

High Resolution Land cover/Land use Information System in Spain (HR SIOSE)

Technical Document

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ABBREVIATIONS

Abbreviations	Definitions
BTN25	Base de datos Topográfica Nacional del IGN a escala 1:25.000 / National Topographic Database 1:25.000
CNIG	Centro Nacional de Información Geográfica / National Centre on Geographic Information
CODIIGE	Consejo Directivo de la Infraestructura de Información Geográfica en España / Board of Directors of the Infrastructure of Geographic Information in Spain
EAGLE	EIONET Action Group on Land monitoring in Europe
EEA	European Environment Agency
HILUCS	Hierarchical INSPIRE Land Use Classification System
HR SIOSE	Sistema de Información de Ocupación del Suelo en España de Alta Resolución / High Resolution Land Cover and Land Use Information System in Spain
IGN	Instituto Geográfico Nacional / National Geographic Institute
INSPIRE	Infrastructure for Spatial Information in Europe
LiDAR	Laser Imaging Detection and Ranging
MFE	Mapa Forestal de España / National Forest Map
PNOA	Plan Nacional de Ortofotografía Aérea / National Plan on Aerial Orthophotography
PNOT	Plan Nacional de Observación del Territorio / National Programme of Earth Observation
SIGPAC	Sistema de Información Geográfica de parcelas agrícolas / Land Parcel Information System (LPIS)
SIOSE	Sistema de Información de Ocupación del Suelo en España / Land Cover and Land Use Information System in Spain

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1. INTRODUCTION

The National Geographic Institute and the National Centre of Geographic Information Spain (IGN-CNIG), organisations both dependent on the Ministry of Transport, Mobility and Urban Agenda, constitute the EIONET National Reference Centres on Land Cover and Land Use & Spatial planning (NRC LC and NRC LUSP) whose main objective is to cooperate with the EEA and European bodies in coordinating and advising on the preparation and dissemination information on land cover and land use. Therefore, the IGN-CNIG is responsible for the production and coordination of information on land cover and land use in Spain and its dissemination throughout the European EIONET network.

The SIOSE project (www.siose.es), is under the frame of the National Programme of Earth Observation (PNOT) establishing a reference geospatial information infrastructure for multidisciplinary use and periodically updated in a cooperative and decentralized way between National and Regional public administrations, which also includes the National Plan of Aerial Orthophotography (PNOA) and the National Plan of Remote Sensing.

SIOSE began at the end of 2004 and four versions have been conducted corresponding to the reference years 2005, 2009, 2011 and 2014 and executed in coordination between by the Regional Administrations and the IGN-CNIG as technical manager of the project.

Next to the production of SIOSE 2014, a new land cover/land use information system began, built by the integration of Spanish official geospatial sources with high geometric, semantic, and temporal detail. This is known as the High Resolution SIOSE (HR SIOSE), and two versions have been produced for the reference years 2014 and 2017.

This new information system, HR SIOSE, beside the traditional SIOSE:

- Pursues to be contributory for the United Nations Sustainable Development Goals in relation to geospatial information and be in line with the principles of the United Nations Committee on Global Geospatial Information Management.
- Contributes to the Copernicus program as national reference information on land cover/ land use to produce or validate Land Monitoring Service products and has been a key element to produce the CORINE Land Cover database which, since the 2012 version, is obtained by geometric and thematic generalization of national data.
- Participates with experience and data to the new philosophy in development by the Land Monitoring Service of the CORINE Land Cover Plus project
- Has contributed from its beginning to meet the demands for information and knowledge required by the EIONET Network and offers the opportunity to actively collaborate in the definition of European products, transmitting the needs and particularities of the Spanish territory.
- SIOSE data ensure INSPIRE compliance and is currently served through web services for viewing and downloading data in accordance with the INSPIRE Directive specifications of land cover and land use themes.
- Ensure available national land cover and land use information for Directives 2003/4/CE and 2003/35/CE about public access to environment information and Directive 2019/1024 for open data and re-use of public sector information
- Fulfil with the IGN–CNIG competences in generation of land cover/land use information.
- Collection and integration of official data sources from National and Regional Administrations, making them participative in the project definition and production, to avoid data duplicities and reduce cost production.

2. ORGANIZATION OF SIOSE

The organization of the HR SIOSE project is based on the involvement of the Public Administrations as the main users of the information on land cover and land use. For this reason, the IGN-CNIG, as the EIONET National Reference Centres on Land cover and Land use and Spatial planning has assumed the project management with the support of the Board of Directors of the Infrastructure of Geographic Information (CODIIGE), throughout its Thematic Working group on Land cover / Land use where diverse thematic experts met. The production of HR SIOSE is shared with the Regional Administrations which have a coordinator responsible of regional management of the project.

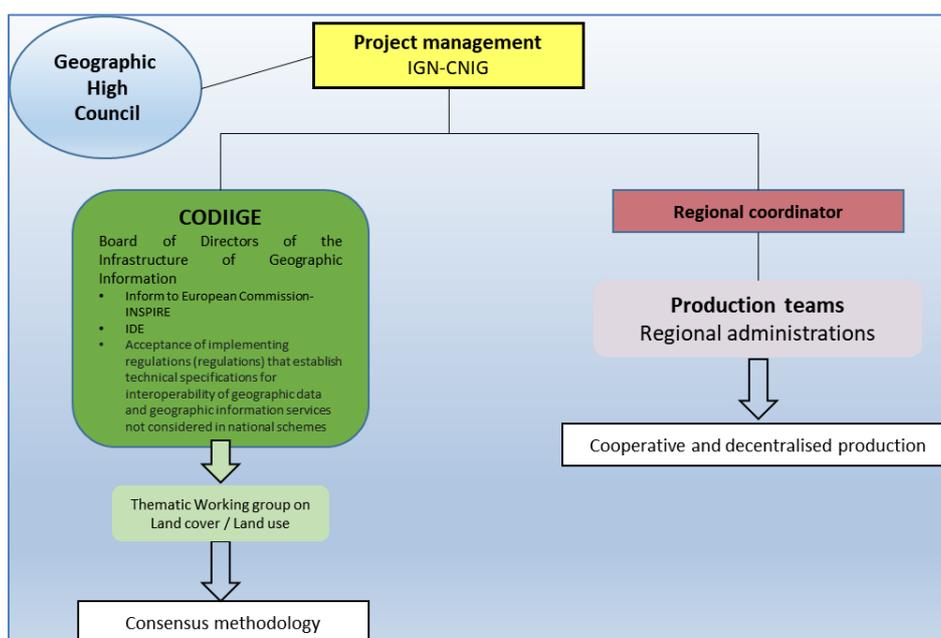


Figure 1. Organizational model of SIOSE project

3. HIGH RESOLUTION SIOSE (HR SIOSE)

After several versions of SIOSE and considering the new needs of the main regional, national, and international users demanding data with higher geometric, thematic, and temporal detail, since 2016 a new production strategy has been developed prioritizing the reference data integration over the manual photointerpretation. This strategy has been called High Resolution SIOSE, and its main objective is the integration, harmonization, and homogenization of official sources to continue being a benchmark product on land cover and land use in Spain.

For the evolution of SIOSE project, it is important to highlight the key role of the European Commission through the Copernicus Program as user of land cover/land use data. The new CORINE Land Cover (CLC +) requires a high-level detail information for land cover and use, defining a minimum mapping unit of 0.5 ha in vector format and 10m pixel size in raster format, with an inferred equivalent scale close to 1:10.000. The Member States

will collaborate with the CLC + by providing official national data on all land cover and use domains, which will be used for the improvement of the continental product and for its validation.

To contribute to this European requirement, Spain needed a high-detail product that integrates official data on all land cover and use domains in a coherent manner. The traditional SIOSE at 1:25.000 scale became insufficient, and it was necessary to establish a more detailed SIOSE, able to integrate official 1:5000 and higher scales information and being consistent with the land parcel information of the Spanish cadastre.

Additionally, HR SIOSE takes also into account the Copernicus and other European policies and directives requirements regarding harmonization and interoperability of pan-European land cover and use data.

In detail, HR SIOSE looks for:

- Generated through integration of reference information, instead of photointerpretation.
- Reach the highest possible geometric and thematic resolution depending on the data sources used.
- Achieved by a remarkably high automatic component that enables objectivity, massive processing, cost reduction and higher update frequencies.
- Offer a complete and continuous result of all aspects of land cover and use domains (artificial areas, crops, vegetation, ...).
- Provide added value in the use of integrated data sources without modifying them.

3.1 Production model and data capture

As integrated in PNOT, HR SIOSE maintains a cooperative production model between the Project management and the rest of participants, especially the Regional Administrations production teams.

Unlike what happened in the production of traditional SIOSE, in which the regions participated from the beginning making a photointerpretation of reference images, within HR SIOSE production, priority is given to the re-use of actual available official information.

The first phase (integration of the different reference sources) is conducted by the Project management to assure homogeneity as much as possible. The result is a product obtained in a completely automatically way, is subsequently reviewed in a second phase by the regional teams, focusing on specific and functional aspects agreed upon with the project management.



Figure 2. Main production scheme diagram

3.1.1 First phase (automatic phase)

In this phase, to assure homogeneity, the integration of the reference sources by the Project is done. Consists of a serial of processes whose result is a basic scheme with geometries from official sources, with high geometrical and thematic detail in their respective areas of competence.

The **fundamental geometric source of reference** chosen is the Cadastre, which provide the delimitation of parcels and buildings. The cadastral parcels can be subdivided internally according to other agricultural or natural reference geometries.

As **fundamental thematic sources of reference** information there are three different areas:

- Urban areas: Cadastre, Reference Geographic Information from the IGN and information derived from Earth observation (for example, LiDAR for buildings).
- Agricultural areas: Land Parcel Identification System/ (LPIS), Geospatial Aid Application (GSAA) the CAP farmers' declarations and information derived from Earth observation.
- Natural areas: LPIS, National Forest Map and information derived from Earth observation (for example, LiDAR for vegetation).

As additional geometric or thematic sources can also be found:

- Official land cover and land use products of the Regional Administrations
- Previous versions of SIOSE
- National Topographic Database 1:25.000
- Reference Geographic Information from the IGN on Transport, Settlements and Hydrography.
- Products of the Copernicus Land Monitoring Service
- Other official inventories, topographical or thematic bases if deemed appropriate

3.1.2 Second phase (visual revision)

This visual review is done by the Regional Administrations based in a photointerpretation on reference images and on information from other data sources not previously considered to improve the previous automatic result.

The revision done is focused on specific aspects already identified as automatic mistakes or lack of precision in the data in previous phases.

It is considered essential and necessary that this participation of the Regional Administrations should be done through a collaborative participation system in which the editors can act on the data in a continuous, online, and shared manner. For this reason, a web editing platform for HR SIOSE has been designed to facilitate and guide the editing of the product. The platform enables online work directly from the source data in a structured and collaborative way, without file exchanges and accessible at any time and with no proprietary software required.

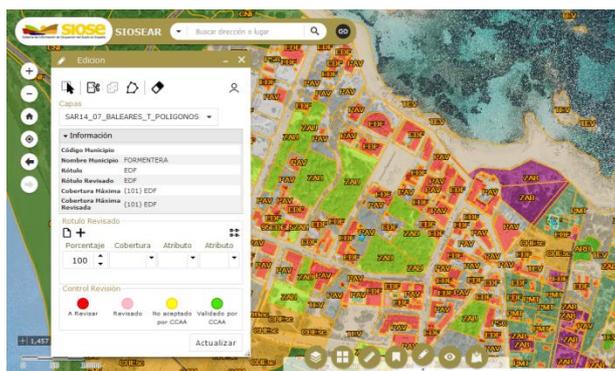


Figure 3. Online interface of the HR SIOSE revision tool.

The revision and edition by the Regional Administrations with the web platform include:

- Geometric edition of SIOSE polygons: Involves the modification and digitization of the SIOSE polygons, by cutting and joining polygons, based on reference information and higher resolution images (PNOA and/or others).
- Thematic edition: Assignment or reassignment of class codes by photointerpretation in each digitized SIOSE polygon.

3.2 Data structure and content

SIOSE data model describes the geographical elements of land cover and land use, as objects with attributes, relationships, and consistency rules. It is an application model in terms defined by ISO 19101 (Geographic Information - Reference Model) and ISO 19109 (Geographic Information - Rules for Application Schema).

The particularity of the SIOSE data model is the way of understanding the land cover and use elements: it follows an object-oriented philosophy, where each type of element is considered an object able to represent the land with characteristics and relationships with other element types.

The characteristics of the SIOSE data model are:

- The working unit is the polygon, geometry entity of the model
- Associated with the polygon, the thematic information on land cover and land use is defined. There is a catalogue of types of land covers and land uses.
- Within each homogeneous polygon, it is possible to identify different land covers and land uses, measurable by a percentage value (%).
- Land cover can be characterized by attributes. There is a catalogue of attributes assignable to classes.

The **SIOSE AR data model** represents an evolution of the traditional data model of SIOSE, which continues with the philosophy of object orientation to describe the territory but adjusted to the information integrated from the reference sources. The modifications made to the model ensure maximum continuation in the definition of the classes of land cover and land use. Another motivating aspect for the modifications in the data model was the need for harmonization to serve the main international demands, such as INSPIRE and Copernicus.

There are two polygon layers, one for land cover (called T_POLIGONOS) and a layer for land use (called T_USOS). Both layers are conformed to each other. T_USOS

corresponds to the cadastral parcels, while T_POLIGONOS are interior geometries to the cadastral parcels that delimit different land cover areas.

Within each polygon of land cover or land use, additional thematic presences can be identified, measurable through a percentage value (%). The presences of land cover inside a polygon must always occupy 100% and are collected in a separate table (called T_VALORES) related to polygons with a multiplicity of 1 ... *, while the presences of land uses may occupy different values other than 100% and are collected in a separate table (called T_USOS_MULTIPLES) related to multiplicity 1 ... *.



Figure 4. Left: Land use geometries corresponding to cadastral parcels (black lines) with different inner land cover geometries (coloured). Right: Land use geometries with different types (coloured)

3.3 Geodetic reference system

In application of Royal Decree 1071/2007, of July 27, which regulates the official geodetic reference system in Spain, the official geodetic reference systems used for HR SIOSE:

- In the area of the Iberian Peninsula and the Balearic Islands, is used the European Terrestrial Reference System 1989 – ETRS89 (European Terrestrial Reference System 1989).
- In the case of the Canary Islands, the REGCAN95 (REGENTE – CANARIAS) reference system is used.

The chosen representation system is the Universal Transverse Mercator Projection (UTM) in zones 28, 29, 30 and 31, depending on each Autonomous Community. EPSG Codes: Peninsula and Balearic Islands (25829, 25830 and 25831), Canary Islands (32628).

3.4 Data maintenance

The traditional SIOSE offered a land cover and land use database for the whole of Spain at 1:25.000 scale with reference dates of 2005, 2009, 2011 and 2014, whose update frequency is 3 years. These update periods correspond with the availability of orthophotographs of the entire national territory through the National Plan for Aerial Orthophotography, which provides renewed images every 3 years. In addition, this three-year period also fits in with the demands for national information on land cover and land use by the Copernicus Program, which requests data for the production and verification of CORINE Land Cover or High-Resolution Layers products.

This time range for updating, defined in traditional SIOSE, is maintained for the HR SIOSE.

The methodology for updating the HR SIOSE must reflect the procedures for its generation. It will have an automatic reference source integration component, plus a visual review to improve results.

Updates will focus on changed areas identified in the reference sources, respecting the work that has been done in the visual review of previous versions.

3.5 Data quality

SIOSE datasets are subject to exhaustive control to ensure their quality. These controls are intrinsic to the production of the data, through the specifications agreed between the project management and the production teams, as well as the managed SIOSE work tools that prevent the occurrence of different errors.

The regional production teams must ensure the geometric, topological, and thematic quality of the data produced.

On the other hand, the Project management conducts a monitoring of production and external quality control where the aforementioned aspects will be considered, as well as the complete compliance with the specifications of the SIOSE data.

3.6 HR SIOSE data distribution

Digital geographic files generated by the IGN, including SIOSE datasets, can be downloaded free of charge from the CNIG Download Centre, as long as these files are accessible and reusable as established in Order FOM/2807/2015, which approves the policy of public dissemination of geographic information generated by the IGN. Order FOM/2807/2015 specifies a use license, compatible with CC-BY 4.0. This license covers the free use for any legitimate purpose being the only obligation to recognize and mention the origin and ownership of the geographic information products and services licensed as IGN.

The SIOSE datasets are accessible from the 'thematic geographic information' product tab, downloadable in a compressed manner subdivided territorially by regions and reference year.

The SIOSE data is in OGC GeoPackage and ESRI File Geodatabase format, with original project information, as well as pre-calculated derived thematic outputs focused on the main user applications.



Figure 5. Icon for SIOSE AR download at the Download Centre of CNIG

Access to CNIG Download Centre: <http://centrodedescargas.cnig.es>

To request versions of SIOSE not present in the Download Centre or other products, contact: siose@mitma.es

Additionally, there are also available different webservices publishing SIOSE data.

CSW: <http://www.idee.es/csw-inspire-idee/>

WMS and WMTS (newest completed versions)

WMS: <http://servicios.idee.es/wms-inspire/ocupacion-suelo>

WMTS: <http://servicios.idee.es/wmts/ocupacion-suelo>

WMS (older versions): <http://servicios.idee.es/wms-inspire/ocupacion-suelo-historico>

WFS (newest completed version): <http://servicios.idee.es/wfs-inspire/ocupacion-suelo>

3.7 Metadata

SIOSE metadata are adapted to the international metadata standard ISO19115-1, in accordance with the Guidelines defined from Europe by the INSPIRE Directive and in its normative development on metadata (Regulation (EC) No. 1205/2008 in what refers to metadata and Regulation (EU) No. 1089/2010 regarding the interoperability of spatial data sets and services) and takes into account the recommendations defined by the Metadata Technical Group of the Board of Directors of the Infrastructure of Geographic Information (CODIIGE) in terms of metadata at the Spanish level.

Metadata are provided for each data set (versions) of the SIOSE series.