Cartographic activities in Spain presented to the 19th General Assembly of the ICA, 2023

NATIONAL REPORT SPAIN2019-2023

XXXI INTERNATIONAL CARTOGRAPHIC CONFERENCE International Cartographic Association 13–18 August 2023, Cape Town, South Africa SMART CARTOGRAPHY FOR SUSTAINABLE DEVELOPMENT









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XXXI INTERNATIONAL CARTOGRAPHIC CONFERENCE International Cartographic Association

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Board of the Spanish Society for Cartography, Photogrammetry and Remote Sensing

Sociedad Española de Cartografía, Fotogrametría y Teledetección, SECFT

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This Board was renewed at the Ordinary General Assembly of the Spanish Society for Cartography, Photogrammetry and Remote Sensing held in Madrid on the 6th of July 2022.

Honorary Members

Mr. Ramón M. Lorenzo Martínez, (Chair of SECFT 1996-2014), Mrs. Isabel Suárez de Centi, Mr. Rodolfo Núñez De Las Cuevas, Mr. Fernando Aranaz Del Río, Mr. Adolfo Dalda Mourón and Mr. Milan Konecny, all of them due to their dedication and commitment to the Spanish Society for Cartography, Photogrammetry and Remote Sensing. Cartographic activities in Spain presented to the 19th General Assembly of the ICA, 2023

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Opening Remarks

The 19th General Assembly of the International Cartographic Association (ICA) and the 31st International Cartographic Conference (ICC 2023) will be hosted in Cape Town, centered around the crucial theme of "Smart Cartography for Sustainable Development."

The application of smart cartography for sustainable development presents a diverse array of opportunities to uplift society. This arises from the enhanced capabilities of advanced cartography technology in collecting, analysing, and visualizing geospatial data more effectively. Moreover, it drives technological innovation, fostering progress in artificial intelligence, big data analysis, and remote sensing, with potential applications across various sectors, significantly enhancing overall societal well-being.



The Spanish Society for Cartography and Remote Sensing recognizes the profound significance of this event, identifying key opportunities in cartography and geographic data that are pivotal to informed decision-making. Smart cartography provides policymakers and planners with precise, up-to-date geographic information, empowering them to make well-informed choices. By providing access to detailed data and interactive visualizations, it facilitates informed policy-making, informed investment decisions, and sustainable development projects.

Furthermore, cartography plays an indispensable role in environmental conservation. With advanced technology, it enables the identification and monitoring of ecologically sensitive areas, critical habitats, and natural resources. This empowers conservation efforts and environmental protection, mitigating the adverse effects of environmental degradation and climate change.

Building upon this foundation, smart cartography is invaluable for natural resource management. By monitoring and managing resources such as water, soil, forests, and biodiversity, it enables the implementation of sustainable practices, ensuring responsible and equitable utilization.

Additionally, we must remain prepared for sudden changes in the planet's behaviour, including disaster management. Cartography is essential in disaster response and resilience planning, as real-time updated maps provide critical information for coordinating relief efforts and rehabilitation operations. Moreover, identifying high-risk areas facilitates proactive measures to avert future disasters.

An equally noteworthy aspect is citizen participation, as smart cartography fosters active engagement in decision-making related to sustainable development. By offering interactive maps with accessible information, citizens can contribute ideas and identify problems and solutions, empowering them to be active stakeholders in shaping their communities.

In conclusion, smart cartography for sustainable development presents significant opportunities to enrich society across various facets, from informed decision-making and planning to environmental conservation, resource management, disaster resilience, and citizen engagement. These opportunities challenge us to harness the potential of technology, paving the way for a more sustainable and prosperous future for all. By seizing these prospects collectively, we can effectively address global challenges, leaving a lasting legacy for generations to come.

> D. Francisco Javier González Matesanz President of SECFT

Introduction

The Spanish Society for Cartography, Photogrammetry and Remote Sensing (SECFT) is the representative in Spain for both the International Cartographic Association (ICA) and the International Society for Photogrammetry and Remote Sensing (ISPRS). Hence Spain has been present over the last fifty-four years in all biannual international conferences organised by ICA (ICC1962.1, Frankfurt, Germany - ICC2017 Washington D.C., USA-ICC2019 Tokyo, Japan and ICC2021 Florence, Italy), and in all eleven guadrennial conferences organised by ISPRS (XIV ISPRS Congress 1980, Hamburg, Germany -XXIII ISPRS 2016, Prague, Czech Republic, XXIV ISPRS 2022, Nice, France, virtual event). Moreover, SECFT has also been the representative for both the Spanish cartographic sector in all general assemblies of ICA, and the Spanish photogrammetric and remote sensing sector in all general meetings of ISPRS.

The International Cartographic Exhibition 2023 can be joined using the SECFT webpage. The work carried out by SECFT is noteworthy in terms of organising the Spanish contribution to the international map exhibitions held at ICA Cartographic Conferences over the last 28 years. Spanish cartography has been awarded 30 times altogether over the last years, i.e. Barcelona (Spain) 1995, Ottawa (Canada) 1999, Durban (South Africa) 2003, Corunna (Spain) 2005, Moscow (Russia) 2007, Santiago (Chile) 2009, Washington DC (USA) 2017, Tokyo (Japan) 2019 and Florence (Italy) 2021. On the 31th International Cartographic Conference to be held in Cape Town, South Africa, the SECFT has included a link on its webpage so that everybody may join ICC2023 and Barbara Petchenik 2023 International Competition (to be observed at <u>www.secft.es</u> and <u>www.ign.es</u>). As a result, a vast representation of the Spanish cartography including all main institutions will be present in Cape Town.

SECFT has received the support of all main cartographic institutions in Spain, i.e.

- National Geographic Institute of Spain (IGN)
- Spanish Army Geographic Center (CEGET)
- Spanish Hydrographic Office (IHM)
- Cartographic and Photographic Center. Spanish Air Force (CECAF)
- Geological and Mining Institute of Spain (IGME)

One of the main targets of these International Cartographic Conferences is to enable knowledge and experience exchange among professionals who develop their work in the academic world, in the official cartographic agencies or in companies specialised in these sectors. In this respect, the various reports of activities presented at the different International Cartographic Conferences play an important role as they are an essential tool for knowing and becoming acquainted with cartographic knowledge, trends and working methods in the manifold countries of the world. The SECFT Board has been paying special attention to preparing reports on the different activities since they are very useful for promoting and showing the goals achieved between meetings, as well a great source of historical information on the achievements of the cartographic development along time.

Spain plays an important role in the ICA Commission on Cartography and Children and its Barbara Petchenik International Map Competition. This competition was created in the year 1993 in honour of Barbara Petchenik, an American cartographer who promoted mapping among children. The main target of this competition is to encourage children to share their vision of the World by drawing creative maps. SECFT has helped organising this competition since 2019 by publishing the rules of the competition on its website and encouraging children to take part in it. This enables many Spanish children to take part in the international competition as they will in Cape Town, South Africa, in August 2023 during the 31th International Cartographic Conference.



IGN website https://www.ign.es/web/ign/portal/concurso-barbara-petchenik



Spanish contribution to Barbara Petchenik Children's World Map Drawing Competition 2021 and 2023 SECFT-IGN.

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Pilar Sánchez-Ortiz Rodríguez (Spain) has been a member of the Jury of Barbara Petchenik Map Competition in the years 2019, 2021 and 2023.

In February 2022, on the occasion of the International Day of Women and Girls in Science, Pilar Sanchez-Ortiz, General Secretary of the SECFT, coordinator and national representative of the Barbara Petchenik 2021 Contest, presented the diplomas and prizes, sponsored by IGN-CNIG, to the three girls selected from Madrid, who together with the two selected from Zaragoza and one from Almeria represented Spain with their wonderful drawings chosen in the 2021 National Phase, who have participated in the Barbara Petchenik Children Map Competition 2021, at the International Cartographic Conference held in Florence, Italy, ICC2021.





Presentation of the BP2021 awards ceremony.

BP2021 awards ceremony to the winning girls.

The Arturo Soria school in Madrid, an educational center to which three of the six contestants selected in the National Phase belong, on the occasion of the International Day of Women and Girls in Science, held a tribute to remember Barbara Petchenik (1939-1992, USA) American cartographer and the first woman who became Vice President of the International Cartographic Association, (EC-ICA, 1991-1992) by giving the name of this great woman promoter of educational cartography to one of her streets-corridors in the educational center, and inviting Pilar Sánchez-Ortiz to inaugurate and discover the plaque.



Image of the plaque tribute to Barbara Petchenik at the Arturo Soria School in Madrid.

Nowadays all reports submitted since 1999 (1999-2003, 2003-2007, 2007-2009, 2007-2011, 2011-2013, 2011-2015 and 2015-2019) may be consulted online on the SECFT webpage <u>www.secft.es</u> (see its Publications - National Reports section) as well as on the ICA webpage <u>www.icaci.org</u> (see the Members-National Reports section) and on the Archive.

The role of the Spanish participation in international conferences has been growing steadily. We hope this contribution will continue developing during the present Conference held in August 2023 in Cape Town, South Africa.

Undoubtedly Spain is a country closely linked to ICA and it is one of the countries that has most contributed to the international cartographic community. Spain is the only country in the World that has hosted three international cartographic conferences apart from Germany, i.e. Madrid 1975, Barcelona 1995 and Corunna 2005. Spain has been actively contributing to the development of ICA for over 60 years, since its very foundation in 1959.

SECFT has taken part continuously in various projects of ICA, especially in developing projects and programs of maps and geographic information dissemination, as well as promoting study meetings and forums on matters of common interest.

In the last years, the SECFT Board presented during the International Conferences ICC2015, held in Rio de Janeiro (Brazil), the candidature of its Secretary General, Pilar Sánchez-Ortiz, to become Vice-President of ICA for the period 2015-2019 and ICC2019, held in in Tokyo (Japan), the candidature of SECFT member, Andrés Arístegui, to become Vice-president of ICA for the period 2019-2023. During this last eight years, the SECFT has promoted and sponsored international projects carried out following the Spanish duties on EC-ICA-VP.

The first project made by the SECFT in the period 2019-2023, has been the book "The World drawn by children. Barbara Petchenik International Competitions 2017 & 2019 / El mundo dibujado por los niños. Concursos Internacionales Barbara Petchenik 2017 y 2019" as a tribute to the 150th anniversary of the National Geographic Institute of Spain foundations in 1870.



The drawing entitled "Good morning world" by Noemí Sánchez Avramova, a pupil at Arturo Soria School in Madrid, received the Audience Award in the 13-15 years old category, selected from 190 maps from 34 different countries, at the 29th International Cartographic Conference in Tokyo (Japan) ICC2019 and is the cover image of the book "The world as drawn by children".

This book has been created thanks to the valuable contribution of the ICA Commission on Cartography & Children and the remarkable cooperation of the Spanish Society for Cartography, Photogrammetry and Remote Sensing. However, above all, it could only come into fruition thanks to the wonderful drawings made by children competing in the 2017 and 2019 editions of the international competition. This competition is organised by the ICA and aims to promote creative representation of the world as seen by schoolchildren, to strengthen geographic and cartographic knowledge and to make participants aware of the world in which they live, favouring understanding and preservation.

The world drawn by children. Maps from the Barbara Petchenik International Competitions 2017 & 2019. Pilar Sánchez-Ortiz, Jesús Reyes, Carla Sena, Temenoujka Bandrova (Eds.) (2020), National Geographic Institute of Spain was the bilingual book.

The pdf-version of the bilingual book is published and can be downloaded in different websites i.e.

SECFT website; www.secft.es

ICA Commission on Cartography and Children of ICA website; http://lazarus.elte.hu/ccc/ccc.htm

National Geographic Institute of Spain (IGN) website; http://www.ign.es/web/ign/portal/libros-digitales/ mundo-dibujado-por-los-ninos



The SECFT, national representative of the International Cartographic Association (ICA/ACI) in Spain with the sponsorship of the National Geographic Institute (IGN), affiliated member of the ICA, promotes the celebration of the "International Conference Atlases in time" in Madrid, in which three ICA commissions participated; Atlas Commission, Map Design Commission and Mixed ICA-IGU (International Geographical Union) Commission on Toponymy. The meeting was held from April 20 to 23 at the IGN headquarters in Madrid, with workshops on atlases, toponymy and map design. After the interruption of face-to-face meetings since 2020 due to the health crisis of the COVID-19 pandemic, Atlases in time recovers the in-person format, also with the possibility of being broadcasted live by video conference. It had the participation of more than 100 people and 33 papers were presented, seven of which given by Spanish professionals.

This international conference has brought together three essential ICA commissions: Atlas, Toponymy and Cartographic Design.

The era of national atlases begins in 1899, with the publication of the Atlas of Finland. The most recent publications of the National Atlas of Spain from the 1960s, 1980s and 2018 by the National Geographic Institute of Spain are a notable example of this important genre. Atlases do help significantly in answering the question "What's where", but they have to rely heavily on implicit naming of "what" they show.

Toponymy addresses this problem and also the symbolic power of place names, their role in the construction of identity related to space. Toponyms reflect historical power relations; place names, their specification and selection which are important and are scientifically indicative ingredients of maps and atlases.

Map design is one of the main tasks when it comes to the cartographic representation of a territory. It is one of the most difficult steps in the map production process, since the design completely affects the communication and information tool that each map has.

This meeting has had the extraordinary collaboration of the National Library of Spain (BNE), the Army Geographic Center (CEGET) and the Royal Observatory of Madrid (ROM) in charge of offering guided tours of their centers and valuable cartographic collections.



From right to left Timothy Trainor, president of the ICA, Lorenzo García Asensio, general director of the IGN, Javier G. Matesanz, president of the SECFT and deputy general director of Cartography and Observation of the Territory of the IGN, and Andrés Arístegui Vice President EC-ICA 2019-2023 in the opening ceremony of Atlases in Time.



At the closing ceremony, the ICA paid tribute to the former ICA Vice President 2015-2019, M^a Pilar Sánchez-Ortiz, for her dedication to this international organization for almost thirty years.

The "Atlases in Time" conference has been a great success, showcasing the important role mapping can play in addressing today's global challenges.

All the information is available at: https://maps-and-atlases.com/madrid2022/

On the occasion of the conference, the Executive Committee of the ICA (EC-ICA 2019-2023) met in person on April 19 at the IGN headquarters. The meeting was attended by the president, Timothy Trainor (United States); the general secretary and treasurer, Thomas Schulz (Switzerland); the former president, Menno-Jan Kraak (Netherlands); and the vice-presidents Philippe de Maeyer (Belgium); Vit Vozenílek (Czech Republic), László Zentai (Hungary); Temenoujka Bandrova (Bulgaria); Liqiu Meng (Germany) and Andrés Arístegui (Spain).

In addition, the SECFT organized on April 23 at the Royal Observatory of Madrid a meeting between the Executive Committee of the ICA and the president of the International Geographical Union (IGU/UGI), Michael Meadows (South Africa), and with his Vice President Spanish, Rubén Lois, in order for both organizations to exchange views on their operation, holding events (conferences and congresses) and their scientific activities.

SECFT newsletter, webpage and social networks

The Spanish Society for Cartography, Photogrammetry and Remote Sensing (SECFT) was created in 1977. Throughout this long period of time, SECFT has devoted its efforts to the dissemination of national and international initiatives related to cartography, photogrammetry and remote sensing. Hence a SECFT Newsletter was founded and is published every six months. It is dedicated to promote the knowledge of what is cutting- edge in these fields of activity. The Newsletter supplements the information provided on the website <u>www.secft.es</u> , enabling its access to professionals of these sectors who work either in the Public Sector, at Universities and/or in private companies. In the year 2019-2022, volumes 22 to 28 of the Newsletter have been completed with a total of 84 articles.



Pictures of the front pages of Newsletters 27 and 28.

Information related to cartography and geographic information systems both in Spain and abroad has continued being updated and disseminated on SECFT webpage www.secft.es.



SECFT website www.secft.es

The presence of SECFT on social networks is continuously being improved, especially on Twitter and Facebook.



SECFT has collaborated and worked since its foundation in 1977 with the National Geographic Institute of Spain (IGN) on numerous projects with than four decades of intense collaboration and great achievements. Now is the time for change and the National Geographic Institute of Spain (IGN) should be the right National Member of the ICA.

National Geographic Institute of Spain

GN



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National Geographic Institute of Spain

Since its foundation in 1870, the National Geographic Institute of Spain (IGN) has been engaged in scientific researches and production activities in the field of mapping. IGN is also involved in projects related to astronomy, geodesy, geophysics, photogrammetry, remote sensing, geographic information systems, spatial data infrastructures and administrative boundary lines.



In 2020, on 150th Anniversary of the creation of the National Geographic Institute 1870-2020 despite the COVID-19 pandemic, the IGN offered activities and events, conferences and exhibitions. The 150th Anniversary event were not face-to-face, adapting to the new reality of that time.

The IGN in the COVID-19 pandemic offering the public an effective and efficient service in its main activities related to the observation, measurement, analysis, evaluation and representation of our territory.





Cover of the book National Geographic Institute 150th anniversary, 1870 - 2020.

Earth Observation

Continuous changes on the territory must be known from time to time in order to monitor and manage an efficient and sustainable economic development. Technological progress has improved in Earth observation methods by providing the necessary mechanisms for acquiring precise and quality information in a shorter period and at a lower cost.

The responsibility for providing useful datasets, services and knowledge to Spanish users in terms of Earth observation and land monitoring, according to RD 308/2022 art.17.1.g lays on the National Geographic Institute of Spain (IGN).

Since 2004, IGN leads the institutionalized master program for Earth observation, National Plan for Land Observation (PNOT), that involves the consolidated projects on orthoimagery, elevations and land cover and land use. PNOT includes all the public stakeholders with authority in geographic information in a decentralized and collaborative production model in which take part all levels for administration: local, regional and national. Through a co-funded economic model this cooperative way of producing information is a powerful tool for sustainability, even in crisis times, for gathering data only once and by the most appropriate agent or group of agents.

In 2014, IGN defined a set of institutional strategic principles aligned with European INSPIRE Directive, the Committee of Experts on Global Geospatial Information Management from the United Nations (UN-GGIM) and users' needs to define and generate Geospatial Reference Information (GRI) datasets. GRI is the basic geospatial information able to organize any subsequent actions that may take place on the territory. GRI acts as a skeleton of geo-infrastructures where other geospatial information may be located or mapped. Accordingly for Earth Observation Unit, IGN carries out the following tasks:

The management and development of national plans on Earth observation for geographic and cartographic applications aligned with relevant initiatives and programs, such us UN-GGIM, Copernicus, INSPIRE, etc. Developing product and services on based on techniques of remote sensing, photogrammetry, LiDAR and digital elevation models. The production, updating and use of geospatial reference information of Land Cover & Land Use, Hydrography and Settlements, according to national, European and international requirements, and also in line with other international initiatives such as UN GGIM, Copernicus, INSPIRE, etc.

In 2014 Copernicus, the European Union's Earth observation and monitoring program, which analyzes the planet and its environment for the benefit of European citizens, was set up and conditioned the management of all kind of information and activities belonged with Earth observation. IGN evolved their projects with the objective to coordinate efforts with the European program, technologically articulate products, facilitate access data and foster Spanish user uptake of international and IGN data.

PNOA Image

The National Aerial Orthophotography Plan (PNOA) began in 2004, its objective is to obtain digital aerial orthophotographs of the entire Spanish territory, with a fixed update period, currently 3 years. The resolution of the orthophotos has also varied over time and since 2017 the resolution is at least 25 cm, from a photogrammetric flight of 35 cm or 22 cm of GSD (Ground Sample Distance) depending on the characteristics of the region.

As a collaborative program, this product is being improved, year by year, thanks to the participation and funding of the Cartographic Agencies in several regions, resulting in higher resolution orthophotographs up to 15 cm of pixel in those areas.

Additionally, orthophotographs form historical flights over the territory are produced and published (Historical PNOA), resulting in a very useful tool for different studies that require temporary information.

The PNOA is a cooperative project in which the General State Administration and the Autonomous Communities participate. A single photogrammetric flight is carried out and a rigorous treatment of the data is carried out, complying with technical specifications agreed upon by all the participating Public Administrations. This cooperative production approach between the different administrations is in line with the spirit of the Inspire Directive.

The overlays of orthoimages are part of the "basic reference data" included in that Directive. Aerial photography is the basis for carrying out cartography and geographic information in general, land occupation, urbanism and territorial planning, cadastre, forest management, hydrography, etc. Using the same starting photogrammetric data, a perfect geometric and temporal coherence of the cartographic and geographic databases existing in all administrations is also achieved.

The characteristics of the products obtained in the PNOA satisfy the needs of all the administrations involved.

The direction of the project is assumed by the Ministry of Transport, Mobility and Urban Agenda (through the General Directorate of the National Geographic Institute and counts with participation of the National Center for Geographic Information) and the Ministry of Agriculture, Fisheries and Food (through the Spanish Agrarian Guarantee Fund) as well as the Autonomous Communities.

https://pnoa.ign.es/web/portal/inicio



Orthoimagery from PNOA.

PNOA Lidar and DEMs

In 2009, after carrying out a series of pilot tests, and in response to the need of some of the project partners, to be able to have digital terrain models with greater precision, the opportunity arose to incorporate LIDAR technology into the PNOA project, thus emerging the PNOA-LiDAR project. The initial objective of the project was to cover the entire territory of Spain (in a 6-year cycle) by means of point clouds with x, y, z coordinates and attributes such as classification or colour, obtained by airborne LiDAR sensors.

The first coverage was captured between 2009 and 2015 and the second began in 2015 and the capture was completed in 2021.

The third coverage began in 2023, with the exception of Catalonia, which began in 2022 thanks to a agreement made with the Autonomous Community and will have a higher pulse density compared to previous coverage (5 p/m2), so that derived products will offer higher resolution detail and will address a greater number of uses.

The density of points has been 0.5 points/m² in the first coverage and 0.5-4 points/m² in the second coverage, with exceptions in which the density is even higher. The altimetric precision obtained in the second coverture was better than 15 cm RMSE Z. With the third coverture, the objective is to obtain a RMSE Z better that 10 cm, and to be able to achieve a hight degree of accuracy on the classification, not only for the most common classes (like vegetation, soil or buildings) but also for minority classes (like walls, electrical towers, wind turbines, ...). To achieve this in the most efficient way, some new technologies for the data processing in this coverture are being investigated and tested.



Picos de Europa, North of Spain, Color Point Cloud, PNOA Lidar.



Pyrenees, North of Spain, DTM, PNOA Lidar.

The LIDAR data and the derived products are distributed free of charge through the CNIG Download Center.

The PNOA-LiDAR is a collaborative project between the Ministry of Transport, Mobility and Urban Agenda (through the General Directorate of the National Geographic Institute and the National Center for Geographic Information and the participation of the public business entity ENAIRE), the Ministry of Agriculture, Fisheries and Food (through the Spanish Agrarian Guarantee Fund), the Ministry of Finance and Public Administration (through the General Directorate of Cadastre) and the Ministry for Ecological Transition and the Demographic Challenge (through the General Directorate of Forests and Desertification), as well as the Autonomous Communities.

https://pnoa.ign.es/web/portal/pnoa-lidar/presentacion

PNT

In 2004, the National Remote Sensing Plan (PNT) was launched, as a project integrated into the National Territory Observation Plan (PNOT), with the idea of combining efforts, both financial and management, between the different Spanish Public Administrations for the acquisition of national coverage with satellite images of different spatial resolutions.

Since 2005, images from different commercial satellites with different pixel sizes have been acquired and processed, and each year more public organizations make systematic use of them.

The National Remote Sensing Plan (PNT) provides regular coverages (annual, monthly and weekly) of the whole Spanish territory via medium and low-resolution satellite images (2.5 to 100 m).

More recently, from 2021 onwards, in the context of this plan, and based on the collaboration of several institutions (CDTI, ESA and IGN), Very High Resolution (VHR) annual coverages of Spain, for the Spanish Public Administration, are being delivered. The satellite mission that completed so far the 2021 and 2022 coverages is Geosat-2. The product has a maximum spatial resolution of 0.75 m. (pansharpened product). The other two products are the panchromatic (0.75 m.) and the multispectral one (3 m.). The processing level is L1C - Ortho. That is, a calibrated and radiometrically corrected product, manually orthorectified and resampled to a map grid up to 75 cm. resolution.

Basic and thematic geographic information is produced using the coverages provided by PNOA and PNT in a wide range of scales, from a local to a national level, by all cartographic institutions in the country.

For more information, please visit: <u>http://pnt.ign.es/</u>

Port of València. 2022 VHR coverage for Spain, with Geosat-2.

Land Cover and Land Use: SIOSE

The generation of Land Cover and Land Use reference information is driven by the SIOSE project (Information System on Land Cover & Use in Spain) which is based on a common object oriented data model for land cover and land use information built by integration of official reference information in the matter from national and regional public administrations, such as Cadaster, Agricultural Land Parcel Information System, PNOA LiDAR, National Forest Map, topographic databases, etc. From 2017 version, SIOSE project improved its spatial and thematic resolution getting a detailed description of the land close to a traditional scale of 1:5,000, adopting the name of High Resolution SIOSE.

On the other hand, SIOSE information is completely integrated in the European Copernicus Land Monitoring Services, offering answers to the production, validation and contrast of continental products. <u>http://www.siose.es/</u>



Example of HR SIOSE layers.

Cartography

According to the Spanish Cartography law, IGN-Spain is in charge of producing the official topographic cartography of the entire country through the maps dataset named National Topographic Map (MTN), which represents the topography at two scales: 1:25,000 (MTN25) and 1:50,000 (MTN50).

The IGN-Spain cartography production methodology has undergone a strong evolution in recent years thanks to new technologies that allow it to meet the new requirements of users who demand more accurate and up-to-date data sets.

Consequently, the IGN-Spain's current topographic cartography production is based on running a flow of automated processes that try to emulate the traditional procedures used in the elaboration of a traditional map. The full processes flow has been implemented both to generate the cartography at 1:25,000 and 1:50,000 scales and it consist of the following phases:

- 1st: Read, from the vector dataset stored in the geographical databases, and extract the information required by MTN.
- 2nd: Run the generalization and editing processes until obtaining a first output in vector format (pre-cartographic dataset).
- 3rd Run the symbolization and rasterization processes to obtain the final output of the map, in raster format.



Flow for the creation of the different products obtained from the automated production of the map.

From this general methodology, IGN-Spain provides different products regarding to the topographic cartography:

MTN25, MTN50 and High Resolution Map

MTN25 is the map sheets set (4,019 files) obtained from the automatic process at 1:25,000 scale, and MTN50 (1,073 files) is the equivalent at 1:50,000 scale. Both datasets are available through the official <u>Download Centre Website</u> and the cartography web map services <u>WMS</u> and <u>WMTS</u>.



Examples of MTN25 and MTN50 automatic outputs.

As a complement to this topographic cartography published via WMS, and with the aim of solving the main problems that the automatic process has got in terms of readability (first, the lack of space for the labelling, secondly the generalization of complex objects) a third dataset is produced: High Resolution Map. In this case the cartographic process feeds from the same geographical databases as well, and generates the information output with the same resolution as the original data, that means, with no generalization or manipulation actions.

The output of this High-Resolution Map is adapted for being viewed via web viewers, where the zoom removes the restriction of the visual limit of the paper, allowing the symbols and texts to be interpreted with smaller pictograms. These smaller symbols avoid applying automatic generalization and automatic editing processes to geometries to fit the available space.

This new automated production methodology started to work in 2020, providing an annual version of the MTN25 dataset. Since 2023, it is also used to produce the other two outputs thus, currently enabling the simultaneous publication of the three products to be provided twice a year, which is an unprecedented milestone and time record in the history of IGN's mapping production.

MTN25, MTN50 printed edition

The automatic production methodology is also applied, as a first step, to the creation of maps sheets sets MTN25 and MTN50, at 1:25.000 and 1:50.000 scale respectively, that must be printed so that users can purchase in the official maps shops.

In these cases, the final quality of the product is higher than the previous one since they are the result of reviewing, and editing if necessary, a checklist of elements focused on the main weak points of the automatic process where the output is not so good as it should be.

The production of the printed edition of MTN25 from automatic output was implemented in 2019 and currently the average annual production exceeds 800 map sheets, so it is expected to have the complete data set around 2024. In relation with MTN50, it is expected that the production starts from 2024.

Special maps at 1:25,000 and 1:50,000

This third set of maps are also generated within the framework of the MTN dataset, and which are created for reasons of tourist interest, either in natural areas or in cities and their surroundings. Production figures are around 10 special maps per year, considering both reference scales.



Special Maps of tourist interest.





Program for the Geospatial Information Databases (BDIG) continuous updating

In order to improve the efficiency in the continuous updating of the geospatial databases (mainly the National Topographic Database, BTN, and the Transport Network, RT) that feed de automatic map production of MTN25 and MTN50, IGN launched in 2017 the Program for the Geospatial Information Databases (BDIG) continuous updating, that includes three connected and complementary projects:

Changes Detection, to know what changes are taking place in the country. Here a wide range of possibilities opens up and the so-called changes generating engines come into play. Between 2020 and 2023, the focus has been on the use of Deep Learning techniques to extract objects from aerial or satellite imagery and compare them with the ones stored in the geospatial databases in a productive way. On the other hand, the huge availability of data, both public and private, makes it possible to detect changes with respect to the existing data in our topographic databases. So, linking to external data sources, especially public ones, gives us a way to automatically update and provide consistent data across different products.



View of road extraction.

Example of linking with other data.

Work orders management, to pack in work orders the detected changes that occur randomly throughout the country, as well as manage the assignment, execution, reception and validation of these work packages in an agile and controlled way. During 2022 – 2023, a new work order management application has been developed. It consists of a web application used by all the roles involved in the update process (Job generator, manager, operators, quality control user, etc.).

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View of the stack of available jobs.

BDIG production environment. To incorporate all these changes in the topographic database, it is important to use a work environment coordinated with the work orders management, to guide the operator in the tasks to be carried out, and that allows a joint update of all thematic areas covered to ensure consistency of data. In addition, although certain themes present a greater dynamism of changes, such as transport and buildings, in most cases they affect objects from other areas. For example, the construction of a highway or a new urban area will surely affect transport routes, buildings, hydrography, elevations, etc. The strategy, then, is to take advantage of the greater dynamism and impact that certain geographic objects

dynamism and impact that certain geographic objects produce to trigger the update in the rest of the themes. In the period between 2020 – 2023, the BDIG production environment has entered the production phase. Much progress has been made to improve the workflows for updating databases.



View of the BDIG production environment.

Let's see that with this new methodology, instead of updating large geographical areas (provinces, municipalities or sheets in full), it acts on tiny areas that are managed as an individual job. So, there has been a change from a planned updating system (predictive) to a more efficient system oriented to where the territory has really changed (adaptive).


Production of Geographic Reference Information

According both to the European Directive 2007/2/EC establishing an Infrastructure for Spatial Information in the European Union (INSPIRE) and to the Spanish Law transposing this Directive, which is Law 14/2010 of Spatial Data Infrastructures and Services (LISIGE) that encourages data re-use, the National Geographic Institute of Spain (IGN) started in the year 2014 to rethink its data production processes in order to become more efficient and to achieve that all cartographic products sharing a common INSPIRE theme could be derived from a single source, the so-called «Geospatial Reference Information Data Base (GRI)».

GRI Hydrography

The goal of the GRI Hydrography project is to get an accurate and easily updated river network as automatically extracted as possible. Even more, the aim is to produce, validate and consolidate the river network and other hydrographic elements between all the national competent organizations Water General Directorate and Hydrographic Confederations from the Ministry of Environment, and regional competent authorities. Thus, GRI Hydrography allows to have a precise, unambiguous updated information that is useful for all institutions and users. Validation has been already completed for 70,000 km corresponding to the Water Framework Directive (WFD) network.



Validated GRI Hydrography river network.

In order to achieve commented challenges, the river network is extracted combining hydrographic criteria (topographic network) and hydrological criteria (flow accumulation river network) from hydrological terrain models with a 2 m. resolution, which are obtained from the full LiDAR coverage for the whole Spanish territory with a 0.5 points/m² density. After this automatic production, process for quality control and validation are done to get a complete product. An last steps are for dissemination, by publication at INSPIRE services, direct download and a viewer. The result of this production is an accurate automatic hydrographic network for the whole country with a significant improvement as well as coherent with elevation datasets.



Hydrographic network coherent with elevation.

GRI Settlements

The main goal of the GRI Settlement project is to provide a high-resolution, nationwide homogeneous spatial information of settlements that satisfies the users' requirements in relation to their spatial management in different thematic areas, such as statistics, spatial planning, urban development, environmental protection, emergencies, demography, mapping, etc.

The GRI Settlement production is based on official data of cadastral parcels, statistical codes from the National Statistical Institute, national gazetteers and land use. To carry out this work, a methodology was developed for an automatic production to extract settlement boundaries according to cadastral data, based on the parametrisation of urban development (dispersion degree) and spatial analysis of cadastral data aggregation. After each step a revision is necessary to solve possible errors and to ensure the best quality for the final product. GRI Settlement offers a complete and accurate answer for statistical and geospatial integration for the most demanded areas where humans interact, move, work and live.



Functional areas: polygons for the predominant use: residential, industrial, services, etc. GRI Settlements v1.2020.



Population nucleus: identified by its statistical code (INE code). GRI Settlements v1.2020.

Envelopes: set of buildings that belong to a location known by the same name. GRI Settlements v1.2020.

GRI Transport Networks

The GRI-TN dataset aims to provide accurate, updated, high resolution and interlinked geospatial data of road, rail, air, water and cable transport network infrastructures.

After a three-year production process, GRI-TN was first released in 2017, in response to two specific requirements: first of all, to provide a dataset compliant with the Transport Network (TN) specification defined within the INSPIRE Directive. And, secondly, to gather in one central project the efforts needed to create and update transport infrastructures related data that would meet the requirements from the diverse mapping products developed by IGN itself.

After publishing that first version, the challenge has been to keep it complete, accurate and updated, and flexible enough to evolve and meet new users' requirements.

To achieve the first of these two goals, the data production and quality control processes developed to create the first release have been improved, based on the experience gained and the users' feedback.

The ability to effectively monitor the everyday changes that have an impact on transport infrastructures has been one of the keys to thrive on it, and it's been possible due to several strategic lines of action:

- First, identifying synergies and establishing continuous data flow agreements with the official stakeholders (mainly Cartographic Institutes of different regions and public institutions in charge of the transport infrastructures and Cadastral information), which has contributed to get straight away notice of most events that need to be represented in the dataset.
- Second, developing AI based algorithms that automatically detect feasible transport infrastructures changes all over the territory. This line consists of several different approaches: one of them analyzes web pages through NLP (Natural Language Processing) tools to find and geolocate news related to changes in the transport network. The second one is based on Deep Learning and Neural Networks to identify, infer attributes and vectorize transport network elements from aerial images and lidar products. A third one refers to massive comparison between GRI-TN dataset and other vector datasets to identify eventual errors.

Data production and quality check processes have been enhanced by implementing ad-hoc working environments both in commercial and open-source GIS software that automatize tasks, speed up dataset production rates, reduce the probability of making mistakes and ensure consistency with other datasets (e.g., GRI Settlements).

While it took 3 years to create the first version of the dataset, later versions have been released in progressively shorter periods of time, because of the steps given. Currently, a new version of the dataset with significant updates is published every three months. It is expected to maintain that rate and to broaden the variety of formats and channels through which the data are published.



The image gives a rough idea of the contents of the dataset: On the left, some summary statistics about the contents of the GRI-TN dataset; on the right, screenshot of the online tool created to help users query the content of the dataset (<u>https://www.ign.es/web/redes_transporte/</u>).

During the last years, GRI-TN has been acknowledged to be a high value dataset due to its homogeneous coverage of the national transport infrastructures and its spatial and temporal resolution. Users coming from different backgrounds have helped improve the dataset by solving specific data issues, describing their needs, or making suggestions about how to improve the data. This is how the data model has evolved to include additional elements not included in the first release, and to be used for some applications that go beyond initial requirements back in 2017. The improvement on topology and orientation of the graph that realizes the road network is a good example of this evolution. It was addressed to analyze the accessibility to public equipment (hospitals, motorways, and highways) and central urban areas from the rural or depressed areas in Spain, as part of a set of indicators needed to improve regional development policies.

Some other ongoing improvements aim to achieve a calibrated network from the current road network, to be able to dynamically geolocate events given by a kilometric point along any road, or to define automatized processes to obtain a generalized but topologically connected network, to meet the requirements coming from small scale products (which currently is still a costly process which highly needs of expert operators).

Summary of IGN cartographic products and geographic information databases

National Basic Cartography

- National Topographic Database 25K (BTN25) is the most accurate official seamless topographic spatial data of the whole Spanish Territory that keeps the consistence between different feature classes and the homogeneity in the whole territory. This database is structured in more than 100 feature types; it is important to highlight that it includes hydrographic and transport networks. On the other hand, it is the heart of our joint geospatial production system, so it is the main information source of the National Topographic Map and the rest of Topographic and Cartographic databases.
- National Topographic Map at 1:25,000 (MTN25) scale. Available in paper and digital format (vector and raster), in continuous updating.
- National Topographic Map at 1:50,000 (MTN50) scale. Available in paper and digital format (vector and raster), in continuous updating.

National Derived Cartography

National Cartographic Database 200K (BCN200) is the most accurate cartographic database of topographic spatial data of the whole Spanish Territory that keeps the consistence between different feature classes and the homogeneity in the whole territory at 1:200,000 scale. The main purpose of this database is to provide cartographic representations. It means that its geometries are edited; have symbology and according to this it could generate displacements in order to obtain a clear visual representation rather than (instead of) a precise location. This database is the heart of our derived cartographic production system, so it is the main information source of the Provincial Map Serie at 1:200,000 scale and the rest of Cartographic Databases and derived Cartography. It is periodically rasterized and it is used in the Web Services of the IGN-CNIG. > Provincial Map at 1:200,000 (MP200) scale. Available in paper and digital format (vector and raster), in continuous updating. It is a set of 48 independent maps of Spanish provinces at 1:200,000 scale.





> Regional Map Series. It is a map series of ten Regions that include several provinces from 1:200,000 to 1:400,000 scales.



- National Cartographic Database at 1:500,000 (BCN500) scale. It is a multipurpose geographic information, linked to the Map of Spain at 1:500,000 scale.
- Map of Spain at 1:500,000 scale. Available in paper and digital format (vector and raster).



Map of Spain at 1:1,250,000 and 1:2,000,000 scale. Available in paper and digital format (vector and raster).



Special Maps. We also respond to requests of public organizations demanding cartographic information. Then we recently design Ebro and Tajo Hydrographic basin map for the management in the Hydrographic Confedetations.



Raised Relief maps. They are a set of printed over the raised relief plastic maps. Regional Map Series, Map of Spain at 1:1,250,000 scale and most of special maps are printed in that way.



National Atlas of Spain

The National Atlas of Spain for the 21st century (ANEXXI), a scientific and technical reference work for knowledge and research into the geographic reality of Spain, currently produced by the Thematic Cartography and National Atlas Area of the National Geographic Institute (IGN), is included in the National Statistical Plan as well as in the National Cartographic Plan and applies the gender variable in the cartographic indicators represented in order to include the equality policies indicated in the Strategic Plan for Equality of Women and Men, all with the aim of being useful to society and the general public. It presents its latest publications in digital format via the geoportal of the National Atlas of Spain (ANE) in both languages (atlasnacional.ign.es and nationalatlas.ign.es) and in its traditional paper format.

The Department of Thematic Mapping and National Atlas follows a rigorous procedure to update and complete the contents of each thematic section that compose the National Atlas of Spain called "Spain on Maps. A Geographic Synopsis". This Atlas is being updated, starting with the 2019 edition; according to the criteria of the experts of the technical scientific network called ANEXXI Network, which stands for Network for the National Atlas of Spain of the 21st Century. Red ANEXXI now includes 150 researchers and professors who work at 36 Spanish Universities as well as the National Library of Spain, the Royal Academy of History of Spain, the Association of Spanish Geographers, the Official Association of Geographers and the Institute for Applied Economy, Geography & Demography at the Spanish High Council for Scientific.

The production of the National Atlas of Spain follows a solid system to guarantee its quality and compliance with management, editing and cartographic design standards.





"Spain on Maps. A Geographic Synopsis".

The ANE Geoportal

From 2019 to the present, the Geoportal of the National Atlas of Spain has been developed and updated in order to improve the dissemination of the thematic contents of the Atlas on the Internet.

The ANE Geoportal (<u>http://atlasnacional.ign.es</u>) is a web page that shows all the contents elaborated in the National Atlas of Spain (ANE) through any browser. In addition to being able to consult the compendium "Spain on Maps. A Geographic Synopsis" and the monograph "The COVID-19 pandemic in Spain", from the Geoportal you can access the viewers Atlas Nacional de España Interactive and "Buscón of National Atlas of Spain" and the sections "Featured maps", "Previous editions of the ANE and background" and "Resources not linked to a publication".

On the main page, the information can be consulted by clicking on the images of the sections or by selecting the type of graphic resource (maps, graphs, illustrations and images). The texts contain hyperlinks to other pages of the ANEXXI Geoportal itself or to other resources or websites. In addition, its pages can be easily shared through all social networks in order to build a network of geographical knowledge. Clicking on the graphic contents opens a multimedia viewer that allows, among other functionalities, the download of the images of the graphic resources.

The maps can be downloaded with more definition and in different formats through direct links from the Geoportal to the Download Centre of the National Centre for Geographic Information (CNIG). If the supplying organisation allows it, the statistical data and cartographic files used can also be downloaded for reuse in Geographic Information Systems.

The software used in the ANE Geoportal is the popular and collaborative Mediawiki. This tool has been chosen because it is free, versatile, its navigation is simple and the information is easy to structure; in addition to being well known by the user as it is the one used to build Wikipedia.



Home Page of the Geoportal of the National Atlas of Spain.

Interactive ANE Viewer

Under the technical support of the Geoclip tool, this web visualiser (<u>https://interactivo-atlasnacional.ign.es/#c=home</u>) presents and offers, in the form of quantitative maps, statistical data provided by the ANE. The maps can be handled interactively: perform any kind of zoom in areas of interest, select territorial units, adjust display parameters such as change of colour, size of symbols, interval thresholds and other actions.

In addition, the data can be consulted in tables and with statistical reports for better understanding and analysis. Another possibility offered by this tool is the possibility to import data. Users will be able to represent their own maps in a unique way or complementing them with the official ANE maps.

There are currently more than 600 indicators loaded, organised according to the sections and themes defined in the thematic structure of ANEXXI (history, population, transport, etc.), and they can also be consulted according to the type of representation (choropleths, proportional symbols or sectors) or the work in which they have been published (compendiums, monographs).





Front page of the National Atlas of Spain Interactive website for quantitative maps on Geoclip and example page.

The web search engine Buscón of the National Atlas of Spain (BANE)



Buscón del Atlas Nacional de España website.

(http://www.ign.es/ane/bane/) is a dynamic application that facilitates the exploration, retrieval and visualisation of all the resources of the ANE. There are currently 6,323 images of all the resources of the ANE elaborated in its different stages (ANE 1955-1985, ANE 1986-2008, ANE of the 21st century). The Buscón is based on the Thesaurus of the National Atlas of Spain (TESANE), a vocabulary created with a controlled language through the selection of terms or descriptors for each of the concepts included in the ANE resources and the establishment of hierarchical relationships (parent and child terms), associative relationships (related terms) and equivalence relationships (synonymous terms).

The ANE Thesaurus is available free of charge in the CNIG Download Centre in the Thematic Geographic Information section.

Monograph The COVID-19 pandemic in Spain. First wave: from the first cases to the end of June 2020

In 2020, the updating of the ANE publications was affected by the unexpected COVID-19 pandemic that occurred worldwide. This event triggered the need to provide Atlas users with a cartographic overview of the effects caused by the pandemic at national, European and global levels. In a first phase, the Atlas department prepared a series of maps in digital and interactive format on the effects on mobility as a consequence of the health crisis. This mapping was for internal use by the Ministry of Transport, Mobility and Urban Agenda (MITMA), and was made available on the Ministry's intranet through the interactive viewer ATLAS COVID: Mobility. These summary maps compared mobility in the different transport systems between the weeks of 2020 and their equivalent week in 2019.

This first contact with the consequences that the COVID-19 pandemic was having on the mobility of the Spanish population led the National Geographic Institute to consider producing an Atlas monograph that would study and geographically describe what had happened in Spain, also placing it in the European and global context. In December 2021, the National Geographic Institute produced the ANE monograph titled *La pandemia COVID-19 en España, Primera ola: de los primeros casos a finales de junio de 2020* (The COVID-19 pandemic in Spain, first wave: from the first cases to the end of June 2020).



Image from the monograph The pandemic COVID-19 in Spain. Spanish and English editions.

The monograph The COVID-19 pandemic in Spain. First wave: from the first cases to the end of June 2020, is an atlas that offers a geographical description, with the utmost scientific rigour, of the impact of the COVID-19 pandemic both in terms of health effects and in terms of its social, economic and environmental effects. The study extends in time from the first cases diagnosed in March until the end of June 2020 and, in space, it focuses on the national territory but placed in its European and global context. It is structured in three sections with 19 themes. It offers, through more than 400 graphic resources (maps and statistical graphs, tables, illustrations and texts) created with the scientific collaboration of numerous researchers

from the ANEXXI Network, relevant aspects to analyse the impact of the pandemic and, more importantly, to provide data that will help us to reflect on how to recover and prepare for similar crises. As in all ANE's works, the data are provided by agencies and entities of the General State Administration, as well as regional and local administrations.

Contexto global de la pandemia COVID-19



Screenshot of the section "The COVID-19 pandemic in Spain" in the ANE Geoportal.



Table of contents of the atlas The COVID-19 pandemic in Spain.



Image of graphic resources of the atlas The COVID-19 pandemic in Spain.

The printed publications, in Spanish and English, bound in hardcover with 160 pages in size 26 x 36.5 cm can be purchased at Casa del Mapa physical stores or at the virtual store (<u>https://www.cnig.es/home</u>) of the National Center for Geographic Information (CNIG).

In addition, they are also offered as digital books, in PDF format, in Spanish and English, for free download, from the website Libros digitales del Atlas Nacional de España (<u>https://www.ign.es/web/ign/</u> <u>portal/libros-digitales/libros-atlas-nacional-espana</u>).

The content of this ANE monograph can be consulted on the ANE Geoportal, in Spanish (atlasnacional.ign.es) and English (nationalatlas. ign.es), and many of the maps on the ANE Interactivo in Spanish (interactivo- atlasnacional.ign.es).

The work was presented on December 14, 2021 by the Undersecretary of the Ministry of Transport, Mobility and Urban Agenda (MITMA) and president of the Superior Geographic Council, Mr. Jesús M. Gómez García, the Director of the IGN and President of the CNIG, D Lorenzo García Asensio and the President of the ANEXXI Network, Professor José Sancho Comíns.

This monograph is a milestone in the long history of the ANE, as it is the first publication in English, the language most widely used in the academic world. The main objective of the ANE in English is to offer the world an official image of Spain that helps any citizen of the world to understand our reality. A presentation of this publication was also included in the Interactive Stories section, an application for educational purposes and general public consultation, where map viewers are combined with textual information, images and multimedia content, with the aim of taking advantage of maps and web services to tell a story.



Image from the StoryMaps COVID-19 of the National Atlas of Spain.

Style book of the National Atlas of Spain

One of the main objectives of the ANE is to establish guidelines that unify the wording of the texts in the Atlas, the use of geographical names and exonyms in Spanish, presented in its maps and publications, giving all the content of the ANE a personality of its own. For this reason, the Style Book of the National Atlas of Spain was presented in 2019. It is structured in four parts: spelling, style, place names and an alphabetical Index of words and concepts. The work is designed, in addition to being a guide book for the scientific collaborators of the Atlas, as an entertaining reference book for anyone interested in the process of written communication.

This ANE publication is available in the digital books section of the IGN website <u>http://www.ign.es/web/ign/portal/libros-</u> <u>digitales/libro-de-estilo-del-ane</u>



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Image of the cover and index of contents of the Style Book of the National Atlas of Spain.

The exonyms in Spanish. Criteria and uses in cartography

The ANE publication *Los exónimos en español. Criterio y usos en la cartografía* and its English version "Exonyms in Spanish. Criteria and usage in cartography", aims to offer an overview of the exonyms in Spanish used in ANE cartography. An exonym is the name used in a specific language for a feature located outside the area where that language is spoken and which differs from the name used in the area where the feature is located. The purpose of this publication is to reflect the debates, trends and criteria for the use of exonyms in Spanish and to collect how the doubts and problems raised in the treatment of foreign toponymy are resolved, especially in the cartography of the ANE.

This work is a benchmark in Spain and is also of great interest to other countries that have not compiled or defined the treatment of foreign toponymy in their cartography. The main reason why this work has been translated into English is to share, with the scientific community and international readers, the difficulties and concerns that have arisen, over the years, regarding the treatment of foreign geographical names and the the current way of solving them in the ANE.



Image of the covers in Spanish and English of the book Los exónimos en español. Criterios y usos en la cartografia -Exonyms in Spanish. Criteria and usage in cartography.

These ANE publications are available, in both languages, in the digital books section of the IGN website. <u>http://www.ign.es/web/ign/portal/libros-digitales/exonimos-en-espanol</u>

Cartographic bases CartoBase ANE

The ANE prepares and keeps updated the official small-scale cartographic bases necessary to prepare its thematic maps and offers them in the CartoBase ANE product in the Reference Geographic Information section of the CNIG Download Center.

It includes cartographic bases of Spain at a scale of 1:3,000,000 or less, and of Europe and the world used to elaborate the thematic maps of the ANE as well as the general maps of the series "Láminas y murales del ANE".

Currently, the ANE has formed and is finalizing the edition of a cartographic base at a scale of 1:10,000,000 that will serve to elaborate continental plates of the ANE Sheets and murals series, and also, allows completing a continuous map of the world that It is offered through standard web geoservices in IGN viewers and applications such as SignA, Iberpix, Atlas Didáctico in the zoom environment corresponding to said scale.

The formation and cartographic edition of this continuous map and continental sheets responds both to the needs of the printed map and to those of the digital map shown through the geographic viewers.

The process of designing the cartographic base at a scale of 1:10,000,000 has led to the definition in a first phase of 8 continental sheets printed at a scale of 1:11,000,000, of which those of Africa and Europe will be published in 2023, in addition to the complete map for web viewers.





World map image 1:10,000,000.

The series of continental sheets has some characteristics that allow us to offer an overview of the selected area and, although the shapes of the phenomena change slightly from one to the other, superficial comparisons between them can be made by choosing a cartographic projection that preserves the areas.

This cartography will allow obtaining sheets and murals derived at other scales, for example 1:50M, already very advanced, for other products and uses (such as didactic ones carried out by the CNIG).

Present

In 2022, after the publication of the monograph The COVID-19 pandemic in Spain. First wave: of the first cases at the end of June 2020, the publication on the Geoportal of the topics or subtopics that had begun to be updated in 2019 has been resumed. The first has been Communications, and the following will be History, Agricultural Activities, Geophysics, Geomorphology and Climate.

Also in 2022, the reconstitution of the ANEXXI Network began to simplify its structure and operation based on the experience acquired. Currently, the network of scientific and academic organizations that collaborates in the preparation of the ANE consists of 35 universities, 2 scientific associations and 3 research organizations. This new network will be the one that will define the contents of the compendium Spain on maps. A geographic synthesis in the 2023-2026 update.

In 2023, the new way of publishing the contents of the ANE begins: instead of waiting for all the contents to be updated to publish a single volume and digital book, it is published, in print and as digital books, by thematic sections, first in Spanish and then in English. In addition, the contents of the topics, or even subtopics, finished in the Geoportal are published. In this way, the time from the preparation of these geographical studies with official and, to the extent possible, consolidated data, from the most recent dates to their publication and dissemination will be reduced. The first thematic section to be published is History, both in Spanish and English, in all formats and channels.

This publication of the National Atlas of Spain is a compilation of the history of Spain explained through maps, from Prehistory to present. It constitutes an attempt to collect the main historical events to facilitate the geographical

comprehension, expressed visually through the territorial component. The maps are accompained by texts, which are the common thread that connects each map, by time lines and by synthetic tables of important events. The National Atlas of Spain has had the collaboration of specialists in History teaching from different Spanish universities, and is part of the masterwork España en mapas, una síntesis geográfica.



Cover of section III History of the National Atlas of Spain.

Library, Map Library & Topographical Archive

IGN is responsible by Law for protecting and updating bibliographic collections, historical cartography and technical documents, archiving georeferenced legal information and enabling their access to users.

These tasks are entrusted to the Service for Geographical Documents which is a department included in the General Secretariat of IGN. This department manages the cartographic and bibliographic collections as well as the Topographical Archive, which is of great value for the development of the cartographic powers entrusted to IGN.

All these documents shall be catalogued, classified, managed and preserved according to the possibilities offered by new technologies, in order to guarantee a suitable service for the different projects within IGN, for the rest of the Public Administration and to society in general.

Due to the diversity of the funds that are preserved and managed at the Service for Geographical Documents, there are three different offices, i.e. library, map library and topographical archive.

The library was founded in 1870, when the Geographic Institute of Spain was first established. During its 150 years of existence, it has specialised and endowed with bibliographic collections on those subjects related to the activities carried out by IGN. All funds are scanned and they may be managed by computer software. These collections are available on various means, i.e. library catalog on the IGN website, email, telephone or in person at the library itself.

The map library was also founded together with the Institution itself, back in the year 1870. It was born with the main task of preserving the different cartographic products used to draw the National Topographic Map at a 1: 50,000 scale.

Over time, the map library has become the deposit of all cartographic products within the National Geographic Institute, as well as other public and private organisations. Their funds are enriched every year by donations or acquiring cartographic collections which are of interest in the antique market. Among our cartographic funds, users may find a collection of maps of Spain and the rest of the world accomplished from the 15th to the 20th centuries, as well as several atlases and globes. Most of them are original pieces, yet some of them are very good facsimiles of unique pieces in the World.



Main page of our online catalog.

The Map library also stores all editions of the National Topographical Map series at 1: 50,000 and 1:25,000 scales, as well as all editions of Provincial and Regional map series.

The Map Library offers a customer service, both in person and by email. Much of their cartographic funds are digitized and some can be viewed and downloaded on the <u>map library catalog</u> that is located on the IGN website. Users may also find on this Catalog various applications such as virtual globes, geographical finder, interactive maps and virtual exhibitions.

The Topographical Archive keeps many of the documents accomplished in the cartographic production processes carried out by the National Geographic Institute from its foundation until approximately the use of aerial photogrammetric methods back in the 1950's. In addition, it preserves numerous documents accomplished by other organisations that existed prior to IGN, such as the General Board of Statistics and the Statistical Commission back in the 19th century. The Topographical Archive has got a vast amount of documents, most of which are original manuscripts, of both literal and cartographic information. The oldest documents date from the second half of the 19th century, yet some technical documents completed by the National Geographic Institute continued to be stored until the first half of the 20th century. Among these funds, the Kilometrical Sheets and the Cadastral Certificates of the General Board of Statistics shall be remarked, as well as some planimetric maps, altimetric maps, urban settlement maps, field notebooks and boundary line statement notebooks that were used for completing the National Topographical Map of Spain at a 1:50,000 scale.

The most demanded documents are currently digitised and georeferenced and can be downloaded using the <u>Download</u> <u>Center</u> on the IGN website. The Topographical Archive also handles requests from users by email, telephone or in person at the IGN headquarters in Madrid.

In addition to these tasks, annual exhibitions are prepared and arranged in order to show the cartographic collections to the general public. These exhibitions are open to the public and may be visited for free during the morning opening hours or by request guided tours by email.



Picture of our current exhibition.

Since 2015, five exhibitions have been developed, which are the following:

- > 2015: «Cartography in the 19th century»
- > 2016: «Maps in the time of Cervantes»
- > 2017: «Oikoumene, the evolution of the world's image»
- > 2018: «From Iberia to Spain through maps»
- 2019-2020: The maps and the first circumnavigation of the world: Magalhaes-Elcano»
- 2020-2022: 150 years of the National Geographic Institute of Spain
- > 2021: Cities of the world. Views, plans
- > 2023 current exhibition: The world in a double hemisphere

Furthermore virtual visits have been created for most exhibitions, so that they can continue being consulted online.

Astronomy, Geophysics and Space Applications

Earthquakes, ground surface deformation, gas emissions at volcanic areas, gravity measurements, geomagnetic datasets... All these observations carried out at IGN in the fields of seismicity, volcanology, gravimetry and geomagnetism are represented with detailed cartography and digital elevation models to provide accurate geophysical maps. IGN is the legal institution responsible for both the National Seismic Network and the Volcano Monitoring Network in Spain. In addition, IGN is also a Tsunami Warning Center of UNESCO and detects, assesses, and informs about phenomena that could induce a tsunami on the Spanish coasts.

These geophysical observations provide information about the physical processes that occur at the Earth's interior and are noted and measured on the ground surface. The information is georeferenced and combined with detailed cartography to give alerts to Spanish Civil Protection and to draw Spanish Hazard Maps. It also allows developing the Spanish Earthquake Resistance Code.

Furthermore, IGN owns instruments and infrastructures for radio astronomy, spatial geodesy and geodynamics that enable studying not only the Universe but also the geodesy of the Earth. Multiple space geodetic techniques and networks provide precise observations needed to monitor, map, and understand changes in the Earth's shape, rotation, and mass distribution, determining the celestial and terrestrial reference frames and giving information about precise positioning, Earth's Global Change, plate tectonics, etc.



National Center of Geographic Information

The National Centre of Geographic information (CNIG) is an independent agency depending on the Ministry of Transport Mobility and Urban Agenda, throughout the Spanish National Geographic Institute (IGN). CNIG is responsible for producing, developing and distributing the geographic work and publications demanded by society. In particular and according to the CNIG statute, approved by Royal Decree 310/2021, dated May 4, it is tasked with the following functions, among others:

- To distribute, promote and market geographic data, products, services and applications, paying particular attention to those generated by the IGN and CNIG itself.
- To exploit the IGN and CNIG geographic data, products, services and applications.
- To manage, evolve and maintain the technological infrastructure of CNIG.
- To plan and manage the Spatial Data Infrastructure of Spain and to administer the node of the IGN. To develop and maintain the portals and web applications of the IGN and CNIG.
- To develop projects and services on the initiative of the CNIG itself or in response to the initiative or demand of other institutions, especially the IGN.
- To provide technical assistance in the field of geographical sciences and the functions established in the statute, as well as those determined by the High Geographic Council.

In 2015 was published the Ministerial Order FOM/2807/2015, that establishes the data policy of the geographic data products of Instituto Geográfico Nacional (IGN Spain).

The article 4 states «The use of the digital geographic information products mentioned in Article 2 will be open and free of charge, provided that the origin and ownership of the data is mentioned, within the scope and in the way authorized by the corresponding license». Therefore, the use of the IGN's geographic data products and services defined within the scope of Order FOM/2807/2015 implies the user's acceptance of a $\underline{CC-BY 4.0}$ license.

The licensing conditions for the use of geographic data products and services produced by the IGN and for those co-produced by the Autonomous Regions and other public bodies within the framework of the National Cartographic System are available in: <u>http://www.ign.</u> <u>es/web/resources/docs/IGNCnig/FOOT-Condiciones_Uso_eng.pdf</u>.

The National Centre of Geographic information has published on paper the following data products between 2020 and 2023:

- National Parks
 - > National Park of the Atlantic Islands of Galicia ed.2022
 - National Park of Sierra de las Nieves ed.2021
 - ▶ National Park of Sierra Nevada ed.2021
 - ▶ National Park of Monfragüe ed.2021
 - National Park of Teide ed.2021
 - National Park of Guadarrama special ed. 2022
 - ► La Pedriza special edition 2022

National Topographic Map 1:25,000

- Seville and its surroundings
- Ávila and its surroundings
- León and its surroundings
- Salamanca and its surroundings
- Segovia and its surroundings
- Toledo and its surroundings
- Zaragoza and its surroundings
- Madrid and its surroundings
- Granada and its surroundings
- Guadalajara and its surroundings

🚺 National Topographic Map 1:50,000

Provincial Maps 1:200,000

- ► Asturias ed. 2021
- 🕨 Badajoz ed. 2022
- ► Cáceres ed. 2022
- Ciudad Real ed.2021
- ▶ Illes Balears ed.2021
- ► Las Palmas ed.2020
- ▶ Lugo ed. 2022
- Madrid ed.2022
- ▶ Santa Cruz de Tenerife ed.2019
- ▶ Soria ed.2021
- ► Valencia ed.2020
- Autonomic maps
 - Andalucia-1:400,000 ed.2020
 - Canarias 1:350,000 ed.2020
 - Comunitat Valenciana-1:300,000 ed.2021
 - Illes Balears-1:200,000 edición 2021
 - Principado of Asturias-1:200,000 ed.2022

🚺 Relief map

- Andalucía 1:500,000. ed. 2020.
- Principado of Asturias 1:200,000 ed.2022
- Canarias 1:500,000 .ed. 2020
- Illes Balears 1:250,000. ed. 2021
- Comunitat Valenciana 1:300,000 .ed. 2022
- Cuenca Hidrográfica of Ebro 1:600,000. ed. 2019
- ▶ Relief of the Iberian Peninsula, Baleares and Canarias 1:1.250.000 ed.2020
- ▶ Relief of Sierra of Guadarrama 1:50.000 ed. 2022

General map of Spain, Europe and world: physical and physical and political maps

- ▶ General Map General of Spain autonomic 1:2.000.000 ed. 2020
- The Iberian Peninsula Ibérica, Baleares y Canarias
 physical map 1:1.250.000. Ed.2021
- The Iberian Peninsula, Baleares y Canarias
 physical map 1:1.250.000. Ed.2022
- Political world map-Physical world map 2023 (mural 138 x 108).
 Printed two sides

- Map of Camino of Santiago (Way of St. James)
 - > Maritime pilgrimage routes to Santiago
- Natural spaces
 - 🕨 Camino Lebaniego
 - Barranco del Río Dulce
 - 🕨 Cabo de Gata-Nijar
 - 🕨 Hoces del Río Riaza
 - Serranía de Cuenca
 - 🕨 Las Batuecas-Sierra de Francia
 - ► Las Hurdes
 - ► Cañón del Río Lobos
 - Despeñaperros y paraje natural Cascada de Cimbarra
 - 🕨 Rio Duratón
 - 🕨 Sierra Cebollera
 - ▶ Neila, Laguna Negra y Urbión.
 - Calares del Mundo y de la Sima
 - Madrid Centre and Retiro park
- 🚺 National Atlas of Spain
 - Spain in Maps (A geographical synthesis) HISTORY.
 - The Covid-19 Pandemic in Spain (first wave: from the first cases to June 2020)
 - The Covid-19 Pandemic in Spain (first wave: from the first cases to June 2020) in English.
- 🚺 Book
 - ► Geoexplorer
 - Cosmographic curiosities
 - National Geographic Institute (1870-2020) 150th Anniversary
 - History of Cartography. The evolution of maps
 - The world drawn by children
 - Exhibition catalogue The world in a Two of Pentacles
 - Exhibition catalogue Cities of the world. Views and Plans
 - > Exhibition catalogue 150 years of the National Geographic Institute
 - > The Alcoy Earthquake of 1620 and the Seismic Series of 1644 in the región
 - Review of the Seismic Catalogue of the Canary Islands
 - > Panorama of the Universe: Journey through the world of astronomy
 - Cosmographic notes on the first circumnavigation of the Earthp

- Historical maps
 - ▶ Nova Orbis Tabula. (1670). 1722 Frederick de Wit
 - ▶ Nova Orbis Terrarum Delineatio (ca. 1658)
 - The first circumnavigation of the world.
 V Centenary Magellan and Elcano expedition
 - Map of the Principality of Asturias. 1870 -Francisco Coello / Pascual Madoz
 - > Geometric Chart of Galicia. 1845 Domingo Fontán

All these products are available in the online shop: <u>http://www.cnig.es</u>



Cathedral of Toledo, 1842.

Institutional website

This website represents the IGN and the CNIG, whose main objective is to bring more and better the geographic information to the society so that the National Geographic Institute and the National Geographic Information Centre become reference organizations in their areas of activity.



The current appearance of <u>www.ign.es</u> is:

Home of web IGN.

The principal components of this site are:

- Horizontal menu: It includes access to legal, historical and institutional information, access to the description of the main activities and services offered to the user and the professional publications. Also, the social Networks and a web browser.
- Gallery of activities: where to access the application, resources, data and documentation of each principal area of activity of IGN
- Central web content: section that allows access to the resources and website that the users visit more frequently: viewer, download centre, online shop, etc.

- Direct links: It includes the direct links to several applications and resources
- Bottom: links to thematic geoportal as well as information of Data policy, legal notice, frequently asked questions, etc.

During these years, <u>www.ign.es</u> has been visited more than 6 million times every year.

The «<u>Digital books section</u>» has increased during last year, offering more than 70 books on various topics. It must be highlighted «Spain on maps. A geographical synthesis», « National Atlas of Spain» and the educational books as the most downloaded.

Finally, it should be noted that <u>educational resources</u>, <u>Geodesy</u> and the <u>Map Library Catalogue</u> and the <u>IBERPIX viewer</u> are resources of high interest among our users.



Page of educational resources.

Access to the IGN website: <u>http://www.ign.es</u>

Download Center

Opening a new version in April of 2017, the <u>Download Center</u> (CdD) is a web site created by the National Centre of Geographic Information, aimed at serving users as a free tool for downloading geographic digital files generated by the Directorate General for the National Geographic Institute (IGN) and other public institutions.

The free and open use of the downloaded information is allowed for any purpose, including commercial and publication purposes, provided that recognition and acknowledgment of the IGN as source and owner of such licensed geographic information products and services is made (CC BY 4.0 ign.es), as indicated in <u>User license</u> document.

The section of «Products» shows the descriptions of all the products available for download. These products are grouped by type of data offered and their possible use for example, images of aerial photographs and orthophotos, map images, vector files, databases for spatial analysis, files containing 3D information, route map files, etc.



Home of Download Center.
Some examples of products to download:

- Images of aerial photographs and orthophotos of several years and with different pixel sizes, besides.
- ► Satelite imaggery.
- Basic topographical data necessary for the representation of the territory, such as transport network, gazetteer, boundary lines and geodetic points.
- Cartographic and Topographic Bases for exploitation by means of Geographic Information Systems (GIS).
- Altimetry information that represents the landform of the national territory and, in the case of LiDAR data, of the elements that are found on it as well (LiDAR 0.5-4.0 points/ m2 covering the whole Spain).
- Route files, including routes of the Camino of Santiago (St. James' Way), routes in National Parks and Greenways, designed for display on computer or mobile devices.
- Digital files resulting from the scanning all printed editions of the National Topographic Maps and other maps at different scales. They include a framework of coordinates and marginal information.
- Digital files from the scanning of documents of great cartographic and historical value, which include plans and manuscript maps, as well as minutes, and limit line records.

The number of products and downloads has increased the last year. In 2022, 2,11 PB of Geographic Information was downloaded; the DTM and Topographic Maps were the most demanded by our clients the last year.

Thanks to these changes, the IGN and CNIG continue to advance in the openness and re-use of geospatial information in Spain, development of new products and the implementation of application web, and to its positive impact in the socio-economic sphere.

Access to the Download center: <u>http://centrodedescargas.cnig.es/CentroDescargas/index.jsp</u>

SignA – The National Geographic Information System of Spain

The National Geographic Information System (SIGNA) of Spain is the on-line GIS of the National Geographic Institute (IGN), whose purpose is to integrate geographic data and services in a single geoportal for its analysis and consultation through internet http://signa.ign.es/signa



Home of SIGNA.

SIGNA was open to the public in December 2010 and nowadays it has reached the fifth version. The geoportal has been increasing the demand and today is a tool for daily use for many users and for very different applications.

It has been developed according client/server architecture, based on a thin client. This means that the processing is done in IGN's servers and it does not require installing any software, just to have a common browser. It is also implemented according to standards so it is fully interoperable with OGC services. The main functionalities are:

- Search: to look for population entities, geographic names and addresses, and locate them in the map.
- Measure of distances, areas and topographic profiles based on the points introduced by the user.
- Report of errors found in the data to improve the cartography
- Connection to standard OGC services: WMS, WMTS, WFS, CWS, etc.
- Loading of user data in different formats: GML, KML, Shapefile and GPX.

Tailor-made printing.

- Query of data using the SignA database containing more than 100 feature types about: administrative boundaries, hydrography, transport network, buildings, facilities, utilities, protected sites, etc. The queries can be:
 - Semantic: filtering by attributes. For example, consult the municipalities of the province of Cáceres with a population less than 500.
 - Spatial: considering spatial relations among different entities.
 For example, obtain the campsites contained in the Region of Murcia.
 - Buffer: obtain entities in a distance to an entity. For example, obtain the population in 10 km around the Gregorio Marañon Hospital.

The result of the queries can be downloaded in different formats: GML, KML, DGN and DXF.

As a conclusion, SIGNA geoportal integrates the best of GIS and SDI worlds in a common environment accessible in a free and open manner for experts and non-experts users.

Access to SiGNA: http://signa.ign.es/signa

INSPIRE Services and Datasets Official Catalogue (CODSI)

The Consejo Superior Geográfico (CSG), or national Geographic High Council, is the executive body of the National Cartographic System (SCN), having consultation and planning role for the official geographic information and cartography. CSG is the National Contact Point for INSPIRE and the body responsible for the coordination and direction of the National SDI of Spain (IIEG).

CSG created the «Consejo Directivo of la Infraestructura of Información Geográfica of España (CODIIGE)» (Executive Board of the Spanish SDI) for managing and controlling IIEG. One of the tasks carried out in the 2016 by CODIIGE was the creation of the «Action Plan» to ensure the implementation of Directive of INSPIRE in Spain and by defining the creation of «National official Catalogue of Dataset and Services INSPIRE (CODSI)».

CNIG is responsible for the implementation and coordination of Catalogue CODSI. This catalogue included 591 INSPIRE metadata files of dataset and services according

INSPIRE regulation 1205/2008 regarding metadata. It is connected via harvesting or files interchange with the catalogues of national and regional SDI nodes.

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CODSI interface.

To ensure the access to CODSI's resources, CNIG has implemented the National discovery service (following OGC CSW standard) to publish the collection of metadata that allows users searching and finding official geographic information and resources through a catalogue client.

The INSPIRE Geoportal is the central European access point to the data provided by EU Member States and several EFTA countries under the INSPIRE Directive. For Spain, the service CSW of CODSI is regularly harvested from the INSPIRE Geoportal to include the Spanish metadata in the Inspire Thematic Viewer.

The Geoportal of the Spanish Spatial Data Infrastructure, IDEE, include the point of access to this CODSI and since 2016 the CODSI is the base of the INSPIRE monitoring process.

Access to CODSI: <u>http://www.idee.es/csw-codsi-idee/</u>

Access to information of Monitoring Information: <u>https://www.idee.es/web/guest/ seguimiento-e-informes</u>

Web Services and mobile Applications

One of the works carried out by the IGN, through the CNIG, is the publication of web services to be used as cartographic map, development of applications for computer and mobile platform.

Web Visualization Services

Taking into account the principles of INSPIRE Directive about services and looking or compliance with Implementing Rules, CNIG publish Inspire Network Services.

From 2015 to present the number and the type of visualization and download web service has been increasing. And the requests of services have increased appreciably in the last few years. In 2022 would close with a record of more than 606TB request to visualization services.

Some of examples of web services most used:

WMS, WMTS and TMS of Base Map

Cartography from different geographic databases of Spain (ordered from smaller to larger scale) produced by several organizations (National Geographic Institute,) CEGET,



WMTS of Base Map.

Army Geographic Center, General Directorate of Cadastre. The access or connection to this service to obtain their intended functionalities is free of charge in any case if the authorship of IGN as proprietary of the service and its contents.

- ► WMS: <u>http://www.ign.es/wms-inspire/ign-base?</u>
- ► WMTS: <u>http://www.ign.es/wmts/ign-base?</u>
- TMS: <u>https://tms-ign-base.idee.es/1.0.0/IGNBaseTodo/</u> <u>{z}/{x}/{-y}.jpeg</u>

WMS, WMTS and TMS of IGN Cartography

Raster Cartography official of IGN at different scales. The access or connection to this service to obtain their intended functionalities is free of charge in any case if the authorship of IGN as proprietary of the service and its contents.

- ► WMS: <u>http://www.ign.es/wms-inspire/mapa-raster?</u>
- ► WMTS: <u>http://www.ign.es/wmts/mapa-raster</u>
- TMS: <u>https://tms-mapa-raster.ign.es/1.0.0/mapa-raster/</u> <u>{z}/{x}/{-y}.jpeg</u>



WMTS of Cartography.

WMS, WMTS and TMS orthophotos of the PNOA

These services lets view the most updated orthophotos of the PNOA (National Aerial Orthophotography Plan) from an approximate scale 1:70,000. For smaller scales (less detailed) Spot5 satellite images are shown. PNOA's coverage is built on different acquisition date and geometric resolution (50 or 25 cm) mosaics. The service shows these mosaics according with the default Inspire style. Allowed picture pixel sizes are between: width (10- 2 000) and high (10-2 000). The access or connection to this service to obtain their intended functionalities is free of charge in any case if the authorship of IGN as proprietary of the service and its contents (which can be stored for private use) is mentioned as follows: «PNOA provided by © National Geographic Institute of Spain».



WMTS of Orthophotos.

- ► WMS: <u>http://www.ign.es/wms-inspire/pnoa-ma</u>
- ► WMTS: <u>http://www.ign.es/wmts/pnoa-ma</u>
- ► TMS: <u>https://tms-pnoa-ma.idee.es/1.0.0/pnoa-ma/{z}/{x}/{-y}.jpeg</u>

It's also possible to see Orthorectified images of different photographic flights of national coverage (SIGPAC, OLISTAT, American flight, Series B flight, PNOA) promoted by different Public Administrations in the «Historical service».

WMS: <u>http://www.ign.es/wms/pnoa-historico?</u>

On this page, you may consult the list of available web services of IGN: <u>https://www.ign.es/ web/ign/portal/ide-area-nodo-ide-ign</u>

Mobile Applications (App)

Mobile device users prefer to use applications installed on their smartphones. For the last several years, CNIG has development several App Mobile:

- Maps of Spain: Free visualizer ideal for hiking, cycling, running, skiing, etc. which uses the services of the National Geographical Institute as background cartography and other sets of services from other Ministries
- Seismology pro: App that allows the reception and visualization of all the seismic events of Spain and surroundings in an Android OS device.
- National Parks: Application that allows you to consult information on the history, wildlife, vegetation and routes of the National Parks of Spain as additional information, such as information centers, accommodation, lookouts, shelters, etc.
- Santiago Way: Application to facilitate the realization of the different stages of the Ways of Santiago (French way, North way, etc.) and their points of interest using the mapping services of the National Geographical Institute as a cartographic background and all the information on the stages provided by the Spanish Federation of Friends of the Camino of Santiago Associations.
- GeoSapiens: Mobile application of interactive maps to study the physical, political and landscape geography of Spain and the world. It is bilingual (Spanish and English) and most of the games do not require internet connection.



App Santiago Way.

On this page, you may consult the list of Apps available: https://www.ign.es/web/ign/portal/dir-aplicaciones-moviles

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Spanish Army Geographic Center

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Darío Gazapo, 8 Acuartelamiento Alfonso X E-28024 Madrid - Spain Phone number: +(34) 91 512 66 00 E-mail address: ceget@et.mde.es

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Spanish Army Geographic Centre

The history of the geographic Centre of the Army dates back to the year 1810, when General Joaquín Blake Joyce created the General Staff Corps and the four sections into which it was organized. Two of them, the second and the fourth, were entrusted with matters related to geography, topography and the file of maps, sketches, etc.

In 1838 the "Depósito de la Guerra" was established and with the creation in 1886 of the Workers' Brigade and Topographic, it was provided with its own auxiliary personnel. The main missions were the preparation of maps and itineraries and their conservation, but in 1881, the appropriate instructions were given for carrying out topographical works of an eminently military nature.

At the end of the Spanish Civil War (1939) by law of September 22nd that reorganized the army, the Army's geographic and cartographic service was created. Subsequently, on December 29th of that same year, it was entrusted with the command of the Workers' Brigade and Topographic. In 1997 it was renamed as the Spanish Army Geographic Centre.



Spanish Officers. Madrid 1927.



Military maneuvers. Salamanca 1932.

The Spanish Army Geographic Centre is responsible for providing geospatial support, either general or specialized, to headquarters and units, both for planning and conducting military operations, as for other exercises and activities carried out on host nation or abroad. For this goal and according to an Armed Forces Cartographic Plan on a four-year basis, the Centre produces both national territory geospatial information as well as for those external areas of interest as determined.

The national territory information production relies on standardized cartographic series. The M781S national territory series production at 1:50,000 scale continues to be by updating the previous M7814 series from the photogrammetric flight and on-field review, all in the European Terrestrial Reference System (ETRS89) and REGCAN95. At the same time, the "MGCP Framework" has been successfully implemented both in the new information extraction and in the database schema, modifying the series final appearance and advancing in the future M7816 series workflows development. At this moment, the MGCP data scheme is fully implemented throughout capturing, field reviewing, quality control, and cartographic training and editing, with the MGCP Topographic Map (MTM) form and symbology.



Sheet 47-38 Corralejo (P714 series).



Sheet 14-06 Ejea de los Caballeros (M682 series).

The M682 series at 1:100,000 scale is produced from the BTN100 vectors. The BTN100 is a database compliant with the European INSPIRE directive and the result of the collaboration between the Spanish National Geographic Institute and the Spanish Army Geographic Centre for the 1:100,000 and below scale cartographic series harmonized production. This project is representative of a milestone in the collaboration between institutions and organizations producing information in Spain.

The small scale series, Joint Operations Graphic 1501 (Ground) at 1:250,000 scale, 1404 series at 1:500,000 scale, and the maps of Spain at both 1:1,000,000 and 1:1,500,000 scale, all with four-year periodic updates, fulfill the national territory information needs for military units planning and conducting operational activities. These series production flows are under consideration, with a 4-6 year aim of gradually adapting the database schemas and the finished products to the Defense Geospatial Interchange Working Group (DGIWG) specifications and common standard framework.

The national territory information for military units training gets supplemented by the CMT series. These heterogeneous series consists of maps and orthophoto maps, at several scales, of training and firing range grounds and military installations. In addition to topographic information, it provides a military information layer with a new symbology according to STANAG 3833 Ed4, in particular AGeoP-15 Edition A version 2 (October 2020). As in the M781S series, the CMT series production flows have been adapted for the workspaces and MGCP database schemas full adoption, including the M881S series.



Sheet 347-C (Sevilla) from 1404 series.





The information production from areas of interest out of the national territory is based mainly on the spatial orthoimage and Multinational Geospatial Co-Production Program (MGCP) information usage. Spain joined the program as a "leading nation", with the Spanish Army Geographic Centre working in high-resolution satellite images orthorectification, vector format (HRV) information extraction, and ensuring quality by inspecting both Spain produced data and other program participant countries data.

In addition, Spain is part of the TREx program (TanDEM-X High Resolution Elevation Data Exchange), where the Army Geographic Center actively participates and Spain is a Nation in Charge of Quality Assurance (QA) in this program. TREx is a multinational coproduction program to build a high-resolution global terrain model from radar imagery from the TERRASAR and TANDEM-X satellites. This program uses a credit-based system vice geotile-based system to make it more equitable to participants. Nations receive credits, depending on the number of credits they generate. Once a nation produces TREx DEM finished worth 300 credits, they are deemed a full access nation and will have access to the entire alliance DEM finished holdings. Due to its production rate, Spain aims to it in 2026.

From these MGCP and TREx data, a 1:50,000 scale standardized cartography is produced from different areas of the world where Spanish military units have deployed, supplementing this information with larger-scale products based on both spatial orthoimage and relevant-in-each-case vector information overlapping. The necessary modifications have been implemented to transform the production flow from the MGCP Derived Graphics (MDG) format to the MGCP Topographic Map (MTM) format.



Sheet MTM 50154 (Adan) of Yemen K762G series, produced from MGCP data. The Army Geographic Unit is capable of deploying in all theatres of operations. It has all the necessary elements to provide accurate and timely geospatial information to the forces on the ground. This support includes, in addition to the cartographic production tasks, the topographic work, the field mapping review, the Battlefield Intelligence Preparation (BIP) process support, the thematic cartography production, the printing and dissemination of cartography, the natural disasters simulation, and the virtual and 3D scenarios modeling, collaborating in both multinational operations and exercises as well as other country-level operations and exercises. Its international collaborations include the participation in the Eurocorps Combined Geo-Support Unit, the NATO Response Force, the Multinational Geospatial Support Group (MN GSG) and the European Union Battlegroup. At the national level, the Military Emergency Unit collaborations stand out.



Army Geographic Unit Geodrone RPAS take off.

It has the most modern material to carry out its duties, highlighting among them a Spanish-made cartographic RPAS system, the GEODRONE, and a Trimble SX10 total robotic laser scanner station, which has led to taking the first steps towards obtaining point clouds and 3D topographic surveys.



Point cloud and panoramic tunnel image.



Another Geographic Centre task is maintaining a representation and participating in several national and international working groups. For instance:

- Multinational Geospatial Co-Production Program (MGCP)
- MGCP Urban Vector Data (MUVD)
- TanDEM-X High-Resolution Elevation Data Exchange Program (TREx)
- Defence Geospatial Information Working Group (DGIWG)
- > NATO Interservice Geospatial Working Group (IGeoWG)
- Spanish Spatial Data Infrastructure (GT-IDEE)
- ▶ The Geodetic Reference System Working Group
- NGIF Data Model Working Group
- Geographical Names Committee
- Any work groups or committees of said Organization that are of interest for the development of its duties

As a geographic information system for the Army, the Geographic Centre holds the "Carta Digital" program technical lead. Carta Digital is a complete Geographic Information System that allows the visualization, analysis, and exploitation of different raster and vector formats of geospatial information, with 3D visualization and analysis capability and advanced symbology, including APP-6D military symbology. This software is widely used in the Spanish ground forces, providing them with an useful tool for managing geospatial information. Recently, there has been an evolution from the latest version (v8.2) to a new 64-bit architecture (Carta Digital v10).



Carta Digital 3D Model from a Geodrone flight.

The Army Geographical Centre is responsible for maintaining and demarcating the borders with Portugal, Andorra and France. Bilateral meetings are held annually with officers responsible for maintenance and representatives of public administrations on both sides of the border. A joint campaign is carried out with the Portuguese and French counterpart partnership on each side to demarcate, mark borders, control and clean up. It has also collaborated with the Spanish Hydrographic Office to study the areas reclaimed from the sea after the last eruption of the Cumbre Vieja volcano (Canary Islands).



GNSS measurements on the island of La Palma and on the Spanish-French border.

The Geographic Centre has a complete graphic arts workshop at its Publications Headquarters to supply the Armed Forces with cartography and other publication types. Its capabilities include a phototypesetting and digital design section, a lithography workshop with "offset" printing presses, a digital printing workshop with small and large format reprography capability including high-performance "plotters", and a bookbinding workshop.

Finally, the Geographic Centre maintains in its Cartographic and Geographic Studies Archive (ACEG) a collection of 290 atlases comprising 354 volumes and around 31166 single sheet maps dated between the 16th and 20th centuries. Although the geographical scope is global, most works correspond to Spain, the Americas, North Africa, and the Philippines. The archive has a permanent exhibition at its headquarters in the "Acuartelamiento Alfonso X" barracks. Annually organizes an itinerant character exhibition in several Spanish cities.





Publication Headquarters "offset" printing press.

Cartographic Archive permanent exhibition room.

NATIONAL REPORT SPAIN 2019-2023 Spanish Army Geographic Centre

Spanish Hydrographic Office

HM



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Spanish Hydrographic Office

The Spanish Hydrographic Office (*Instituto Hidrográfico de la Marina, IHM*) is a Spanish Navy organization of public and international interest, tasked with the safety of navigation and the capture and dissemination of maritime and coastal information to further nautical sciences. One of its main missions is the production, publication and updating of nautical charts considered of interest for mariners, as well as military cartography. Also, production of military cartography developed in different Additional Military Layers (AML) to be used in WECDIS consoles is carried out.

The «Instituto Hidrográfico de la Marina» (IHM) as we currently know it did not operate under such a name from the start, and it was not even based in Cádiz as it is now. To find the roots of the activities carried out by the Instituto we should go back to the *Casa de Contratación*, established in the Atarazanas at Seville in the early 16th C, specifically in 1503, by the Catholic King and Queen. The *Casa de Contratación*, despite being subordinated to the *Consejo Real y Supremo de Indias* in 1524, directed for a long time the discovery, colonization and commerce with the New World. When the *Casa de Contratación* was officially ended in 1790, it was evident the need for some body to fill the gap that this disappearance had left. Although there was a Hydrographic Deposit since 1770, the edition of the *«Atlas Marítimo de España»* (Maritime Atlas of Spain) by Vicente Tofiño -the most important cartographic work in Spanish

History-, prompted the creation of some organization for the coordination and standardization of the cartographic production. So, by the R.O. dated 17 December 1797 it was established the Dirección de Trabajos Hidrográficos or Dirección de Hidrografía (Directorate of Hydrographic Works or Directorate of Hydrography). In 1921, Spain became a Founding Member of the International Hydrographic Bureau, an organization established to foster cooperation and standardization among Hydrographic Offices of their Member States. In 1927 the Observatorio de Marina de San Fernando (ROA), established its Section IV, Servicio Hidrográfico de la Armada (Navy Hydrographic Office). In 1943, considering the need to further hydrography, the hydrographic service was detached from the ROA and so the IHM was born by law dated 30 December, sited in Cádiz and as an organization under the Navy Staff to promote cartography and achieve wider action in all functions related to hydrography and navigation.

The Law on the Organization of Cartography (7/1986) states that the production and maintenance of basic Nautical Cartography belongs to the State Administration, through the IHM. On 1 December 2007, Royal Decree 1545/2007 dated 23 November entered into force, regulating the National Cartographic System. Basically it reiterates the same principles, and it specifically states: «It belongs to the *IHM* all planning, production scheduling, creation and maintenance of nautical cartography».

Honorary mentions

In 2022, was celebrated the 225th anniversary of the Hydrographic Service in Spain.

From 2019 to 2022, IHM participated in the celebration of the 500th anniversary of the first round the world.



V/CENTENARIO <u>1^a VUELTA AL</u> <u>MUNDO</u>

Competencies:

Collection of data and news on alterations in the environment, aids to navigation or dangers to the same, which will be disseminated as Notices to Mariners, for the updating of nautical charts. In especial:

Hydrographic surveys and studies on submarine relief in Spanish coasts and maritime areas. As well as, systematic observation and study of tides and currents, temperatures and acoustic and electromagnetic propagation in seawater.

Development of Nautical Charts, books and documents as aids to navigation, and their printing and distribution.

During the last two years the production of New Charts and Editions on paper is considered as adequate, as the average age of published cartography is 12 years, which compares favourably with neighbouring Hydrographic Offices.

Also, as a part of the Cartographic Project, production of ENC Electronic Cartography is continued, having achieved full coverage for Purpose 2 «General 1:1,000,000», Purpose 3 «Coastal 1:100,000», Purpose 4 «Approaches 1:50,000», Purpose 5 «Harbour 1:8,000». Purpose 6 «Berthing 1:4,000» is at 10% coverage and it is expected to achieve complete coverage at the end of 2022, covering all main ports and harbours.

From 2019 to 2023 this IHM provided the Central Registry for Cartography under the National Geographic Institution with the updated coastline for Spain, derived from the base chart series at scale 1:50000.

Cartographic Production

Cartographic production during the relevant time period is as follows, both for paper charts and ENC.

Paper Charts

A total of 151 nautical charts were published, as follows:

- ▶ 83 New Charts and New Editions.
- ▶ 68 Re-printings.



NC 4011, INT1852, Puerto de Santander. This chart achieved the second award in the 30th International Cartographic Conference - ICC 2021, in the category charts over panels. The graphic includes the entrance to the estuary, as well as the shipyards and main docks.

Electronic Nautical Charts (ENC)

A total of 266 ENC have been produced, as follows:

- > 24 new charts.
- ▶ 242 new editions.



Electronic Nautical Chart ES541513 Puerto de Portosín. This chart has been the 8000th chart published by the International centre of ENC.

Currently the overall amount of available ENC is 318, which can be classified by their navigational purposes as follows:

- 🗩 General 4
- ▶ Coastal 21
- Approach 84
- ▶ Harbour 203
- ▶ Berthing 6

Updates

Our chart portfolio is updated using information received mainly from Port Authorities, Hydrographic Commission, Harbour Master and Naval Offices. They are distributed as follows:

- 1547 Notice updating paper charts, 98 of which included a block correction, published in the Weekly Edition of our Notices to Mariners Bulletin.
- Also, the corresponding corrections were applied to the stocks of paper charts at this IHM.
- ▶ 1928 updates for ENCs.
- ▶ 5455 Print on Demand paper charts.
- > 3063 Total overturned notices to mariners.

Other Nautical Publications

- A new edition of IHO INT1 publication «Símbolos, abreviaturas y términos usados en las cartas náuticas» (Symbols and Abbreviations Used on Nautical Charts) was published in December 2022 as 7th edition. This is the Spanish version of the official IHO INT1 publication.
- A new edition of «*Catálogo de Cartas Náuticas y Otras Publicaciones*» (Nautical Chart and Publication Catalogue) was published in 2019, 2020, 2021, 2022 and 2023.
- IHO S4 publication «Regulations for International (INT) Charts and Chart Specifications of the IHO (Spanish: Edition 4.9.0, March 2021 was translated into Spanish.
- A new edition of «Catálogo de Cartografía Nautica Militar» was published in June 2023.
- 3 Leisure charts, D49AN, D49AS and D46 were published in A3 booklet format.
- New printings of the Training Chart and Plotting Sheet (OB).

Historical Nautical Cartographic

Historical Nautical Cartographic production during the relevant time period has been a total of 56 new charts plus 650 ancient nautical charts from Vicente Tofiño's campaigns have been digitized. One example of this historical cartography is this chart of South Hispano América surveyed during Malaspina Expedition at the end of the XVIII Century in the former Spanish territories.



Military Cartography

AML Project

Once NATO has implemented STANAG 4564 (Warship Electronic Chart Display Information System (WECDIS)), covering the considerations from all participating countries in the development of the so-called Warship Electronic Chart Display and Information System (WECDIS), which is a customization of ECDIS performance standards for warships, a CD was produced with several demonstrations following with the stages of a project for AML development STANAG 7170 (Additional Military Layers (AML) – Digital Geospatial Data Products). These involve a number of digital geospatial data products in a joint presentation to satisfy the requirements of NATO naval defence beyond simple navigational use. AML production follows S-57 specifications, supplemented by some special Product Specifications to cover their specific needs.

A production scheme for 246 products has been designed, prioritizing such layers with updated data available and considering the geographic areas where the Navy carries out major exercises.

Developments

IDE Infrastructure

In the last four years, the IHM Spatial Data Infrastructure Geoportal (IdeIHM), available at https://ideihm.covam.es, has been updated. This update involved developing a new geographic information viewer, updating the Data and Web Services Catalog (CSW), and creating new INSPIRE-compliant services

An API has been created to access tidal information. The viewer now includes a plugin to access to all maritime signals included in the List of Lights.

In addition, an application for mobile devices has been developed, "IHM Información Náutica" [IHM Nautical Information], available for Android and IOS. This application accesses IdeIHM display services (WMS) and provides access to information on the Nautical Chart Catalog, Notice to Mariners Bulletins, Maritime Signals and Tide Predictions.



International and National participation

IHM as cartography institution takes part in the following organizations:

 Council Geographic Superior (CSG) and its Specialized Commissions.

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Spanish Geospatial Data Infrastructure (IDEE).

Represents the Spanish State in the International Hydrographic Organization (OHI), and it is involved in the following international forums and working groups:

- Assembly and Council.
- Mediterranean and Black Sea Hydrographic Commission (MBSHC).
- **East Atlantic Hydrographic Commission. (CHATO).**
- > Hydrographic Commission on Antarctica (HCA).
- Meso-American and Caribbean Sea Hydrographic Commission (MACHC).
- South-East Pacific Hydrographic Commission (SWPHC).
- Long-range Radio-Notices for the Mediterranean and the Black Sea (NA-VAREA III).
- > Hydrographic Services and Standards Committee (HSSC).
- > Hydrographic Surveys Working Group (HSWG).
- S-100 Working Group (S100WG) and its associated project teams.
- **ENC** Standards Maintenance Working Group (ENCWG).
- ▶ Worldwide ENC Database Working Group (WENDWG).
- Sub-Committee on the World-Wide Navigational Warning Service (WWNWS-SC).
- Nautical Cartography Working Group (NCWG), (Formerly CSPCWG).
- > Nautical Information Provision Working Group (NIPWG).
- ▶ Tides, Water Level And Currents Working Group (TWCWG).
- ► Capacity Building Sub-Committee (CBSC).

Represents the Navy in the following Bodies and Commissions

- ▶ International Maritime Organization (IMO).
- IMO Subcommittee on Navigation, Communication and Search and Rescue (NCSR).
- International Commission on Lights (IALA).
- > NATO Committees and Working Groups that are determined.
- > NATO Geospatial Maritime Working Group (GMWG).
- NATO Geospatial Maritime Working Group Technical Panel (GMWGTP).
- NATO AML Co-Production Programme Technical Panel (NACPP TP).
- Part of the International Boundary Commissions with Portugal and France.
- Any work groups or committees of said Organization that are of interest for the development of their duties.

Cartographic and Photographic Center. Spanish Air and Space Force

Base Aérea de Cuatro Vientos Avenida de la Aviación 14L-10 E-28054 Madrid - Spain Phone number: +(34) 91 649 32 33 E-mail address: cecaf@ea.mde.es Cartographic and Photographic Center Spanish Air and Space Force

Cartographic and Photographic Center Spanish Air and Space Force

From 1920, when the aerial photographic and reconnaissance activities began, until now, the Spanish Air and Space Force has produced many cartographic and photographic series, which have been used in every flight of an Air Force aircraft.

In 1930 the Cartographic and Photographic Military School was created in order to train the aircrews in the photographic techniques. Later, in 1950, the Cartographic and Photographic Service produced the first aeronautical charts for fighters. Meanwhile the School continued training personnel in photogrammetric and cartographic sciences. In 1979 the Cartographic and Photographic Centre adopted the current denomination, CECAF.

Today, CECAF main activities are aeronautical cartography production, photointerpretation, aerial photography, flight inspection for navaids calibration, instrument flight procedures design and aerial validation, topography, photogrammetry, offset printing, historical photography archive and photo-video production. CECAF main geospatial productions are instrumental and visual aeronautical charts and instrument flight procedures. The geospatial aeronautical information depicted in these products are mainly collected from two sources:

- Aeronautical Information Publication (AIP) from Spain, Portugal, France, Morocco and Algeria.
- CECAF topographic equipment and aerial images from the digital sensor on board of CECAF aircrafts. This aeronautical information is managed under the structure of Aeronautical Information Exchange Model (AIXM).

The aeronautical elements published in CECAF charts use the WGS84 Geodetic Reference System. The altimetry reference system for the Iberian Peninsula is the mean sea level marks in Alicante, and in the islands is used the local tide gauge information of each one.

Charts for Instrument Flight Rules (IFR) Scale 1:2,000,000

The usefulness of these charts is the instrumental navigation through airways, following IFR regulations. IFR are flights referenced to instruments in cockpit. Navigation (course and distance) is accomplished by reference to electromagnetic signals.

There are two instrumental charts, Lower Airspace Chart which contains aeronautical information up to flight level FL245 (24,500 feet), and Upper Airspace Chart with aeronautical information from FL245 and above. Both charts have Lambert conformal conic projection.

Geographic information is considerably simplified because in aeronautical charts only aeronautical information is required for flight procedures.
The following information is depicted: airways, navaids, aerodromes, waypoints and airspaces. Significant airspaces are Prohibited Area (P), Restricted Area (R), Dangerous Area (D), Wildlife Sensitive Area (F), Flight Information Region (FIR) and Terminal Maneuvering Area (TMA). It is depicted also magnetic course, distances (measure in feet) and another information that may be used for IFR purpose.

Airways are routes followed by airplanes and are the most significant features depicted in instrumental charts. Airways can be one-way or two-ways. Course and elevation are depicted for every airway. Different elevations within the airway determine level flight of the aircraft. The airways are composed of sections between two points. These points are navaids or waypoints.

Navaids are electronic equipment facilities used to provide course, range and/or altitude to aircrafts so that they can determine their position and in some cases the distance to them. There are several types of navaids, TACAN, VOR, DME, NDB, etc.



Lower Airespace Chart of Iberian Peninsula, partial view.

Terminal Maneuvering Area (TMA)



TMA Chart partial view, TMA of Galicia.

These charts provide information for airplane operating with IFR in the TMA airspaces established in the Spanish territory. The aim is to provide information to move from the en route phase of flight to the initial approach. The scale may vary according to the area to cover and the projection is Lambert conformal conic.

Airports affected by terminal routings and airways are represented on TMA charts. Also is depicted navaids, radio frequencies, waypoints, distances, magnetic declination, holding patterns, magnetic bearings, airspaces, altimetry data, etc.

This chart is edited on a single sheet, using the front and back. It is selected the eight most important TMAs: Madrid, Galicia, Valencia, Zaragoza on the front and Barcelona, Seville, Palma, and the Canary Islands on the back. That provision has not been arbitrary; it has taken into account the folding of the sheet.

Visual Navigation Chart (CNV) Scale 1:1,000,000

Airfields, airspaces, obstacles and navigational aids (navaids) are depicted on the Visual Navigation Chart. An important subject in this kind of charts is altimetry information, showed in feet. Vertical obstructions from 200 feet and above are depicted, combined with the maximum elevation figures, that show the highest elevation value in each grid, to ensure flight safety. Hypsometric and bathymetric curves are used too in this chart.

According to NATO standards, this chart uses WGS-84 and Lambert Conformal Conic projection. CNV is published each year and is divided in three separate sheets that completely cover the entire Spanish territory (East and West of the Iberian Peninsula and the Canary Islands). On the back of each of them is depicted airspace restrictions, communications, graphic scales and the chart legend.



Visual Navigation Chart East Peninsula partial view.

Low Flying Chart (LFC) Scale 1:500,000

LFC is designed primarily for navigation under visual flight rules in peacetime missions. This aeronautical chart is used for mission planning as well. Aeronautical elements and topographical information are combined in order to navigate using terrain visual references. The aeronautical features depicted in LFC are airfilds, runways, navaids, waypoints, obstacles, airspaces and emergency landing sites.



Sheet number 6 corresponding to LFC Balearic Islands area.

In each grid of the chart, the Maximum Elevation Figure (MEF) is depicted, showing a number which represents the highest elevation in hundreds of feet. Moreover, vertical obstructions higher than 61 meters (200 feet), like windmills, power lines or antennas, are highlighted. These elements make the chart safer for low level navigation, avoiding dangerous elements.

LFC use WGS-84 and Lambert conformal conic projection. Spanish territory is divided in nine sheets which are updated each year.

Transit Flying Chart (TFC) Scale 1:250,000

TFC is an aeronautical chart quite similar to LFC, but using higher scale. This chart is designed primarily for low level navigation under visual flight rules in peacetime missions, and is published each year too.

TFC uses the same Geodetic Reference System and projection as well, according to NATO Standards.



TFC NJ3008 Granada.

Joint Operations Graphic - Air (JOG-A) Scale 1:250,000



JOG-A NJ3005 Ciudad Real.

Joint Operations Graphics Air is designed primarily for navigation under visual flight rules in operational environments and also for mission planning. It uses WGS-84 and UTM projection. It is published each five years, dividing Spain in 44 sheets which cover the entire territory.

JOG-A is made using topographic features provided by Spanish Army Geographic Center and published in their Join Operations Graphic (Ground). These features like lakes, rivers, villages and mountains are taken as visual reference.

This topographic information is combined with the necessary aeronautical information features for low level navigation, including airfields, emergency landing sites, navaids and vertical obstructions over 61 meters.

The aeronautical information comes from Aeronautical Information Publication of Spain (AIP-Spain) and our own aeronautical information produced in CECAF. Maximum elevation figures (MEF), that show the highest elevation value in each grid, are depicted to ensure flight safety.

Pilot's Manual Charts

The Pilot's Manual are produced for Spanish military airports and civil and military airports under the Defense Ministry authority. Pilot's Manual provides to air crews the following information: Instrumental Approach Charts (IAC), Standard Instrument Departure Procedures (SID), Standard Arrivals (STAR), Visual Approach Procedures (VAC) and Airport Diagrams (AD).



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LEZG Military Jets VFR Corridor.

Instrumental Approach Charts (IAC):

For aircraft operating under instrument flight rules (IFR), an instrument approach is a predetermined maneuvers for the orderly transfer of an aircraft under Instrument Meteorological Conditions (IMC) from the beginning of the initial approach to a landing, or to a point from which a landing may be made visually.

There are two main classifications for IAC: precision and nonprecision. Precision approached utilizes both lateral (localizer) and vertical (glide slope) information. Non precision approaches provide lateral course information only.

Publications depicting instrument approach procedures are called Terminal Procedures, but are commonly referred by pilots as approach plates. These documents depict the specific procedure to be followed by a pilot for a particular type of approach to an airport.

They depict prescribed altitudes and courses to be flown, as well as obstacles, terrain, and potentially conflicting airspace. They list missed approach procedures and commonly used radio frequencies.

CECAF uses NATO military standards to design these aeronautical charts, which is an extension of ICAO 8168 Vol II document. The projection is UTM and the scale is between 1:500,000 and 1:1,000,000. The aeronautical information is update every 28 days (AIRAC cycle).

Standard Instrument Departures (SID) and Arrivals (STAR)

SID and STAR describe the routes followed by the aircraft according to their destination, from the airport to the assigned airway and from route to the starting point of the approximation, respectively. The function of these procedures is to allow simultaneous departures and arrivals at the airport control area without risk of collision.

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LEMO ILS procedure.

Geospatial information depicted in these charts are:

- Identification of each of the departures or arrivals represented in the letter.
- ▶ Identification of airport runways.
- ▶ Radio frequency contact with different ATC services.
- ▶ Date of entry into force.
- ▶ Transition altitude.

- VOR, NDB or GNSS locations are used as reference in the chart and have the following information: name of item, type and frequency (only navaids), which identifies Morse sequence (navaids only), latitude and longitude.
- Performance Based Navigation (PBN). CECAF is involved in the process of design and implementation of instrumental navigation procedures. In this framework, CECAF has received support from Single European Sky ATM Research (SESAR), which has co-funded the financial needs to transform the design and implementation systems from conventional navigation procedures to PBN navigation procedures. In this context the CECAF has reached an agreement with European Union Agency for the Space Programme (EUSPA) to design and publish military airfields PBN procedures charts.



PBN procedure proposal.

Maps for Mission Planning Systems

CECAF provides different types of mapping utility for aeronautics in different standard formats of digital maps for use in the various weapons system and cockpit. The types of charts supplied in digital format are:

- ▶ Global Navigation Chart (GNC) (1:5,000,000).
- > Operational Navigation Chart (ONC) (1:1,000,000).
- ▶ Tactical Pilotage Chart (TPC) (1:500,000).
- ▶ Joint Operational Graphics Air (JOG-A) (1:250,000).
- > Transit Flying Chart (TFC) (1:250,000).
- > Charts for Instrument Flight Rules (1:2,000,000).
- > Chart of Visual Navigation (1:1,000,000).
- ▶ Low Flying Chart (LFC) (1:500,000).
- ▶ Topographic maps (1:50,000).
- ▶ Orthoimages.

Charts for Aeronautical Easements

Aeronautical easements established in air bases, military aerodromes, heliports and naval bases respond to the need expressed by Spanish Air Navigation Law. An Aeronautical easement defines the airspace that should be keep without obstacles around the aerodrome in order to carry out aircraft operations safely.



León airport aeronautical easements.

There are three types of maps produced in connection with easements:

- Aerodrome easements: space used to protect mainly the runway.
- Radiofrequency easements: space which protects the issuance of aeronautical navaids.
- Operations easements: space which protects instrumental procedures established around an airport.

The maps used for this type of easements meet the requirements of the National Law and is entirely drawn up by the CECAF. Cartographic characteristics are:

- 1:10,000 scale for aerodrome and radio electric easements.
 1:100,000 scale for operations easements.
- ▶ UTM projection, Reference Systems ETRS89.
- > True ortho of the area.
- Contours with 5 or 20 meters equidistance (for vector files).

Infrastructure Cartography Maps



Villanubla Air Base true ortho. Scale 1:5000.

Another CECAF mission is the production of topographic maps at different scales, from the digital photogrammetric flight to the cartographic product. These maps are obtained by photogrammetric triangulation and editing the photogrammetric block, and CECAF is able to obtain different geospatial products, such us: true ortho, vector files, digital models or point cloud. The scales usually produced are 1:1,000, 1: 5,000 and 1:10,000. These maps are used to identify thresholds, air navaids, Aredrome Reference Point (ARP), boundaries, buffer zones, infrastructure works, etc.



Aerodrome Obstacle Charts - ICAO Type A

This chart, in combination with the relevant information published in the AIP, shall provide the data necessary to comply with the operating limitations of the aircraft during take-off.

Aerodrome Obstacle Charts are made in order to provide necessary data to ensure that the aircraft, in case of any failure (for instance, engine failure) during take-off maneuver, can interrupt or start the flight rising to a specified height, with a given security margin over all obstacles located in the flight path area, which previously have been measured, identified and published in the AIP.



Zaragoza Aerodrome Obstacle Charts - ICAO Type A.

Automatic Obstacle Detection

CECAF, with the digital photogrammetric flight, not only is able to cover a bigger area, but also has gain efficiency in terms of producing geospatial products (Digital Surface Model, Digital Terrain Model, point cloud, true-ortho and vector files).

Once these products are complete, and the critical airspaces have been designed to protect safely the aircraft operations, they are uploaded to the Automatic Obstacle Detection Tool, based on a Geospatial Information System (GIS). This tool is a software program designed to compare, pixel by pixel and through a complex mathematical algorithm, the DSM and DTM against those defined surfaces intended to protect aircraft in flight.

After data processing, the tool will show the elements that extend above the protected surfaces. Amongst these elements there are usually antennas, trees, buildings, wind turbines and even terrain itself.

Lastly, a CECAF operator will then exhaustively verify point by point, developing quality control, checking parameters (height, location, kind of element and airspace infringed) just to make sure that every item is correctly identified. In case a double check of these parameters is necessary, it can be carried out using stereoscopic vision and the Photogrammetric Block. Every obstacle would be identified and defined in a report.



CECAF Automatic Obstacle Detection Tool.

In the field of automatic obstacle detection, CECAF is involved in the use of Remotely Piloted Aerial Systems (RPAS), both fixedwing and rotary-wing, with which it is accumulating experience and carrying out the necessary tests to incorporate them into the current workflow in the near future.



RPAS tests.

Navaids Calibration and Flight Procedures Validation

Navaids calibration was assigned as a mission to CECAF on December, 9th 2008. The aircraft (Cessna Citation 560) incorporates a calibration console UNIFIS 3000, which obtains and records the data necessary to perform the inspection of navaids.

CECAF also conducts flight validation and data verification of flight procedures design (FPD). Several steps are mandatory:

- Verify for accuracy of terrain, obstacles, aerodrome and navaids data.
- Validate «intended use» of FPD as defined by stakeholders.
- Validate flight capacity.
- Validate flight safety.

International participation

CECAF, as aeronautical cartography institution, is involved in several international forums and working groups. For instance:

- ▶ NATO Geospatial Board (NGB)
- NATO Joint Geospatial Standardization Working Group (JGSWG)
- ▶ NATO Geospatial Aeronautical Working Group (GAWG)
- Airfield Services and Procedures Panel (ASPP)
- Military Instrument Procedures Standardization Team (MIPST)
- Spanish Spatial Data Infrastructure (IDEE)
- ▶ OPEN SKIES Treaty

One remarkable international activity in which CECAF was involved is the International Survey Networking Execise ISNEx since 2018. This annual exercise takes place in the framework of the Multinational Geospatial Support Group, a multinational cooperation project between NATO and EU nations, to improve and train interoperability between the nations in potential joint missions related to topographic geospatial information.



iSNEx 2023.

Geological and Mining Institute of Spain





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Geological and Mining Institute of Spain

The Geological and Mining Institute of Spain (IGME) is an institution with a long history of research in Earth Sciences since its creation in 1849 under the name "Madrid and Kingdom General Geological Map Commission". From April 2021 the IGME has become a research centre integrated in the Consejo Superior de Investigaciones Científicas (National Research Council) as a National Centre (CN IGME-CSIC). Despite this new affiliation, the CN IGME-CSIC retains the elaboration and maintenance of the geological mapping and related earth-sciences thematic maps of Spain among his main commitments. According with this duties, a wide variety of cartographic products, intended for research, professional services and dissemination purposes are developed.

Since its very beginnings, IGME develops systematic geological map series. First, as a set of provincial maps developed until 1914. The first attempt to produce a complete coverage of the Geological Map of Spain at 1:50,000 scale was developed from 1927 to 1970) (1st Series) but ends unfinished. A new and more ambitious project: Geological Map of Spain 1:50,000 scale (2 nd Series, MAGNA) was completed between 1970 and 2004. Associated with this program a new series of geological maps at 1:200,000 scale and a geological mapping of the Spanish continental platform and adjacent margins (FOMAR) were started. From 1863 on, together with those middle scale cartographies, broad or mural geological maps of the whole country have been published at 1: 1,000,000 and 1: 2,000,000 scales. Starting about the middle of the 20th century, thematic geological cartography has been developed, paying special attention to surficial geology: geomorphologic and quaternary deposits maps, as a useful tool for land use planning. Aiming to integrate these cartographies into the systematic 1:50,000 geological mapping and update them, a 3rd Series MAGNA of Geotemathic Maps was developed. Special attention towards the social and economic impact of natural disasters promotes definitely the making of geological risk and/or geological danger cartographic databases and maps. Geological resources are also considered, including hidrogeological, geotechnical, metalogenetic and industrial and mineral rocks resources maps.

Spatial information and digital maps in particular, like almost any other type of information, is mainly demanded in digital format. The digital transformation is shown in the amount of digital information available on IGME's website. In order to allow easy and intuitive access to this huge amount of information, the InfoIGME portal http://info.igme.es has been developed. Thus, this portal lets users to search, query, display and download of all the digital geoscientific information available at IGME. To get directly to the maps, a specific website has been created http://info.igme.es/cartografiadigital,, where maps are grouped by type, series and availability.

The main cartographic series developed at present by the IGME are:

Geological Cartography

1:50,000 scale (MAGNA series)

Constituting the main geological database of Spain, the MAGNA program includes a total of 1143 geological maps represented at 1: 50,000 scale in the mainland areas and a more detailed 1.25.000 scale in the island territories except Mallorca. The published information of each sheet includes a geological map, a geomorphological one (from 1991 onwards) and an explanatory report. A complete set of related information including paleontological, petrological and sedimentological reports, photographs, rock preparations and samples, inventory of geological sites, etc. for each sheet are also available for free consultation and are freely accessible through the web site:

http://info.igme.es/cartografiadigital/geologica/Magna50.aspx?language=en

This huge task was developed after 35 years of work, from 1970 until 2004.



Fig 1.- Image of one of the last published geological maps of MAGNA series: Sheet 254 Gósol.

Continuous Geological digital map 1:50.000 scale. GEODE project



Fig 2.- Distribution of GEODE geological provinces.

After the completion of MAGNA program, a new activity of geological harmonisation of geological maps at 1.50,000 scale was developed. The aim of this project is to create a new, seamless 1: 50,000 geological map avoiding discontinuities between sheets and to deliver information in a quick, modern and efficient way to the user.

This endeavour, named as GEODE project, aimed to ensure a geological continuity between the different geological sheets produced after the MAGNA program and to improve the dissemination and the usefulness of the geological mapping. For this purpose, the territory of Spain was divided in 30 geological homogeneous provinces. This product, entirely digital, and accessible only by web browsers, includes a series of geological information layers (shapefiles) and a legend for each of the regional units.

http://info.igme.es/cartografiadigital/geologica/Geode.aspx?language=en

3th Series MAGNA of Geological Maps

1: 50,000 scale

Combining the main commitment of the update the detailed geological cartography with the purpose of complete the geomorphological map series, a new mapping program was designed. This project constitutes the 3rd series of the geological map at 1: 50,000 scale and is so-called MAGNA 3rd Series.

His objectives are to update MAGNA series maps and complete them with surface geology and underground information. Every sheet of the new Geological Map of Spain at 1: 50,000 3rd Series, includes a Geological, Geomorphological and Active Process map and a complete descriptive memoir.

For a while this new digital series was distributed in interactive DVD format, which includes a GIS client accessing maps, reports and auxiliary information. In this media, all the information obtained during the elaboration of the map is included and fully consultable.

In recent years, seven new Maps of this 3th Series have been published online and the Memoirs are available in electronic book format.

http://info.igme.es/cartografiadigital/geologica/Magna3S.aspx?language=es.



Fig 3.- Example of a memoir in electronic format of the Sheet of 3rd series (Grado, number 28).

Geomorphology, Active Processes and Geomorphological Units Maps

Included in the MAGNA 3rd Series Plan, the Geomorphological Map of Spain series at 1: 50,000 scale is a set of thematic maps derived from the geological map, but focusing in surficial geology and landscape interpretation. It is composed by three related individual maps: Geomorphological map that delivers information about landforms. Active processes, a geodynamic activity inventory (seismic, geotectonic, volcanic, landslides, erosion, floods, antropic activities and sedimentary processes associated with some lithologies) drawn by the forms that they generate. The third map, Geomorphological Units map, divided the territory in homogenous areas from a geomorphologic point of view, as a summary of previous cartographies.

Geomorphological Map coverage starts in 1991 as a part of 1: 50,000 MAGNA cartographic series as a full colour and at 1: 50,000 scale map. After three decades of development the Geomorphological Map has experienced several changes and improvements. Nowadays the 40% of the Spanish territory is covered by this series.



Fig-4.-Geomorphological (upper) and active processes (lower) map 1: 50,000 scale of the sheet 668 Sagunto, published in 2021.



Regional synthesis, mural and popular maps.

Small scale geological maps published by the IGME include the systematic series of Geological Maps at 1: 200,000 scale. Benefiting from the great improvement of scientific geological knowledge obtained during the geological mapping at 1: 50,000 scale, these maps aim to face regional geological controversies. The notice of the maps is structured as scientific monographies using the cartographic information to resolve regional geological problems. As in the MAGNA series, the scale varies, being 1: 200,000 in the mainland and becoming 1: 100,000 for the maps of the islands. At this moment the coverage of this series attains 50% of the territory of Spain.



Periodic preparation of mural maps of the whole of Iberian Peninsula is a traditional activity and a way to show "the state of the art" of broad Spanish geological knowledge. Nowadays a new tectonic map of the Iberian Peninsula at 1: 1,250,000 scale entitled "Tectonic Map of the Iberian microcontinent and his adjacent Pyrenean and Betics-Rif, orogens) is currently being finalized. This map is backed by the Commission of the Geological Map of the World.



Fig 6.- Draft of the new tectonic map 1: 1,250,000 scale of the Iberian microcontinent.

Geological Maps of National Parks: GEONATUR Series



Fig 7.- The new Geological Map of the Aigüestortes National Park and Sant Maurici lake at 1: 25,000 scale.

In 2018 the IGME starts a new cartographic series devoted to geological and geomorphological maps of National Parks and other protected natural areas. The first publication was the Geological Map of the Ordesa and Monte Perdido National Park at 1: 25,000 scale. In the year 2022, a new Map of this series has been released: that of the Aigüestortes National Park and Sant Maurici Lake at the same scale. This series, printed over a new support: ecologic stone (limestone) paper, include a basic explanation of the main geological features of the Park in its back.

Simplified geological and geomorphological maps constitute also a key element of the Geological Guides of National Parks. It shows relationships between geology, relief and vegetation. Also includes some itineraries of interest. All this series deals with nature tourism demand of information.

Marine Geological Mapping

A major activity of IGME is the geological study of the marine environment and its resources. With this aim, IGME is participating in the "European Marine Observation and Data Network project (EMODnet-Geology)", launched by the European Commission. This project aims at providing harmonised information on marine geology for the entire European seas, and the Caspian and the Caribbean seas. In this project, IGME has provided standardized marine data and new multi-scale digital maps including sea-floor geology, seabed substrate, geomorphology, coastal behavior, geological events (earthquakes, tsunamis, submarine landslides, active faults, volcanic centers, fluid emissions), mineral occurrences (aggregates and metallic minerals) and hydrocarbons and submerged landscapes. The outputs (maps, documents and additional data) are open and freely delivered through an Internet portal (https://emodnet.ec.europa.eu/en/geology).



Fig 8.-Seabed substrate map of Spain at 1.1.000.000 scale (EMODnet-Geology).

In addition, IGME published in 2021 the "Atlas of the Spanish Continental Margin at 1:500 000 scale" which is the first digital geological cartographic base of the Spanish marine territory. The Atlas includes the following thematic maps to be used with

geographic information systems: Geological Map, Geomorphological Map, Map of Volcanic Edifices, Map of Structures associated with Fluid Emissions, Seabed Sediment Map, Maps of Mineral Resources (Polymetallic Nodules, Polymetallic Sulphides, Placers, Cobalt-rich Ferromanganese Crusts, Evaporites, Rock Pegmatite and Veinhosted mineralizations and Phosphorites). The maps are presented on a hillshade that allows to visualize the relief of the seabed. Other auxiliary maps of interest such as a map of toponyms and a map of commercial and research wells are provided together with images of the maps (jpg files). The geographic area covered includes the Mediterranean and Atlantic continental margins and the Canary Islands and the adjacent abyssal plains. From the point of view of the United Nations (UN) Convention on the Law of the Sea, this Atlas includes the Exclusive Economic Zone (1.2 million km2) and the extended continental shelf areas requested and registered with the UN Commission of the Limits Continental Shelf (431 416 km2).

This data can also be consulted on the IGME website: info.igme.es/visor/?Configuracion=GeologiaMarina



Fig 9.- Geomorphological Map of the Balearic Sea. Geological Atlas of the Spanish Continental Margin.

Considering that the economic potential of marine minerals is growing, as a consequence of the pressure on terrestrial resources, an additional effort is being devoted to map different types of mineral occurrences. In this sense, IGME coordinates the project "Seabed Mineral Deposits in European Seas: Metallogeny and Geological Potential for Strategic and Critical Raw Materials" (GeoERA- MINDeSEA), also funded by the European Commission. In the framework of this project, mineral maps and datasets of seabed deposits and mineral-potential and prospectivity maps (massive sulphide deposits, Fe-Mn crusts, placer deposits, polymetallic nodules, phosphorites and critical raw materials) are being developed (<u>http://geoera.eu/projects/mindesea</u>).



Fig 10.- Metallogenic map of ferromanganese crusts and phosphorites in the European seas (GeoERA- MINDeSEA project).

Geological Hazards

Research, forecast, prevention and mitigation of hazards generated by natural processes of geological origin are an IGME commitment. They deal with earthquakes, tsunamis, volcanism, floods, landslides (subsidence and slope), avalanches and those related with coastal processes.

The activities of the IGME in this topic include field works, in situ investigations, digital elevation models and a qualitative and quantitative zoning as a result of the multifactorial analysis using GIS.

Scale varies from regional to 1:5,000/1:25,000 when the study areas are high populated.

Earthquake Hazards: QAFI and ZESIS databases

In 2012 IGME implemented a web service hosting a database of Quaternary-Active Faults in Iberia (QAFI). This database contains a compilation of faults showing geological evidence of activity during the Quaternary period (last 2.6 million years). Its main purposes are a) to become an official repository of scientific data in relation to Quaternary tectonics, and b) to facilitate transfer of knowledge to the earthquake hazards community in Spain and Portugal (engineers, decision makers, seismic hazard analysists). The database is currently hosted and maintained by IGME, originally in cooperation with the Portuguese LNEG. The database is periodically updated, the current version 4 having been released in 2022. QAFI is freely accessible to the research and technical community at <u>http://info.igme.es/qafi/</u>.



Fig 11.- Screenshot of the QAFI v.4 web service (<u>http://info.igme.es/qafi/</u>).



Fig 12.- Screenshot of the ZESIS web service (<u>http://info.igme.es/zesis/</u>).

In 2015 a new web application was launched with the name ZESIS (Zonas Sismogénicas de la Península Ibérica - Seismogenic Zones of the Iberian Peninsula). The database documents the criteria and data used to define and characterize a total of 55 different zones that were included in a comprehensive probabilistic seismic hazard analysis at a national scale directed by the Spanish Instituto Geográfico Nacional (IGN) in 2012. The main purposes of the database are a) to inform the earthquake hazard community about the main seismogenic model used in the calculations of the Spanish seismic hazard map and, b) serve as a basis for future improvements and updates of the national hazard map. Currently ZESIS database is about to be updated in the midterm.

Flood hazard and risk mapping

Since 2013, and during the period from 2019 to 2023, IGME and its collaborators have developed some of the first Spanish maps of true flood risk and its components (integrated hazard, social and economic vulnerability and exposure). As a result of this initiative a series of true integrated vulnerability maps, including both economic and social affectations originated by flood hazards, are available for several Spanish municipalities, selected river reaches and singular heritage elements (Duero river between Toro-Zamora, Guadix Roman Theatre, Taburiente National Park, Santa María de Huerta Monastery), including cartographies and cost-benefit analyses of mitigation measures. Besides, a paper entitled 'Technical evolution of flood maps through Spanish experience in the European framework' has been published in the prestigious 'The Cartographic Journal' (Olcina & Díez-Herrero, 2022).



Fig. 13.-Probabilistic map of building economic damage (%) areas in Zamora city (Spain) for the USACE model (a-d), and the JRC model (e-h) (Garrote et al., 2021).

Since 2019, IGME has developed a new georeferenced database: PaleoRiada, that collects information on past floods that have left evidence in the natural record: geological-geomorphological (river and lake sediments, speleothems, erosional marks, landforms), biological (dendrochronological and lichenometric) and hydrologicalglaciological (accumulations of water, snow and ice). PaleoRiada is structured as a relational database composed of six tables, containing 40 variables for each record. It is related (N:M) to a vector coverage of points and polygons in GIS format that allows both thematic and spatial searches. The uses of this database, which in the future is intended to be freely accessible through a web viewer and Internet query application, are varied: flood hazard studies considering the maximum recorded event or statistical analysis for high return periods; land use and urban planning of basins and riverbanks, considering low frequency and high magnitude events; location (or not), design and dimensioning of highly vulnerable critical infrastructures in riverbanks and floodplains; and resizing and adaptation of pre-existing infrastructures (dams, treatment plants, industries) in riverbeds and riverbanks to comply with safety and environmental regulations.



Fig. 14.- Spatial distribution of the first 179 records included in the PaleoRiada database (Sandoval et al., 2023).

Ground movements mapping and monitoring



Fig. 15.- Ground movement database from the Geological Survey of Spain: <u>http://mapas.igme.es/gis/services/Cartografia_Tematica/IGME_BDMoves_ES/</u> <u>MapServer/WMSServer</u>.

In 2016, IGME implemented a new web service that shows cartographic representation of ground movements (landslides and subsidence) in Spain (BD-MOVES). The database BD-MOVES meets European and international standards and data specifications of the European Directive INSPIRE. For this purpose, it includes alphanumeric and cartographic fields (shapes) for the spatial and temporal description of ground motion (location, name, typological classification, morphometry, hillside situation regarding the date of the main event, reactivations, etc.), characterization of the medium in which occur (geology, hydrogeology, land use, slope orientation, etc.) and evaluation of its current state of activity. It also contains information on the intrinsic physical, geomorphological and anthropic causes that condition and trigger movements on the warning signs and the damage they cause (costs, losses, type of affected items, degree of damage, number of people affected, etc.). Finally, it records costs of interventions to mitigate risk, techniques and methods used for data collection and all references and links to documentation references available on IGME and internet.

IGME combined BD-MOVES information with landslide databases of 17 Geological Surveys of Europe to elaborate the first European Landslide density map. The 849,543 landslides reveal 210,544 km2 landslide prone areas in 23,681 administrative areas where the Geological Surveys recorded at least one landslide. However, we estimated that the completeness of the databases from the Geological Surveys is on average 17%, varying between 1% and 55% among analysed countries. Moreover, since 2015 the Geological Surveys deliver an annual report on damaging landslides producing an impact in Europe. According to this work, 194 landslides produced fatalities or injuries, and 3710 produced an impact in urban structures and infrastructures. The Emergency Response Coordination Centre (ERCC) from DG ECHO has recently published this information of interest for the European Commission.



Fig. 16.- Landslide hazard map elaborated by DG ECHO based on the review of landslide hazard of the Geological Surveys of Europe: <u>http://www.europe-geology.eu/map-viewer/</u>.

Geological hazard and risk mapping for insurance purposes

The IGME provides assessment to the Spanish insurance system of natural disasters (Consorcio de Compensación de Seguros) which has lately included flood, earthquake and volcano risk mapping for the Canary Archipelago at a postal code scale. Such mapping and the concluding remarks were published in 2014 as a book and a free online ebook called GEOMEP, Modelo de Evaluación de Pérdidas por Peligros Geológicos (Loss evaluation method for geologic hazards). This mapping effort provides a clear view of the insurance needs and increases public awareness related to such natural phenomenon, their possible consequences and the different strategies to mitigate unwanted outcomes. A forthcoming agreement with the CCS will soon allow mapping tsunami hazards and tsunami risks.

At an EU level, the IGME has actively contributed to the development of several data specs within Anex III of the INSPIRE Directive, their implementation and follow-up.



Fig. 17.- Lava flows risk, scenario: c520_17 of Tenerife (Canary) island.
Geophysics

Geophysical Maps (gravimetric, magnetic and radiometric maps) are a main tool to obtain important information about the internal structure of the interior of the Earth. For this kind of information, the IGME has developed a specific Geophysical Information System (SIGEOF) (http://info.igme.es/SIGEOF/) where it stores and publishes gravimetric, magnetic and radiometric data obtained during its geological and mining field exploration works during the last 50 years. In addition, SIGEOF provides display and access to other geophysical data available in IGME.

Research subsurface activities include the realization of gravimetric, radiometric and aeromagnetic maps in digital format at different scale. In the future, we will try to incorporate this digital mapping to the System.



Fig 18.- Screenshot of SIGEOF website (http://info.igme.es/sigeof/).

Hydrogeology.

IGME's hidrogeological maps show regional aquifer features as well as exploitation aspects as basic information for further detail works.

The Hidrogeological Map of Spain at 1:1,000,000 (1972) is previous to a systematic series at 1:200,000 carried out between 1982 and 1990. Since then hydrogeology is included as a complementary information in the Geological Map at 1:50,0000 (MAGNA). Hidrogeological and Hidroenvironmental Atlas are made in collaboration with regional and provincial institutions.

Metallogenic Geology, Geochemistry and Industrial rocks and minerals.



Fig 19.- Critical Minerals Map of Andalucía (2022).

Metallogenical Maps are essential tools to know potential mining of an area. They display metal, non-metal and energy mineralization evidences on a geological base. Publishing scale is usually 1:200,000 or regional and provincial layouts (1:100,000/1:400,000).

Geochemistry cartographies contribute to the knowledge of a wide set of chemistry elements geographical distribution related with superficial formation such as alluvium and soils. 1:100,000 and 1:600,000 are common regional scales. Association or anomalies maps have a more straightforward application with concrete objectives such as mining exploration, land planning or health issues.

The Industrial Rocks Map at 1:200,000 scale had an old development based on deposits with an associated inventory card. Current proposal, the Industrial Rocks and Minerals Map (MANARMIN) is a geologicalmining map that summarizes current knowledge of industrial rocks and minerals mining and its potential use. Regional maps, issued from collaboration with regional authorities are also developed, as the new "Critical Minerals Map of Andalucía "published in 2022.

Geological Heritage.

The map of main geological domains of Spain is crucial for geological heritage research. Geosites selection was done specifically for each geological domain through a systematic geoheritage inventory. The Spanish Inventory of Sites of Geological Interest (IELIG acronym in Spanish) is one of the governmental official inventories included in Law 42/2007, on Natural Heritage and Biodiversity, and its legislative development (BOE, no. 299, 14.12.2007; no. 112, 11.05.2011). The Strategic Plan for Natural Heritage and Biodiversity 2011-2017 (Royal Decree 1274/2011, BOE, no. 236, 30.09.2011) entrusted the IGME with the development of the IELIG methodology and the coordination of inventory activities together with the Regional Governments, in compliance with Objective 2.8 "To increase knowledge of geodiversity and geological heritage and increase its protection". The Regional Governments that have so far contributed to the IELIG with their official inventories are Andalusia, Catalonia, the Basque Country, Aragon and the Region of Murcia, while others, such as the Canary Islands and La Rioja, have also contributed, but without making their inventories official. Since 2008, the IELIG - (<u>http://info.igme.es/ielig/</u>) web service is a tool which hosts the complete database which currently has about 4200 Sites of Geological Interest.



Fig 20.- IELIG (<u>http://info.igme.es/ielig/</u>) web service which hosts the Spanish Inventory of Sites of Geological Interest.

Dissemination of cartographic information

In 2003, IGME started the compilation and organization of digital maps in a shared repository. A unique access point to get the digital maps available was opened in order to improve dissemination and use of maps in digital format. Nowadays, InfoIGME (<u>https://info.igme.es/</u>) is the website to gain the geoscientific information generated by the IGME. It integrates the digital mapping portal, a dataset catalog, an advanced search system, a map viewer and a large number of web map services.

The digital mapping portal (<u>https://info.igme.es/cartografiadigital/</u>) is the access point to IGME geological and thematic maps available in digital format. As well as dossiers, web map services, metadata and any other information of interest. Most of this information can be downloaded in jpg and/or pdf format. Vector maps are supplied in ESRI shapefile format on request to the digital mapping service.



Fig. 21.- Home page of IGME digital mapping portal.

The Map of the month section has recently been launched, in which each month a sample of the geoscientific cartography available on the digital mapping portal is presented and completed with brief explanations of an informative nature. The Data catalog (https://info.igme.es/datacatalog/) discovers more than 2200 IGME's spatial datasets. From 2018 to the present, the number and type of spatial datasets has been increasing and new functionalities have been added. The Integrated Searching Engine (commonly known as ISE: https://info.igme.es/ise/), is a tool that allows selecting, by alphanumeric and spatial criteria, features from different IGME's geoscientific information datasets, as well as displaying the main attributes of the selected features and their location on a map. It is also possible to access the dataset to which the features belong to in different formats or open applications to query or display those features.

The Web map services (https://mapas.igme.es) provide interoperable geoservices for displaying and querying the IGME's cartographic information and databases. The WMS/WMTS (Web Map Services) follow the Open Geospatial Consortium (OGC) standards. These standards make it easier to display and get information from vast amounts of permanently up-to-date spatial information ready to use in any desktop or web GIS application. In addition, KML and ArcGIS Server services are included.

The Map viewer (https://info.igme.es/visor/) allows users to display, navigate and integrate, through standard tools, all the spatial dataset from IGME with the data and map services published by other organizations that follow common standards and specifications. It also allows users to manage this information, changing the layers visibility, their order and transparency. It is possible display additional information for layers (legends, metadata, etc.) and for identified features (reports, pictures, etc.)



Fig. 22.- Screenshot of IGME map viewer.

InfoIGME also includes a series of specialized web applications developed to facilitate concrete thematic capabilities to query, display and analyze different IGME's databases without the need for any specific software or special computer knowledge. These applications were designed to be as similar as possible in order to avoid users having to familiarize themselves with different query screens depending on the topic consulted.

The most commonly used include QAFI (<u>https://info.igme.es/qafi/</u>) or ZESIS (<u>https://info.igme.es/zesis/</u>) based on web services. There are also other web applications designed for selecting, viewing and downloading information from different databases such as the mineral resources database (<u>https://info.igme.es/BDMIN</u>), the ground movement database (<u>https://info.igme.es/BDMOVES</u>), or the hydrocarbon inventory (<u>https://info.igme.es/Hidrocarburos</u>), among others, which have been updated this year.

In 2023, the first thematic map viewers have been launched, such as the one recently developed for the Geological Atlas of the Spanish Continental Margin (https://info.igme.es/visor/?Configuracion=GeologiaMarina) or the one for the inventory of mineral waters (https://info.igme.es/visor/?Configuracion=AguasMinerales).

Technological support

Aerial Works Service (STA in Spanish) was established in 2017 to support IGME's technical and scientific projects, facilitating the collection of all types of georeferenced ground data using low cost air platforms, with high spatial and temporal resolution.

The STA/SORT (Aerial Work Service/Remote Earth Observation Service) offers drone/RPA/UAV flights by geologists and technicians specialized in earth sciences, to obtain various products such as aerial photography, photogrammetry, RGB and thermal video, ground control point collection, inspection and sampling (liquid) in complex access areas or photography and filming of video documentation of different processes. Our tasks include flight preparation and generation of flight plans (permissions included), post-processing of collected information (obtaining 3D models, GIS treatment, point clouds, etc.), video and photo editing, generation of GIS with the information collected in the field, publication and dissemination in networks, etc.



Fig. 23.- Lava fountain, west mouth, Tajogaite volcano, La Palma 2021, Photo: Carlos Lorenzo (Phantom 4 PRO).

IGME has developed an application for mobile devices (Android tablets) as a support for all Earth science professionals, and especially geologists, who need to obtain georeferenced data in the field. INGEOTAB integrates multiple tools that facilitate the capture and display of information on a single device: maps, GPS position and track recording, compass, clinometer, georeferenced photographs, and so on. INGEOTAB is a simple and user friendly tool which allows create customizable forms for data entry, draw sketches on maps or photos or record data in custom fields with pre-defined drop-down lists, among other facilities.



International Activity

IGME spreads his activities abroad through developing countries, and in the last years has participated in mapping programs in Angola and Dominican Republic.

Between 2015-2022, the Minister of Geology and Mines of the Angola Republic, through the Geological Institute of Angola (IGEO), launched and funded the National Plan of Geology (PLANAGEO). This is a nation-wide ambitious exploration program that comprised the regional aerogeophysical survey (magnetic/radiometric) and the geological mapping at a scale of 1:250,000 of the country, together with other detailed cartographies, geochemical prospecting campaigns and specific mineral studies in areas of interest.

PLANAGEO has as a main objective to improve the geological knowledge and the mineral resources potential of the country of Angola in order to re-activate the national mining sector and guarantee the sustainable development of the nation.

The IGME participates in the PLANGEO Program as a part of one Temporary Union of Companies (UTE), jointly with the National Laboratory of Energy and Geology of Portugal (LNEG) and IMPULSO, a private Spanish company. Within PLANAGEO, the UTE is responsible for the execution of the regional geophysical and geological surveys and the elaboration of geological maps of 480.000 km2, out of 1.280.000 km2 of the whole country (Fig. 25).



Fig. 25.- Synthetic geological/metallogenetic map at scale 1: 1,000,000 of the UTE cartographic block (legend for of the igneous and metamorphic rocks of the Angola Shield).

Currently, the main results of the PLANAGEO have been the realization of 44 geological maps at scale 1:250,000 (as the shown in Fig. 26), synthetic and mineral resources maps at scale 1:500,000, and tectonic-structural, hydrogeological and metallogenetic maps at scale 1: 1,000,000 (Fig. 25), as well as thematic spatial databases and other geo-referenced information. These results constitute a basic infrastructure for the exploration and location of areas of mineral resources, the evaluation of geological hazards and the prevention of disasters, the management of land uses and the planning of the territory, among other objectives.



Fig. 26.- Geological map of Namibe sheet at scale 1: 250,000.

These objectives were attained despite the extreme geological complexity of the territory of Angola, which includes very old rocks of the Angola Shield affected by Eburnean Orogeny: ortho and paraderivated metamorphic rocks of Neoarchean to Paleoproterozoic age, and Paleoproterozoic granitoids; sedimentary and volcanic rocks of Cretaceous to Quaternary age, belonging to the coastal Namibe Basin; and siliciclastic sedimentary rocks of Cenozoic age of the intracratonic Kalahari Basin. In the Dominican Republic, the CN IGME-CSIC has collaborated in the project "Inventory and susceptibility of landslides in three areas of the (Puerto Plata, Santiago de los Caballeros, and Jarabacoa)". Landslides are one of the main geological hazards in the Dominican Republic and this project analyses the relationship between the cartographic distribution of landslides and their conditioning and triggering processes, such as lithology, rainfall, and tectonic activity.



Fig. 27.- Landslide susceptibility map of Puerto Plata County, Dominican Republic.

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