

(Spanish National Program for Aerial Orthophoto): Collaborative and Innovative Spirit in Geospatial Information

At the beginning of the 21st century, Spain faces very important challenges for sustainable development: significant infrastructure expansion and huge urban and tourist-oriented residential pressures need to be fitted into a structure of adequate environmental impact evaluation and minimization.

By Guillermo Villa



a, b en c: Orthophoto
samples: 50 cm / 25 cm / 10 cm
pixel size.

A large percentage of Spanish territory undergoes modifications every year, and it is imperative to monitor and manage this rapid rate of change. Traditional cartographic and GIS databases are not well suited to this task because of high production costs and lengthy updating periods. The only way to keep up the pace at a reasonable cost is by using orthoimagery coverage.

Digital orthophotos have been used in Spain for many years by different public organizations (regional and national) for specific needs (cadastre, topographic cartography, environmental and agricultural management, etc.). These different needs were addressed through specific orthophoto projects, each with its own specifications for resolution, precision, product list, and so on.

In 2004, IGN Spain (Instituto Geográfico Nacional) decided to apply INSPIRE's principles ("Information should be captured only once") and proposed our public organizations join a common orthophoto production project that would serve different needs, consolidating the requirements of all them. This would save money, reduce duplication of effort, and foster derived vector database harmonization and convergence.

Organization

In accordance with the decentralized organization of Spain into 19 Regional Governments (RGs) - Comunidades Autónomas - PNOA (Spanish National Plan for Aerial Orthophoto) was defined from the beginning as a decentralized yet coordinated project. The production of each region's territorial products was the responsibility of the RG, and IGN would act as coordinator of the national part with four Ministries involved technically (Public Works, Environment, Agriculture, Economy) and some others involved as users (Housing, Science and Education, Interior).

Through a hard negotiation process, PNOA was launched. This plan included:

- Strategies (resolution, update period, products) for the entire territory (505,000 km²).
- Budget: an annual amount and how it would be shared among all the different participating organizations. It was decided that the national contribution would be 66% and the

regional contribution 34% of the production costs.

- Technical specifications: workflow, product list (48 different products in the different phases), process and product detailed specifications (data and metadata).
- Chronogram (general and particular for each region).
- Quality assurance process.
- Organization (national and regional technical and management teams, meeting schedules, legal documents to be signed, property issues, etc.).
- Principle of data policy agreement.
- Dissemination process.

In most cases, RGs contract production through a call for tender to Spanish or European companies.

Resolution/Updating Strategies

PNOA 50cm

The main technical discussion has been on the geometric resolution, update period, and annual cost strategy. After much negotiation, it was decided to set minimum requirements for the entire territory of Spain for the 2004-2007 period:

How It's Being Done

Venturo, which with 125 employees is one of Spain's largest private mapping companies, is responsible for creating orthophotos of 4 of the 17 PNOA regions. Their portion of the project covers some 60,000 km², captured at 50 cm resolution (50,000 km²) and 25 cm resolution (10,000 km²). While that's a huge undertaking by most standards, the firm hopes it is just the start of its PNOA involvement.

The firm, founded 17 years ago by brothers Manuel and Jose Antonio Coronado, is based in Asturias, an area once known for its coal mining industry. With the mines now closed, the region looks to high-tech employers like Venturo for future growth and prosperity.

The firm's 2,000 m² office is equipped to support such growth with 12 Leica Photogrammetry Suite (LPS) digital photogrammetric workstations, 40 Digij3D (a local feature extraction SW) stereoplottling workstations, a Leica DSW700 photogrammetric scanner, five Leica IMAGINE Professional remote sensing licenses, 24 SIGRAF cadastre licenses, and an EMC2 Clarion 35TB massive storage disk library.

Venturo's current project scope includes orthophotos, stereoplottling, mapmaking and cadastre. The company hopes to extend into other areas with the acquisition of aerial sensors and airborne LIDAR. "Our goal is to be one of the leaders in the Spanish/European mapping market," explains Pedro Llorens, a director of the firm.

- 50 cm pixel size color aerial flight with GPS + IMU (scanned film or digital camera).
- Integrated orientation (GPS + IMU + field control + aerial triangulation).
- Digital elevation model (DEM) by automatic correlation and manual editing with 2 m rmse in Z.
- 50 cm pixel size digital color orthophotos with 1 m rmse in X,Y.
- Updating period: 2 years.

These specifications allow for 1:10,000 topographic mapping and satisfy most of the needs detected in the definition phase of the project. Some regions, based on their territorial characteristics (such as population density, parcel size, and change rate) decided to go for higher resolution and/or shorter updating periods; some decided to make annual coverages. The excess cost would be paid by that region.

PNOA 25cm

For 2008-2011, it has been decided to increase the resolution while keeping the two-year update period. To maintain a reasonable budget, alternate 25 cm/50 cm coverages were recommended. While the 25 cm coverages follow the same rigorous process as before, the 50 cm coverages are treated through a "quick" orthorectification process (re-using existing DEM and field control points, totally automatic color balance and mosaics, no manual retouch).

The 25 cm coverages are associated with a 5 m grid 1 m rmse Z DEM. The minimum requirement is automatic correlation plus stereoscopic manual editing, but simultaneous or almost simultaneous LIDAR capture and processing is recommended. Some regions are opting for this technique. In the near future, LIDAR coverages should be compulsory, because there are many applications (hydrology, flood prevention) that need higher quality DEMs than can be obtained by automatic correlation.

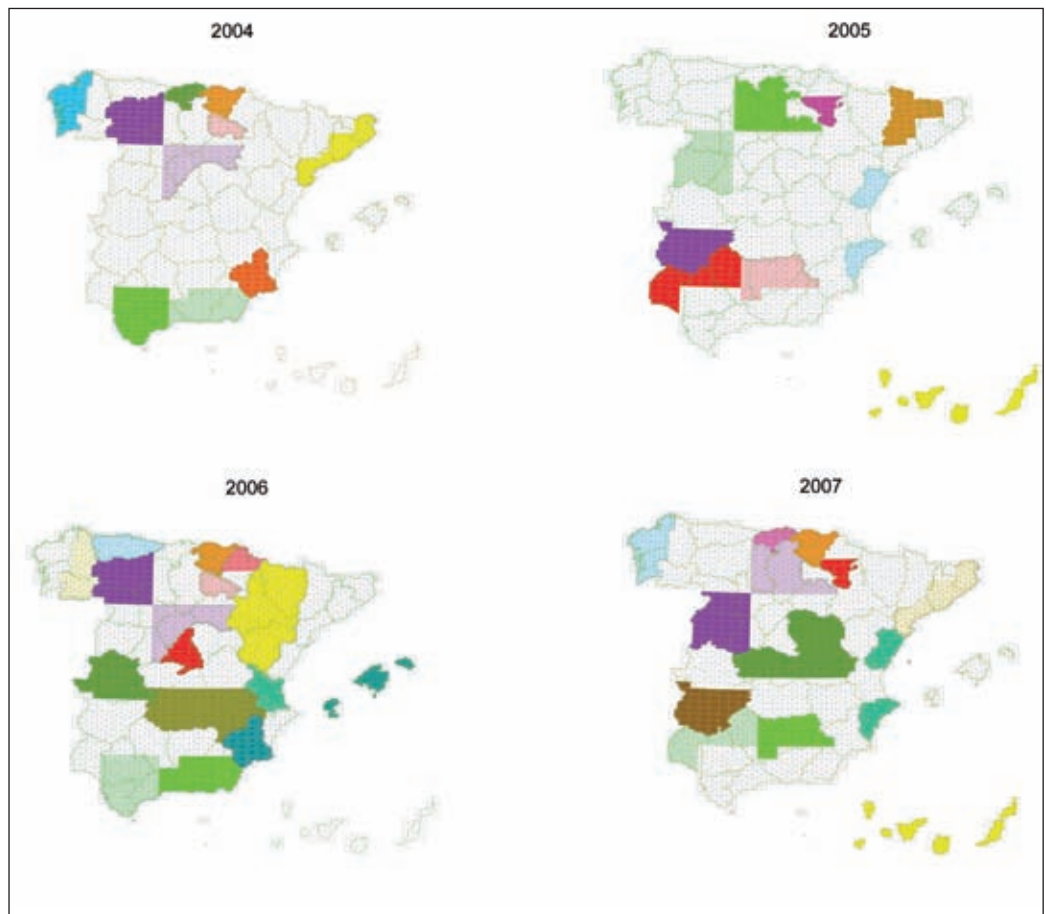
These specifications will allow for four-year updating of 1:5,000 topographic mapping of all of Spain. Again, some regions have adopted more ambitious strategies -- annual flights and/or 25 cm resolution for all of their coverages.

PNOA 10cm

As of June 2007, we are also negotiating the extension of PNOA to coordinate the production of 10 cm pixel aerial flights and orthophotos of urban areas and the coast with a maximum four-year update period. These coverages have been produced in the last few years by various RGs, city authorities, and the Environment Ministry. Once again, the task is to consolidate all the requirements and define a comprehensive and coherent project including all organizational and technical aspects mentioned above for the 50 cm/25 cm case. These flights will be made with simultaneous 1 point/m² LIDAR capture for orthophoto production and basic 3D-modeling.

Historical flights

Some regions, as well as the national CNIG (Centro Nacional de Información Geográfica, which is in charge of disseminating IGN's products), are scanning and sometimes orthorectifying historical photogrammetric flights. This is useful information for monitoring territorial evolution.



PNOA coverages 2004-2007.

Technical Aspects and Advances

Detailed technical specifications have been written and corrected by collaboration among all participants and are constantly revised and improved. Technological changes in state-of-the-art aerial photography, DEM and digital orthophoto production are adopted as soon as possible. Some examples are:

- On board GPS + IMU mandatory since 2005
- Aerial cameras: in 2004 some of the flights were made with digital aerial cameras. In 2005 they were in the majority. In 2007 they are almost all digital. Eight digital aerial cameras are owned by Spanish aerial survey companies. If a digital camera is used, a false color infrared orthophoto is produced as well.
- LIDAR capture and MDE instead of automatic correlation has been recommended since 2007. Some companies are offering it at no extra cost. They say that the reduction in manual editing compensates for the increase in flight costs, provided LIDAR and photographs are taken at the same time with one single flight with a two-window plane.

Storage

PNOA 50 cm of the whole of Spain is about 15 TB/year of uncompressed data and PNOA 25 cm/50 cm is about 30 TB/year. All this informa-

tion must be stored in online or near-line storage and adequately backed up. In 2004 IGN installed a NAS server with scalable architecture that accommodates this growth rate. Old information (past years' coverages) must be kept online (compressed) or near-line (uncompressed files) for multitemporal comparisons.

Data Policy

By tradition, aerial photogrammetric data in Spain is the property of the organization that pays for the work, not of the private company that makes the flight as in some other countries.

In PNOA, RGs and the national administration are co-proprietors of all the information, so PNOA is the property of all Spanish citizens. This provides us with total freedom for data policy definition. The spirit of the project is that information should be as inexpensive, open and widely used as possible. IGN and CNIG are evaluating some kind of Creative Commons type license. The basic principles to be followed in data policy are transparency, neutrality, openness of information, privacy assurance, public guarantee of true data, and public service.

Dissemination

Transmitting large data sets between different organizations is done with external USB-2 or e-SATA hard disks. Both RGs and national

SPANISH NATIONAL PROGRAM FOR CONSERVATION OF TERRITORY (PNOT)							
1 ^a Phase: Aerial & Satellite Image Acquisition & Processing		National Aerial Orthophoto Program (PNOA)			National Remote Sensing Program (PNT)		
	Spatial Resolution	10 cm <small>urban and coastal areas</small>	25 cm <small>(alternate coverages)</small>	50 cm	<small>periodic: 10 to 15m</small> multispectral: 1 to 20m	<small>periodic: 10 to 15m</small> multispectral: 20 to 50m multispectral: 100 to 1000m	
	Update Period	4 years	2 years		3-12 mos.	1-6 mos.	2-30 days
	Approximate Cost (euros/Km ²)	350	55 (rigorous) 19 (quick)	29 (rigorous) 7.5 (quick)	4 (2.5m)	0.05	0
	Examples of Sensors	Digital aerial cameras (4 bands) with GPS-IMU LIDAR			SPOT, Furuseat, PIS, Cabot, etc. Future:MEOSAT	Landsat 7 (ETM+) Landsat 1 (TM) Future:Sentinel2	MODIS MERIS Vegetation NOAA
2 ^a Phase: Extraction of Vector Information	Scales/Projects and Databases						
	Theme	Organizations Involved	1 : 500 to 1 : 2000	1 : 5000 to 1 : 10,000	1 : 25,000 to 1 : 50,000	1 : 100,000 to 1 : 200,000	1 : 1 Million
	Topography	National			Topographic Database BTN25	BCN200	BCN1000
		Regional		Topographic Maps			
		Local	Topographic Maps				
	Cadastr	National	Urban cadastre	Rural cadastre			
		World					.Globcover
	Land Cover	European				Corine Land Cover 2000 Land Marking Cor Service	
		National		.SIGPAC	SCORE Agriculture Map ForestMap		
		Regional		Regional Land Cover Databases			
Environment				Remote sensing biophysical parameters and agri-environmental indicators			
3 ^a Phase: Dissemination of the Information	Spatial Data Infrastructures: INSPIRE, IDEE, regional SDI Image Servers (WMS, etc.)						

In this figure we can see a schema of PNOT components.

ministries have set up and are improving web portals and web services for public access to all this data. Images are served through Internet services by ad hoc portals and are also integrated in Spanish SDI (IDEE) through WMS standard services. Some portals also allow FTP compressed file download.

The main concern now is what should be and what will be the role of the private sector in this dissemination. We are trying to define a scenario in which the contribution of each part (public and private) adds to the general benefit and does not hamper it, as could be the case with an exclusive rights philosophy or monopolistic scenario.

Innovation

One of the main objectives of this project is to foster innovation in the Spanish and European photogrammetric sectors. Many interesting initiatives in Spain are reaching the market at this moment. Among them are StereoWebMap (a stereoscopic Internet server for aerial photos), DIGI21 (a powerful yet inexpensive digital photogrammetric software) and many others.

PNOT

PNOA is part of a bigger national plan called PNOT (Spanish National Program for Observation of the Territory). In the figure you can see a schema of PNOT components.

Among PNOT components are:

- PNT (Spanish National Remote Sensing Program): systematic national coverage with different resolution satellite images. In this

aspect we are quite concerned about what we perceive to be the erroneous copyright, use license and data policies of some satellite image distributors. In our opinion, these policies have hampered the development of operational medium and high resolution remote sensing applications with constant interruptions of the “added value chain.” A 2.5 m resolution Spanish remote sensing satellite (SEOSAT) is in the final development phase, scheduled to be launched in 2010.

- Another interesting component is the SIOSE Project (Spanish 1:25,000 Land Cover Information System) for which we have developed a very innovative parametric object-oriented land cover data model. This model overcomes the important limitations and shortcomings that have been experienced in the production and use of traditional hierarchical classification land cover databases (Corine Land Cover and others). However, that is a theme for another article.

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