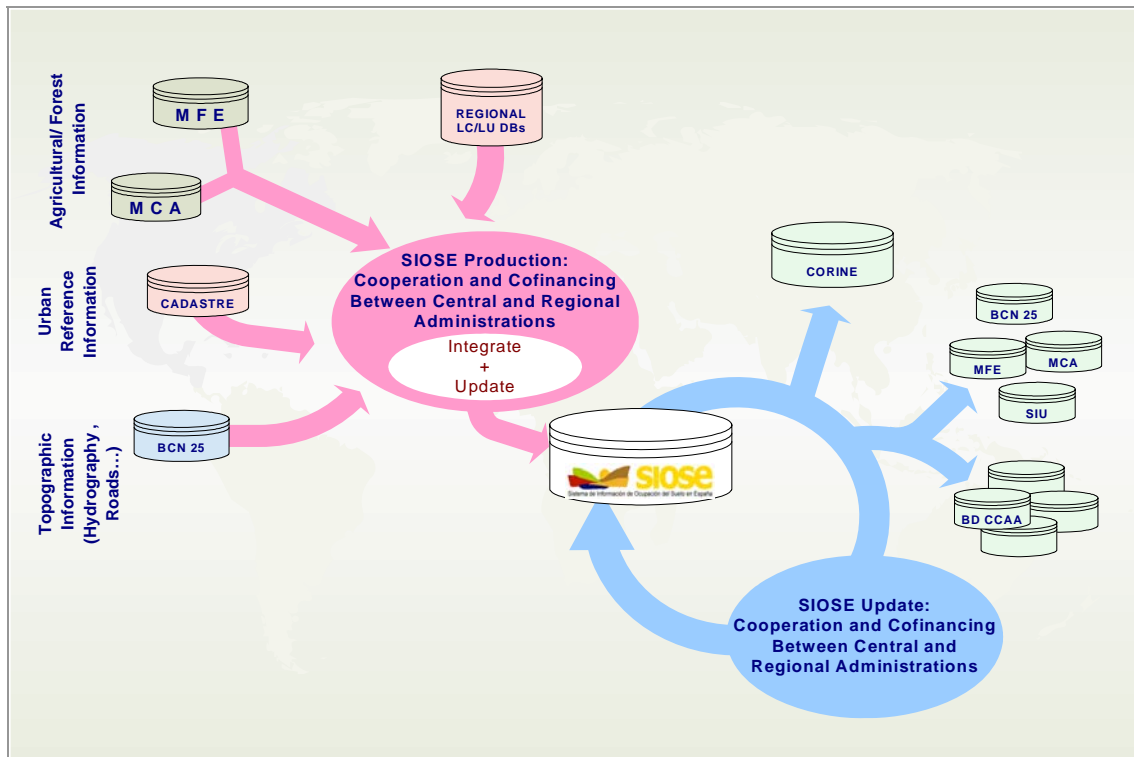


Figure 2. SIOSE Production and update

#### 3.4 Example

The following example shows how the integration of two national thematic databases is used in the SIOSE photointerpretation phase. Green and red lines represent the National Crop and Forest Map, with different production periods and thematic legends. It is possible to see that some

differences appears due to the thematic classes to be represented by both maps. SIOSE integrates the two nomenclatures considering the land cover in the territory as a whole concept. So the best geometry is selected for each SIOSE polygon, updating when necessary parts of these previous reference lines, which conforms the SIOSE ‘skeleton’.

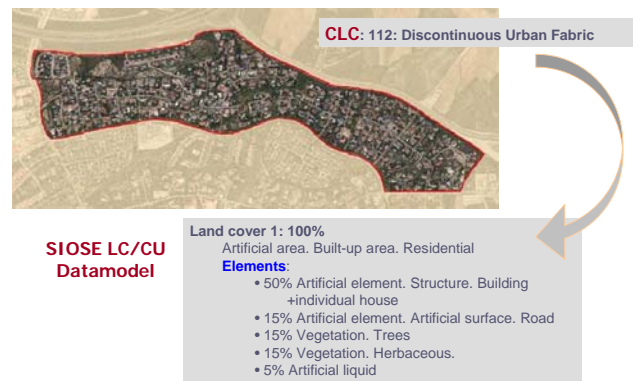
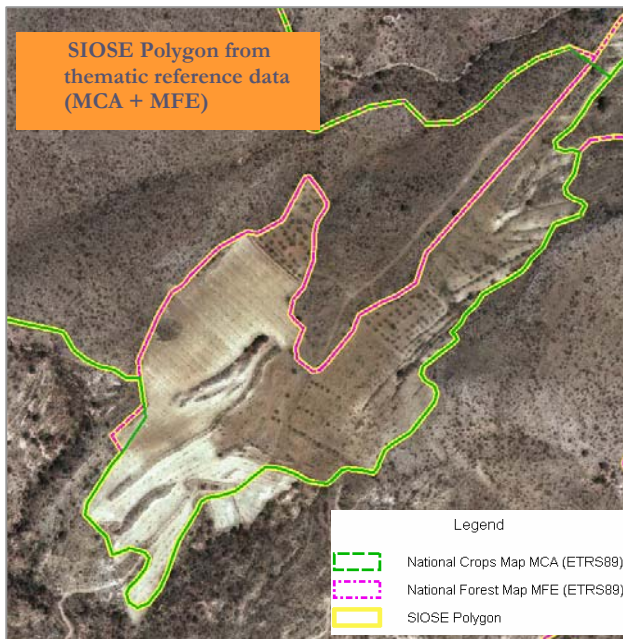


Figure 3. Corine Land Cover code versus SIOSE data

In urban areas, street axes of the Cadastre Urban database are used to delimitate the SIOSE polygons. This ensures the posterior geometric interoperability between SIOSE and Cadastre. There are some other important advantages, for example, the use of the SIOSE geometries by Cadastre to look for urban areas with new urban developments to be updated.

#### 4. SIOSE FEATURE MODEL AND CORINE LAND COVER NOMENCLATURE

Several problems in the Corine Land Cover nomenclature can be solved using land cover feature model, as in SIOSE. For example:

- Proliferation of threshold classes, due to differences in the values of a particular parameter.
- Proliferation of mixed classes, due to the need to assign a class to polygons that contain several different land cover categories, providing little information to user.
- Complex definitions for land cover classes
- Important spatial variations in certain land cover parameter values which do not appear in the database
- Impossibility to make calculation of derived variables and environmental indicators based land cover parameters.

SIOSE solves these problems, but without losing the interoperability backwards with previous Corine databases; it is possible to obtain the Corine Land Cover nomenclature and legend using SIOSE data, as a result of a relational SQL query to the SIOSE relational database.

The following figure shows the comparison between the Corine Land cover code and the instance of SIOSE land cover information for the same land area:

#### REFERENCES AND SELECTED BIBLIOGRAPHY

Anderson, R., Hardy, E., Roach, J. T. y Witmer, R. E. A Land Use And Land Cover Classification System For Use With Remote Sensor Data. Geological Survey Professional Paper 964. A revision of the land use classification system as presented in U.S. Geological Survey Circular 671

Di Gregório A., Jansen, L.J.M. Land Cover Classification System. Classification concepts and user manual, Software version (2). Revised by Antonio Di Gregorio. Based on the original software version 1. Food and Agriculture Organization of the United Nations, Rome, 2005.

Chuvieco, E. Teledetección Ambiental: La observación de la Tierra desde el Espacio. Ariel Ciencia, 2002. pp. 155 - 197

Murray I. Blázquez, M. y Rullan, O. Los cambios en la cobertura de la Tierra. Una revisión bibliográfica desde la geografía. *Revista Bibliográfica de Geografía y Ciencias Sociales, Universidad de Barcelona*, Vol. X, nº 571, 2005.

Pinilla, C. Elementos de teledetección. Editorial RA-MA. 1995. pp. 85 - 96

Sanderson E. W., Jaiteh, M., Levy, M. A., Redford, K. H., Wannebo, A. V. and Woolmer, G.. The human footprint and the last of the wild. *Bioscience*. 2002, 52(10):891-904.

#### REFERENCES FROM OTHER LITERATURE

Land-Based Classification Standards. Online, American Planning Association: Chicago, Illinois. <http://www.planning.org/LBCS>.

CORINE Land Cover update. I&CLC2000 project -Technical Guidelines. Final version, EEA 2002.

- INFORME TÉCNICO I&CLC2000. Área de Teledetección. Subdirección Gral. de Geomática y Teledetección, Instituto Geográfico Nacional, 2002.

**SIOSE TECHNICAL GUIDELINE**

Doc. Técnico Descripción del Modelo de Datos SIOSE versión 1.12 Equipo Técnico Nacional Proyecto SIOSE. S.G. de Producción Cartográfica, Instituto Geográfico Nacional, 2007.

Manual de la Base de datos SIOSE versión 1.12. Equipo Técnico Nacional Proyecto SIOSE. S.G. de Producción Cartográfica, Instituto Geográfico Nacional, 2007

Manual de Fotointerpretación (Sistema de Información de Ocupación del Suelo de España) Versión 0.2. Equipo Técnico Nacional Proyecto SIOSE. S.G. de Producción Cartográfica, Instituto Geográfico Nacional, 2007.

Modelo de datos SIOSE versión 1.12 – Estructura básica (diagrama UML). Equipo Técnico Nacional Proyecto SIOSE. S.G. de Producción Cartográfica, Instituto Geográfico Nacional, 2007.

Modelo de datos SIOSE versión 1.12 – Coberturas simples (diagrama UML) . Equipo Técnico Nacional Proyecto SIOSE. S.G. de Producción Cartográfica, Instituto Geográfico Nacional, 2007.

Modelo de datos SIOSE versión 1.12 – Coberturas Compuestas (diagrama UML) Equipo Técnico Nacional Proyecto SIOSE. S.G. de Producción Cartográfica, Instituto Geográfico Nacional, 2007.

