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IDE-OTALEX C. The First Crossborder SDI between Portugal and Spain: Background and Development

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Abstract: IDE-OTALEX is the first crossborder spatial data infrastructure between contiguous Portuguese (Alentejo and Centro) and Spanish (Extremadura) regions. It was implemented to share official geographic information from Alentejo and Extremadura, and now Centro region, with everyone. This is the most effective way to have a distributed and flexible system to be used as a territorial observatory for sustainable development and environment protection in these rural and low populated regions. It also contributes to territorial cohesion, one of the tree main pillars of European Cohesion Policy. It's characterized for being a distributed, decentralized, modular and collaborative system, based on standards OGC (Open Geospatial Consortium), W3C (World Wide Web Consortium), ISO (International Organization for Standardization) and open source technology, developed to guarantee interoperability between the different GIS (Geographic Information System) provided by each project partner. The geoportal is multilingual (Portuguese, Spanish and English) and integrates a Map viewer, Metadata Catalogue and Gazetteer. It consists in central and local nodes which communicate through WMS (Web Map Services), CSW (Catalogue Service Web) and WFS (Web Feature Services). It is now implementing SOS (Sensor Observation Services) and WPS (Web Map Processing). The geographic information available results of an extensive work of data harmonisation adapted to INSPIRE Directive (D 2007/2/EC, the European Parliament and Council, March 14, 2007). It integrates basic cartography, socio-economic, territorial and environmental indicators.

Key words: Spatial data infrastructure, IDE-OTALEX, Alentejo-Centro-Extremadura, EuroACE, crossborder cooperation, Spain-Portugal, indicators, sustainability.

1. Introduction

OTALEX C is the Territorial and Environmental Observatory of the crossborder region composed by Alentejo and Centro regions of Portugal and Extremadura region of Spain. It was build up on the close cooperation between several Portuguese and Spanish entities of Alentejo and Extremadura regions who collaborates in the fields of landscape management and geographic information systems since 1997. Along these 16 years, several projects where developed with the co-finance of the crossborder cooperation programs for Spain-Portugal of the ERDF (European Regional Development Fund) (Table 1).

It aims to monitor and analyze territorial and environmental changes and pressures on both sides of the Spanish-Portuguese border. OTALEX C (Territorial and Environmental Observatory of

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Table 1 Background common cooperation projects between Alentejo, Centro and Extremadura Regions

Project	Program	Aims	Project partners	Results
CoordSIG (1997-2001)	INTERREG II C	Coordination of GIS and instruments of earth observation.	JE, AMDE (CIMAC), GA, MMA, Midi-Périnée	Standardization of information between Portugal and Spain; continuous mapping test; Creating the background for cooperation
PlanExAL (2003-2005)	INTERREG III-A	Addressing joint planning strategies on both sides of the Spanish-Portuguese border.	JE, AMDE	Mapping for both sides of the border, orthophotomaps; Study of Widespread Build [1] and Territorial Plan for Alqueva [2].
GeoALEX (2004-2006)	INTERREG III-A	Development of territorial and environmental management model for Alentejo-Extremadura: Creation of common cartography.	AMDE (CIMAC), JE, IGP, CNIG-IGN, CCDRA, AMNA (CIMMA), Dip.Badajoz e DGCE	Geographic data and crossborder indicators harmonization: Publication of two books GESTA Model [3] and Common Cartography Object Catalogue scale 1:10,000 [4].
OTALEX (2006-2009)	INTERREG III-A	Creation of the Territorial Observatory of Alentejo and Extremadura—OTALEX.	JE, AMDE (CIMAC), IGP, CNIG-IGN, CCDRA, AMNA (CIMMA), Dip.Badajoz e DGCE	Creation of the Territorial Observatory of Alentejo and Extremadura—OTALEX; First crossborder non-pilot SDI—www.ideotalex.eu in 2007; Data harmonization according to international standards—INSPIRE Directive; Publication of OTALEX Results [5] and Corine Land Cover Level 5 [6] books.
OTALEX II (2008-2011)	POCTEP—Cross Border Cooperation Program Spain-Portugal 2007-2013	User services development thought IDE-OTALEX; Management and monitoring environmental system.	AMDE (CIMAC), JE, IGP, CNIG-IGN, CCDRA, AMNA (CIMMA), Dip.Badajoz, UÉvora e UExtremadura	Creation of a physical space for OTALEX in *La Cocosa* (Badajoz, Extremadura, Spain); Improvements on IDE-OTALEX; Eenvironmental Indicators; Creation of OTALEX indicator System; Publication of the first Alentejo-Extremadura Atlas [7], OTALEX II Final Results book [8], Land cover/ Land use Map of Évora District, at scale 1:150,000 [9] and Alentejo and Extremadura Map, at scale 1:600000 [10].
OTALEX C (2010-2013)	POCTEP—Cross Border Cooperation Program Spain-Portugal 2007-2013	Integration of Centro Portugal region; development of sustainability indicators; parametric maps of soil; footprint. SDI new services improvement —WPS and WCS. New I & D working group; Linked data and SOS.	JE, CIMAC, JE, DGT (IGP), CNIG-IGN, CCDRA, Dip.Badajoz, Dip Cáceres, IPCB e EDIA, UÉvora e UExt.	Improvement of IDEOTALEX geoPortal: map viewer, geoprocessing tools (WPS), backoffice, SIO, SOS and linked data.

JE—Junta da Extremadura; CIMAC—Comunidade ntermunicipal do Alentejo Central; GA—Gobierno de Aragón; MMA–Ministerio de Madio Ambiente; Midi—Pérenné Region (France); CIMAA—Comunidade Intermunicipal do Alto Central (old AMNA), DGT—Direcção Geral do Território (old IGP), DGCE—Dirección General de Catastro de Extremadura; EDIA—Empresa de Desenvolvimento de Infrestruturas do Alqueva, S.A.; UEvora—Universidade de Évora, IPCB–Instituto Politécnico de Castelo Branco, CNIG-IGN —Centro Nacional de Información Geográfica-Instituto Geográfico Nacional; Dip.Badajoz-Diputación de Badajoz–O. A. Área de Igualdad y Desarrollo Local; Dip.Caceres-Diputación de Cáceres—O. A. para el Desarrollo Local; UExt—Universidad de Extremadura

Alentejo Extremadura and Centro) project area is composed by three administrative units (NUTSII): Alentejo, Centro of Portugal and Extremadura in Spain, covering about 92.200 km^2 and having the same geographic area of the European region. EUROACE—European Alentejo Centro Extremadura (Fig. 1), created in September 21, 2009, as an organizational structure that aims to reinforce cooperation between these three regions that share's a common border and problems.

These are sparsely populated regions (less than 37 inhabitants per km^2) with a generalized high

aging index and low natural growth, which has been partially contradicted by immigration. The main

Fig. 1 OTALEX C project area.

economic activities are agriculture and services. They are also quite rich in natural, built and landscape heritage, including several nature conservation sites and protected areas (Natura2000 sites, Birds Protection Areas and National Parks). However, these regions are also threatened by different kinds of pressures: urban and industrial expansion, abandonment of traditional land systems, impacts of CAP (Common Agriculture Policy), soils contamination, erosion and loss of fertility, clime changes and others, which are causing increasing impacts on the environment, biodiversity and local populations.

Sensitive to these problems and to the difficulty of having quality GI (Geographic Information) available of all this territory, project partners decided to create the first non-pilot crossborder SDI (Spatial Data Infrastructure) called IDE-OTALEX (Infraestrutura de Dados Espaciais-OTALEX) (www.ideotalex.eu), which integrates national, regional and local administrations levels, as the first GI sharing platform of Alentejo, Centro and Extremadura. Despite the different data sources (Portuguese and Spanish and different entities), SDI is feed by harmonized information of the whole area.

Fig. 2 OTALEX C working team.

IDE-OTALEX, which is online since 2007, is the first cross border non-pilot and multilingual SDI project in Europe. Thought all this time, it was consolidated the inter institutional and multidisciplinary working team, that works together until today (Fig. 2).

The partnership underlying IDE-OTALEX had its origins in CoordSIG project (1997-2000) when several entities across border gathered in an INTERREG II-C project to develop common methodologies with the purpose of overlap the gap of geo-referenced information and cartography in this bordering area. At the same time, it was built a permanent exchange group of information between the regions, through GIS platform. Several projects have followed until todays OTALEX C project, having several important results to the regions, as it is summarized in Table 1.

OTALEX C has presently 11 partners and it is organized in four working groups: WebGIS and Cartography committed to the harmonization of spatial data and implementation of the SDI, services and functionalities; Indicators Group that takes care of the SI-OTALEX (Indicator System-OTALEX), with the territorial, social, economic, environmental and sustainability indicators; Promotion Group, which takes care of the promotion and divulgation of the project, and the I + D (Investigation and Development) group, that develops several areas of research in OTALEX C.

2. IDE-OTALEX

Spatial data infrastructures are, in general, for their characteristics, the best technological tool to publish sustainability data in the web. They can synthesize, calculate and analyze spatial data through interoperable web based services. SDIs are essential to manage natural resources, economic development and environment protection in a way to monitor the changes of the territory.

IDE-OTALEX is the crossborder spatial data infrastructure of Alentejo, Extremadura and Centro. It was implemented in 2007 to share official geographic information between these regions. This has been the most effective way to have a distributed and flexible observatory for sustainable development and environment protection in this rural and low populated regions [11]. It also contributes to territorial cohesion, one of the tree main pillars of European Cohesion Policy.

IDE-OTALEX is a distributed, decentralized, modular and collaborative system, based on standards (OGC, W3C, ISO) and open source technology, developed to guarantee interoperability between the different GIS provided by each project partner. The geoportal is multilingual (Portuguese, Spanish and English) and integrates a map viewer, Metadata Catalogue and Gazetteer. It has central and local nodes which communicate through WMS (Web Map Services), CSW (Catalog Service Web) and WFS (Web Feature Services) [12].

The data available results of the harmonization adapted to INSPIRE Directive (D 2007/2/EC, the European Parliament and Council, March 14, 2007). It integrates basic cartography (topography, hydrography, DEM) socio-economic and environmental indicators. Fig. 3 represents the home page of IDE-OTALEX C portal.

OTALEX developed also an Indicator System—SI-OTALEX, to identify, measure, monitor and evaluate human pressures and its dynamics in the region. The established set of indicators has a common and standard structure designed by a multidisciplinary team with experts from both countries. Its main objective is to evaluate the transformations of the

Fig. 3 Home page of the website IDE-OTALEX C—www.ideotalex.eu.

territory and help to solve common problems of the territory and their populations.

Following the guidelines of the EU-SDS (Sustainable Development Strategy of the European Union), the national Development Strategies for Portugal and Spain, SI-OTALEX was framed by the conceptual model PSR (Pressure-State-Response), adopted from Ref. [13]. Although, we know that choices always involves disregarding something [14], since there is no universal set established, and there is such a high and diverse number of indicators, the core indicators for SI-OTALEX was built with those that best fit the project objectives, had more relevance and representativeness in the area, and also easily available and measurable. Furthermore they should be simple, easy to read and update.

To each of the structure elements was assigned a code number in the hierarchical system comprising by three levels: vectors, themes and indicators. The first one, the widest, integrates five vectors: territory, environment, social, economic and sustainability (Fig. 4).

These vectors include now twenty two themes such as climate, hydrography, soils, air, water, waste, landscape, land use, population, economic activities

and others (Table 2). The third level is composed by the indicators themselves. Examples of these are water quality, waste management, green spaces in urban areas,

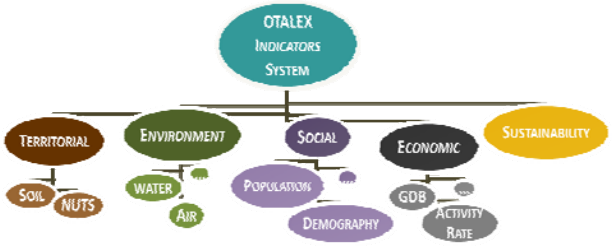

Fig. 4 OTALEX C Indicator System (SI-OTALEX).

Table 2 SI-OTALEX main structure.

VECTOR	THEME
01. Territory	01. Climate 02. Geology and geomorphology 03. Hydrography 04. Soil 05. Administrative structure
02. Environment	01. Air 02. Water 03. Waste 04. Polution sources 05. Land use 06. Environmental performances and Urban spaces 07. Noisa 08. Energy 09. Nature conservation 10. Landscape 11. Soil protection
03. Social	01. Population 02. Demographic structure 03. Equipments and services network
04. Economy	01. Economic activities
05. Sustainability	01. Territorial matrix 02. Sustainable transport

landscape units, demographic structure, economic activities and others [15]. Each indicator have an appropriate metadata file that describe the calculation method, the sources of the original data, year and other important information that allows its application to other regions and periods.

These indicators are now been integrated in IDE-OTALEX C (www.ideotalex.eu), so each indicator was geo-referenced and harmonized in terms of geometry, time and spatial scales, to be comparable and contiguous in OTALEX C territory.

It were made several developments in the indicators definitions. One of the most interesting was the new Rurality Index proposed by Mateos [16] on OTALEX project and applied to OTALEX area. This indicator has its roots on the definitions proposed by the Spanish Ministry of Agriculture, Fishery and Food, the OECD (Organization for Economic Co-operation and Development) and Eurostat, but integrates also information from other indicators like population dynamics, aging index, main economic activity, health care and education centers, that in general gives a better information of the reality of the municipalities, and became an useful tool for understand OTALEX area.

In addition, it was made the first study on the effects of air pollution by the presence and distribution of wet acid deposition resulting from industrial emissions on OTALEX area [17].

In this thematic, it was also developed a map based on lithology, slope and vegetation of OTALEX area that was used to collect soil samples. As final results, It will be produced the original maps of several soil parameters, such as pH, soil color, organic carbon and others.

Designed to be flexible and open SI-OTALEX is a GI platform, fulfill with updated information through each one of the local nodes and available to everyone. It has not been easy to work with different definitions, criteria, information sources, and obtain good results. But, the team is committed in developing a reliable and consistent tool that will help to evaluate environmental performance to pressures and understand the territory and his dynamics.

3. Results

Since 2007 the IDE OTALEX C has grown up and research new tools focused on three main goals: to provide harmonized spatial information about EUROACE regions; to provide and improve analysis tools useful for users; to provide the IT framework for remote and local information sharing.

The main results are available in www.ideotalex.eu. Here we present several examples of the different results and functionalities developed. In the successive developments, there have been added different tools that allow the users to take advantage of the information.

As main results achieved:

(1) Data harmonization (cartography and indicators) on both sides of the border (Fig. 5). More than 60 indicators harmonized. Integration on IDE OTALEX C and creation of the SI OTALEX C.

(2) Development of Analysis Tools through OGC standard WPS (Web Processing Services), such as:

- number of bands in the raster; maximum and minimum value of the raster band; multipart to single part operations;
- buffering; intersection; symmetric difference; polygons generalization; vector combination; distance between two maps;
- maps bonding; indication if a layer WFS is in contact with another WFS layer;
- mathematical operations of: cross, disjoint, contains, equal, within, contact and superimposed.
- conversion of GML (Geography Markup Language) layer to shape format;
- These tools help to make decisions in spatial planning at different level, allowing concatenation of geo-processing (WPS).

(3) IT framework for remote and local information sharing. These tools includes:

- support of several GI formats, WMS, WFS, shape file, GML and KML;
- drawing tools and export to KML;
- Local Nodes Remote Administration (BackOffice). Remotely enables management of information from different local nodes.

SDI OTALEX C to mobile devices (Android powered) and desktop, accessible to all users (Fig. 6).

(4) I + D developments. In this workgroup there have been developments in these two fields:

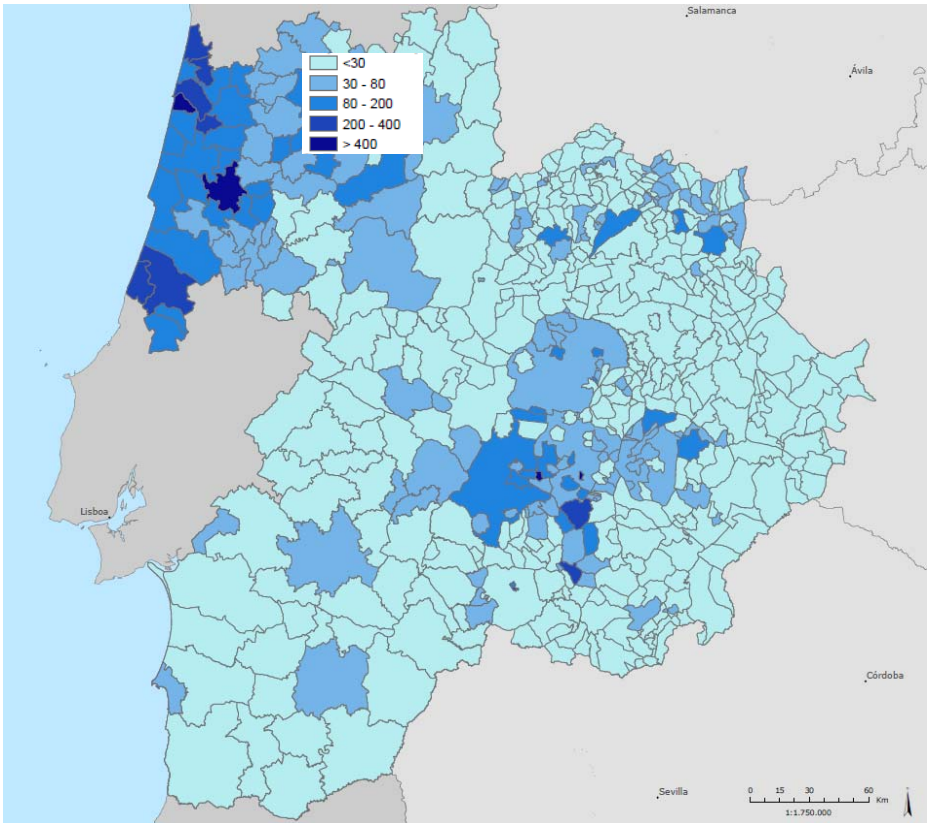

Fig. 5 Data harmonization sample: population density (population per km^2) by municipality for Alentejo, Extremadura e Centro regions.

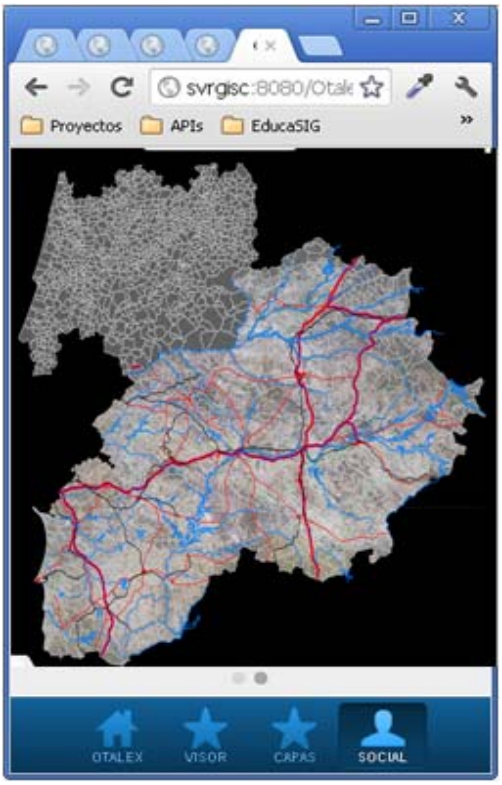

Fig. 6 Mobile version of SDI OTALEX C.

- environmental monitoring (SOS), responsible for collecting the measurements made by each of the sensors that comprise a network of environmental monitoring, and also for processing and publishing the resulting data.
- transformation of OTALEX C GI into WEB 2.0 (linked data and WEB semantic).

With an oriented architecture to services, IDE-OTALEX C is the sharing platform for spatial data, information and resources, for Alentejo, Centro and Extremadura regions, in a very flexible and dynamic way through the web.

4. Conclusions

For its particular characteristics, OTALEX has become one distinctive project. It has established a permanent crossborder cooperation channel between the different administration levels. It ranges local (inter-municipal communities and diputaciones, which represents municipalities), regional (Junta da Extremadura and CCDRA—Comissão de Coordenação Desenvolvimento Regional do Alentejo), national (Spanish National Geographic Institute and Portuguese Geographic Institute), high education institutions (University of Évora, University of Extremadura and Polytechnic Institute of Castelo Branco) and public enterprises EDIA (Empresa de Desenvolvimento da Infraestrutura de Alqueva) of two different countries: Spain and Portugal. This 16 years of cooperation keep on going and it is getting stronger and useful among users.

OTALEX is a best Practice case of the INTERREG III-A Program of Crossborder Cooperation Spain-Portugal 2000-2006.

In 2009, it is invited to the SDI Best Practice Award of the eSDI-Net+ project (www.esdinetplus.eu) and received an honor mention. In 2011, it received an honor mention of the AEBR (Association of European Border Regions), in the context of the AEBR Award of 2011 [19].

OTALEX is a member of the Spatial Data Infrastructure of Spain since March 29, 2011, and it is one of the three environmental geoportals. It is also a member of the Directive Council of the Spatial Data Infrastructure of Spain and of the OSE (Observatorio de Sostenibilidad de España) [20]. It collaborates with several different entities responsible for the territory management, like EUROACE and it is of the Portuguese Nacional Program to Combat Desertification, developed in the framework of UNCCD (United Nations Convention to Combat Desertification).

5. Outlook

As future outcomes, the partnership is committed in extending its main work to the new intervention area Centro of Portugal, consistently with the European strategies of crossborder cooperation and EUROACE Strategy 2020 [18].

It is also improving IDE-OTALEX interface, developing new tools, such as WPS, SOS, linked data studies and sustainability indicators.

One of the near future outcomes will be the ATLAS of Alentejo, Centro and Extremadura regions, to be published by the end of 2013.

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