HOW TO DEAL WITH TERRESTRIAL AND OCEANIC INFORMATION USING SDI TECHNOLOGIES

Antonio F. Rodríguez Pascual[1], José Luis Sanz Alonso[2], José Ángel Alonso Jiménez[1], Paloma Abad Power[1], Alejandra Sánchez Maganto[1], Luis Manuel Vilches Blázquez[1], Juan Emilio Ayuso[1]

[1]: Instituto Geográfico Nacional, Madrid, Spain
[2]: Instituto Español de Oceanografia, Madrid, Spain

ABSTRACT

A Spatial Data Infrastructure (SDI) is a computer system integrated by a group of resources (catalogues, servers, programs, data, applications, web pages …) for managing Geographic Information, i.e. maps, ortophotos, satellite images, geographical names. It's available in Internet and complies with interoperability rules, allowing the user free access to information provided by different organisms and, also, the overlapping of this data.

The Spatial Data Infrastructure of Spain (IDEE for Infraestructura de Datos Espaciales de España) is an initiative integrating data, metadata and geographical information produced in Spain by a wide set of data producers, which enables data discovering, viewing, and sometimes analyzing and downloading.

SPATIAL DATA INFRASTRUCTURE, INSPIRE, IDEE, OPEN GEOSPATIAL CONSORTIUM, INTEROPERABILITY.

Summary

The main points of this paper on Spanish NSDI (IDEE) are the following: the need for geographic data harmonisation and standardization; SDI technology as a solution; the state of play of IDEE Geoportal; new ways of producing harmonized geographic data; level of use in operational practice; and future lines of development

On June of 2004 the IDEE geoportal was officially opened as the access point to the resources provided by a community of organisms and institutions from the three levels of government in Spain (national, regional and local). Several services were offered from the beginning:

- Geodata catalogue. Interface to look for the available geographic datasets at a given scale, about a specific topic,…
- Web Map Service (WMS). It provides visual access to a set of spatial data (graphical and alphanumeric) which can subsequently be overlapped on the users´ screen. Therefore integration of datasets with different thematic content can be addressed at the users´ side.
- Gazetteer Service (Gaz). This service provides searching facilities for geographic names stored in a data base with more than 350.000 records.
- Web Feature Service (WFS). It allows to download several information layers in GML format.

- Web Coverage Service (WCS). To download and analyze raster and grid data. An application analyze the DTM data in the scope of visualization and obtain the highest altitude, the lowest altitude and the average value.

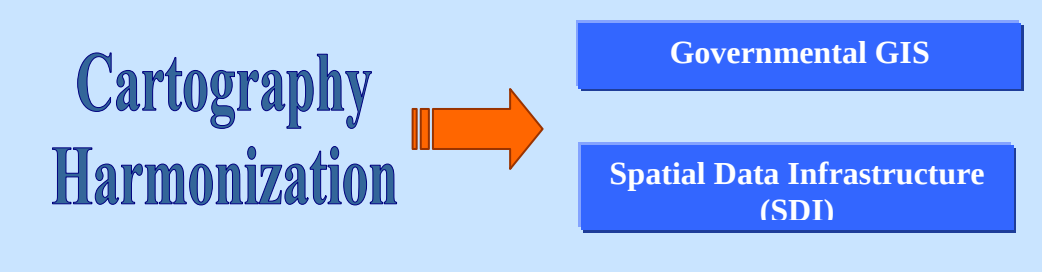
In Europe, an initiative to implement an European SDI, taking into account both public and private actors, is under development. All began at the end of 2002, when the European Commission adopted an initiative to establish the legal frame for the creation of an Infrastructure of Spatial Data in the European Community (INSPIRE). Among the spatial data themes considered, "Oceanographic geographical features" and "Sea regions" can be found.

This paper shows several implemented examples related with this topic, points out some of the existing problems related to GIS management of oceanic information, e.g: location of hydronyms, the definition of the coastline, Spatial Reference Systems, and analyses the great opportunities that this SDI technology offer to oceanographic information management.

Harmonisation in Spain.

Today official and private cartography is used by public, private sectors and citizens with different aims. Managing cartography from different data producers implies complex processes to transform and harmonize it.

In order to solve the harmonisation and standardization problem, governments have two solutions. On the one hand, it's possible to collect all the cartographical information in a governmental GIS, performing harmonisation processes to assure data integration and homogeneity in order to supply GI ready to be used by final-users in their own systems. This is quite a complex process, almost impossible, at least when different governmental levels have the competence on cartographical data. On the other hand, it's possible to define a Spatial Data Infrastructure at National level (NSDI) as a collaborative project based on cooperation and agreement among different actors: national, regional and local governments, universities, companies, and also individual citizens, opening geoportals that publish and shares OGC services and complementary resources.



The NSDI Geoportal needs to be a key resource and an effective leverage for: giving visibility to all available SDI implementations; contributing to the creation of a healthy competitiveness; stimulating technological innovation on this area showing the new developments in each geoportal and node, as a sort of on-line demonstration; taking

advantage of the official corporative image from the main actors at every governmental level.

In conclusion, the main goal of a SDI is setting up a true GIS on the Internet, fully distributed, offering services and functionality based on the interoperability of standardized resources spread over the Net.

In Spain, the solution adopted to harmonize GI has been the implementation of a NSDI.

IDEE project (Spanish NSDI)

The Spanish NSDI is a SDI composed of many SDIs. The reason is the three levels of Government we have. Regions need to set up their own regional SDI and geoportal giving access to data and service servers at Regional Departments, Local Authorities, public and private companies, and Academia in the context of regional territory. At national level some Ministries, Public and Private companies, also need to set up Internet data servers, metadata catalogues, and GI web services.

The National Geographical High Council ("*Consejo Superior Geográfico*") is the governmental collegiate body appropriate as Public Authority in Spain to define and set up the NSDI (in Spanish: IDEE for Infraestructura de Datos Espaciales de España) and its national Geoportal, harmonizing existing initiatives. This is an advisory collegiate body of the Ministry of Public Works, which technical secretariat is held by National Geographic Institute, and whose members are representatives from the three government levels in Spain. It was established by Art. 9 Law 7/86 for Cartography in Spain and its rules are defined by the Royal Decree 1792/1999.
Its members are:

- President: SubSecretary of the Ministry of Public Works
- First VicePresident: Director General of National Geographic Institute
- Second VicePresident: Director of Hydrographic Institute of Army
- Representatives from Ministries: Foreign Affaires, Public Administration, Economy & Finances (Cadastre, National Statistical Institute), Environment, Agriculture, Interior (State Civil Defence Office), Defence, Education.
- 17 Representatives from every Regional Government
- 2 Representatives from Spanish Federation of Provinces and Municipalities (Local Authorities)

On April 2002 the National Geographical High Council (NGHC) committed to its Geomatic Commission as Executive Board the definition and setting up of the NSDI (IDEE).

The Commission on Geomatics is working through a Working Group established on November 2002, and reporting and advising to the NGHC. Working Group´s members are technical experts representing NGHC members: geographic data producers, academia and companies dealing with catalogue and data services. It is open to all relevant actors actually involved in the process and having some activity in this field: data producers, software companies, universities, governmental bodies, up to more than 180 individual members. Its main objective is to develop a Spanish project joining initiatives in a decentralised and transparent framework, based on data harmonisation

and interoperability. The Working Group is developing IDEE under the INSPIRE principles and rules. IDEE WG holds three meetings per year and one technical workshop, and develops recommendations based on electronic revisions and consensus:

- Procedure for the definition of recommendations.
- Minimum services to be implemented in a SDI
- Spanish Metadata Core of ISO19115 (NEM)
- Spanish Model for Gazetteer (MNE).
- How to implement WMS.

All of them are available at www.idee.es.

Each actor integrating resources in IDEE must afford the required resources by its own. The National Geoportal is funded by the Spanish Government using the National Geographic Institute (IGN-E) budget (State General Budget). The IGN-E has made a collaboration agreement with the University of Zaragoza to develop the software running in the National Geoportal, and other complementary collaboration agreement with other Spanish universities.

At the National Governmental level the main agencies that deal with GI production, as IGN-E, Ministry of Environment, Cadastre and Defence, are funding their own IDEE nodes or portals. Regional SDIs are funded by Regional Governments. That is the situation at the Regional Governments of Cataluña, Aragón, La Rioja, Navarra, Basque Country, Cantabria, Asturias, Galicia, Castilla y León, Castilla-La Mancha, Valencia, Murcia, Andalucía and Extremadura. Every day more than 100 Local Authorities are developing and funding Local SDIs.

Geoportal

The IDEE Geoportal was opened on December 2003 as a provisional beta version, the first version appeared on July 2004, and the second version with a new interface dates from 2005. Today it is available in 7 languages (Spanish, English, Basque, Galician, Catalan, Portuguese and French) and implements 8 different OGC services (WMS, CSW, Gaz, WMC, WFS, WCS, SLD and WCTS)

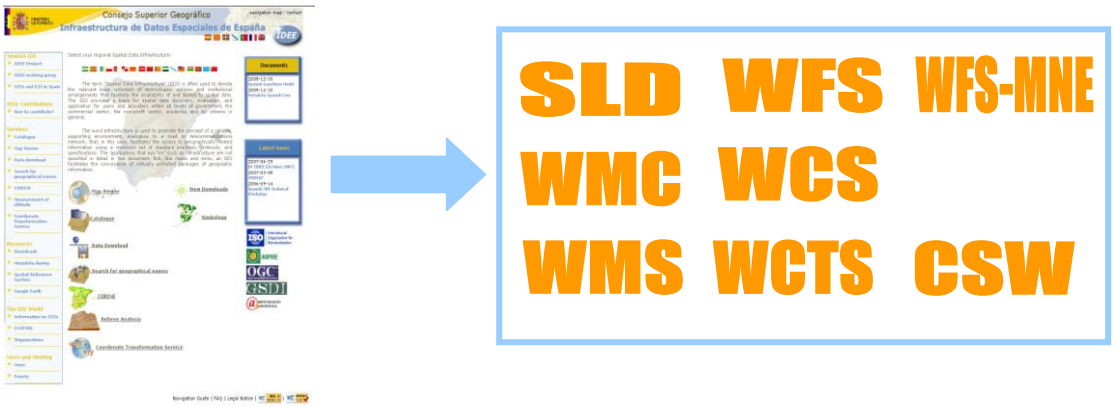


Figure 1: The IDEE Geoportal and its Services

Main characteristics of the services and application of the Geoportal are:

- **Gazetteer:** This service is based on a database of more than 400,000 geonames, and is implemented as a WFS using the Spanish Gazetteer Model (MNE), a conceptual model for geonames defined by WG IDEE including some key attributes (language, source and etymology), and allowing several names for the same feature.

- **Map Viewer:** This application access directly to more than 90 WMS services coming from all over Spain offering more than 1,000 layers, classified as reference data at the three levels of government (National, Regional and Local), thematic data and other not official data, following the INSPIRE annexes classification.

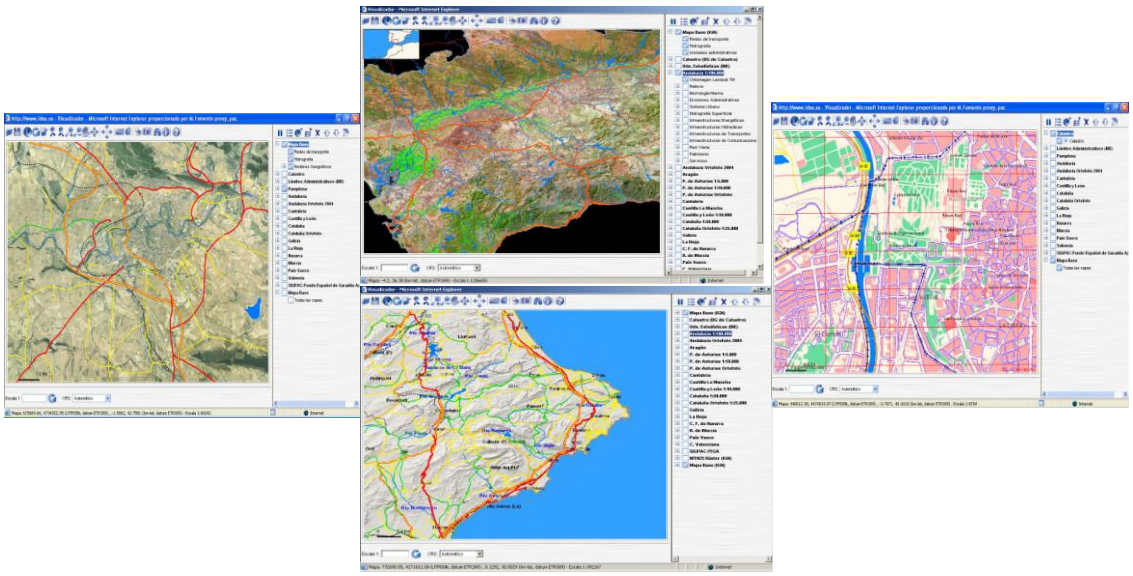


Figure 2: Examples of the Map Viewer

- **Catalogue:** This service allows searching and selecting in a metadata database describing more than 40,000 datasets produced by IGN and the Catalonia Cartographic Institute. IDEE is now fostering a project to create a distributed catalogue doing harvesting of XML files via FTP collection, as a first tentative solution to distributed catalogue.

- **Data Download:** It enables to freely download some general and basic reference data in GML format: Administrative Boundaries of Spain at three scales, Geodetic Networks and a Euroglobal Map Data Base at 1:1,000,000.

There are also two simple examples of **remote analysis**: a Corine-Land Cover analysis utility, based on WFS and offering a statistics about land uses in each municipality; and a DTM analysis application, based on WCS, allowing the calculation of maximum, minimum and average height of an area.

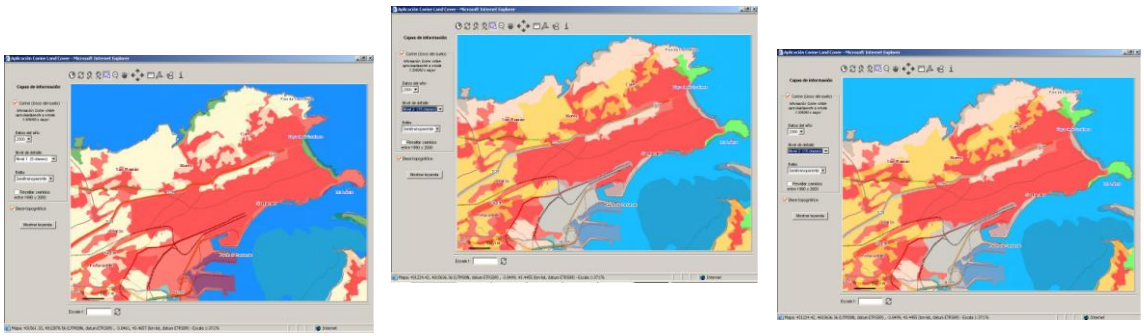


Figure 4: Examples of Corine Aplication

- A **Relieve Analysis** [Fig 5]: This utility uses DTM 1:200.000 and 1:25.000 to provide analysis of altitudes, slopes and orientations of the screened area.

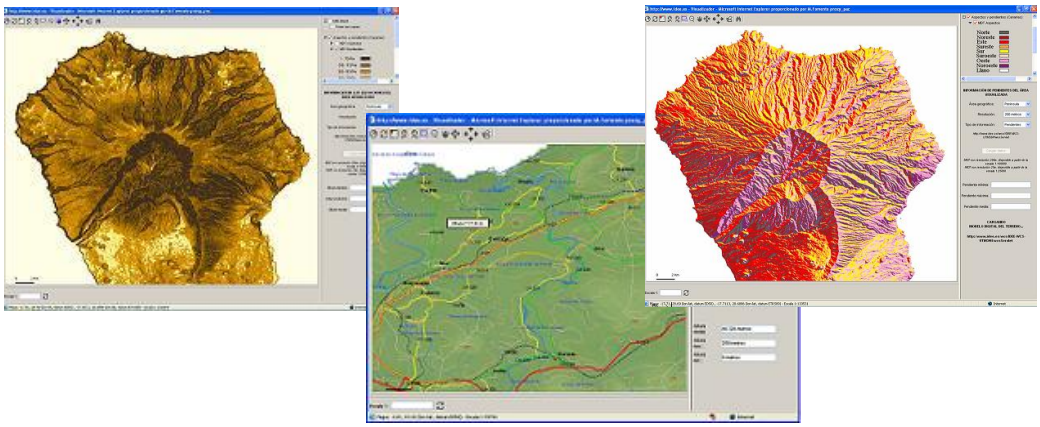


Figure 5: Examples of relieve analysis

- A set of software tools are available as **freeware**: a simple OGC conformant client application for access to WMS and Gazetteer services from PDA; the IGN-CNIG 2D/3D Viewer, a thick OGC client to perform virtual flight over a cartography served as WMS and using a DTM obtained via WCS; a simple light WMS viewer to be inlaid in a web page.

- Two **Free Software** application: CatMDEdit for metadata capture, multiplatform, with multilingual support, thesaurus facilities, ISO 19115 compliant interface and XML export facilities; and a Toponomy Editor to graphically edit geonames according to MNE and using WMS services.

- **A Directory of Services** is available showing a link to the information of the Capabilities about OGC services available in Spain, and the address to bind them.

The production of harmonised cartographic data in this new framework

As a consequence of the existing Spanish SDI, there is a new cooperative way of producing harmonised GI in Spain. IDEE WG data harmonisation effort is concentrated

on the Reference Information (INSPIRE Annexes I & II): trying to get harmonised national coverage among the three government levels (National, Regional, Local): harmonizing data specification for data production among them; agreeing to jointly produce and share GI.

As an example on that, the three levels of government are looking for agreement:

•To move the Geodetic Reference System from ED50 to ETRS89, according the INSPIRE rules.
•To set up the National Gazetteer, working together IGN-E (National Mapping Agency), Ministry for Public Administrations, INE (National Statistical Institute) and Regional Mapping Agencies.
•To improve High Resolution Administrative Boundaries working together Regional Mapping Agencies, Regional Departments dealing with the juridical definition of administrative boundaries, IGN-E, Ministry for Public Administrations.
•To work in close cooperation between the National and Regional Governmental GI producers Agencies to set up:

- Aerial Orthophotography National Plan (PNOA) funded by National (68%) and Regional government (32%), to produce a national ortophoto coverage 50, 25 and 10 cm resolution, depending on the area, each two years, to be published as a free, open WMS.
- Land Cover & Use System 1/25,000.
- Harmonized Topographic Database (BTA), as a harmonized by consensus Data Product Specifications for topographic regional DB at 1:5,000 and 1:10,000 scales, compatible with national DB at 1:25,000 scale.
- CartoCiudad, the official street and road database build harmonizing cartography from IGN, Cadastre, Statistical Office and Mail Authority, published using OGC services. The plan includes: to cover main urban areas this year, 76% of total population; and to get full coverage in 2009.

Figure 6: CartoCiudad Project

The new SDI node of the Spanish Oceanographic Institute

The Spanish Oceanographic Institute is presently facing a huge challenge, the development of a SDI with geographic information about marine areas.

This implementation of a SDI about marine areas is very difficult because only with the present status of technology has been possible to know fairly accurately the geographical position and seafloor topography.

Besides there are different institutions producing lots of information about sea zones but, unfortunately, the working methodology and objectives of studies are different in each of them. Some times data collections are slightly standardized, uses different scales and are oriented to performed studies focused on different areas or scopes (searching of areas to pull out sands for coast regeneration, studies on beach stability, etc.). No standardisation process has been adopted for collection, management and organisation of information, this point can have relevant consequences in the future.

For this reason the collected information does not have spatial, temporal or classes continuity, and therefore studies and research results on the same fields are usually hard to correlate when performed by different actors. Objectives are also different, as well as the precision on data collecting, the scale of analysis, the meaning or the interpretation of the same elements. In consequence it is difficult to develop metadata elements.

Therefore, in most cases gathered information should be synthesized and filtered, and even reinterpreted to be organized with homogeneous criteria and similar quality.

This work has been carried out by Spanish Oceanographic Institute for the last years. The result has been the setting-up of a WMS of marine information with around twenty different layers.

Information available in this WMS is related to bathymetry, nature of the seabed, administrative, legal and marine limits, bionomy, fishing areas (shoals), artificial reefs, proposed Protected Marine Areas, marine bioregions and other environmental parameters (areas of cetaceans and marine turtles, etc.)

Future lines

Web Processing Services (WPS) implementation, according to OGC specification, well defined pieces of software, easy to be bound and chained to make possible to have a real virtual GIS implemented in Internet with some kind of toolbox. We want to show that is possible a remote analysis combining standard resources from different systems. We are planning to develop services providing: shortest way between two addresses; nearest point of interest from an address; areas of influence around an address; generation of buffers from a point, a line or a surface; overlay and reclassification of surface layers; and others.

Geolinked Data Access Service (GDAS) and GeoLinking Service (GLS) implementation, to make possible the on-line effective linkage between thematic and surface datasets logically related to generate maps and diagrams on the fly. IGN and

UNIZAR are participating in an OGC experiment to improve and make usable those two specifications.

Practical and usable implementations of some complementary OGC specifications as Style Layer Descriptor and Filter Encoding.

One of the main points of innovation of this project consists of having actual cooperation between different parties as: three levels of government in Spain (National, Regional and Local), universities, private companies and we hope to get citizens publishing their own maps and Point of Interest (POI) in the future. We also expect to develop services focused on sea information as the WMS of the Spanish Oceanographic Institute.

Coastal and marine information problems

There are some specific problems related to coastal and marine geographic data management, that makes difficult to extend the are covered for SDI implementations to include sea regions. Some of them are:

- The definition of the coastline, is the most evident problem to be solved when trying to merge in the same system sea and land geographic data. The border between the two worlds is not sharply defined, it is a specially fuzzy feature and there are different coastlines defined according to different criteria. In this topic, SDI approach offers the opportunity of publishing on the net the different definitions of coastline to make evident the differences, problems and inconsistencies existing.

- Some terrestrial Spatial Reference Systems (SRS), are not applicable to marine regions. European Datum 50 is not applicable nor usable at all, the most usual projections (e.g.: UTM) are not very practical, and as far as a global datum is required (WGS84), and latitude, longitude is the most sensible coordinates system, the problem is the transformation of all the geographic data describing the land area of interest to this SRS to have a continuous solution.

- Location of hydronyms and other phenomenon. Geographic Identifiers based on Administrative or Statistical Units, like NUTS, or in the tile division of map series, are very useful and widely used to have a georeference of geographical names or any kind of Point Of Interest (POI). It's not easy to extend this kind of Geographic Identifiers Systems to sea and coastal regions.

- Vector models, based on features with a well defined geometry, despite are the more implemented and used in practice, doesn't fit very well to the description of a continuous reality like the sea. Sometimes it would be more appropriate to use raster models and to manage data coverages to better represent marine information.

- The wide diversity of data sources, scales and conceptual models and the strong fractal and fuzzy character of coastal and marine related data, cause a high level of heterogeneity in the data of interest.

INSPIRE

The recently approved Directive INSPIRE defines the principles and methodology for implementing an European SDI based on existing National SDIs. INSPIRE annexes defines reference data themes (Annexes I and II), and thematic data (Annex III), including at least four themes containing information directly related to coast, sea and oceans:

- Hydrography (Annex I), covering hydrographic elements, including marine areas.
- Elevation (Annex II), including Digital Elevation Models for ocean surface, bathymetry and shoreline.
- Oceanographic geographical features (Annex III), physical conditions of oceans (currents, salinity, wave heights, etc.).
- Sea regions (Annex III), considering seas and saline water bodies divided into regions and sub-regions with common characteristics.

There are specific data specification to be defined in the framework of Implementing Rules for each one of the INSPIRE themes, and all the initiatives related to each one of the INSPIRE themes need to be coordinated in each member state. In particular, regarding oceanic data and the INSPIRE themes mentioned above, it is necessary that all data producers and relevant actors of a country playing a role in oceanic data process and management, creates some kind of joint working group to harmonize, coordinate and promote the implementation of OGC services and Geoportals to be integrated in an SDI.

Conclusions

Spanish SDI initiatives about land data has reached a very high level of development and outreach, but it is necessary to make an effort to extend SDI paradigm to marine and coastal information.

There are a set of problems to be solved related to the management of geographic sea related data, but SDI technologies brings great opportunities to point out those problems, to make them evident and to have tools to manage them.

It’s time to make land and sea data more interoperable, to extend SDI implementations to sea, oceans and coastal areas. One of the lessons learnt from the quick development of Spanish NSDI is that some kind of bottom up approach, based on a good spirit of cooperation and on the implementation of how many OGC services as possible, is a good way to produce results in the short time and push the overall process of implementing and exploit Spatial Data Infrastructures.