Boletín de la A.G.E. N.º 21-22 – 1995-1996, págs. 137-145

CARTOGRAPHY, GIS, AND REMOTE SENSING IN THE RECENT EVOLUTION OF SPANISH GEOGRAPHY

José Sancho Comins; Joaquín Bosque Sendra; Emilio Chuvieco Salinero
University of Alcalá de Henares

Two features characterise the recent evolution in cartography: its growing importance in diverse fields, and the dynamism of techniques used in the different phases of the cartographic process (information capture, analysis and production/presentation).

In fact, cartography has aquired the status of a standard subject in many technical courses and degrees. Today subjects traditionally associated with cartography, geography and geology, are joined by biology and the environmental sciences which have included in their curriculum a significant number of credits devoted to the study of this science. For instance in some Spanish universities geodesy and cartography have been introduced within engineering doctorate courses in the field of topographical engineering. These courses are also available to geography postgraduate degree students who have first passed a conversion course.

Public institutions produce a high output in both basic and thematic cartography. Territorial analysis requires cartographic suport in both aforementioned aspects and, at the same time, versatile operation to allow processing of both analog and digital data. The interest is stimulated by an ample supply which transcends the demand of public bodies. On the other hand, every day there are more private enterprises demonstrating more «standard» applications of cartography to the general public. Maps have become a common resource, of frequent and general comsumption. This will undoubtably contribute to the necessary improvement of cartographic study in Spain.

The second aspect, dynamism in cartographic technique, has perhaps proven even more dramatic. Development has been very rapid in the last few decades in anticipation of a greater acceleration, if possible, in the immediate future. Information capture methods have

been augmented by space-based sensors outputting via systems consistently faster and more automated. Storage and processing of cartographic information is carried out with IT support and, finally, presented using products compatible with both analog and digital formats. As a whole these factors have contributed to disseminating the application of cartography on the part of researchers, scientists, teachers, and the general public.

1. FROM REALITY TO THE MAP

In the cartographic process the capture of spacial information has always been a central and problematic issue. Fieldwork, then later aerial photography and now data supplied by sensors aboard artificial satellites combine in the work of the cartographer. The contribution of remote sensing to our discipline can be examined in four ways:

(1) The generation of environmental variables: such as surface temperature, albedo, marine topography, or the chlorophyll content in plants (Coll et al., 1994), thanks to the systematic sampling which remote sensing sensors conduct in certain bands of the electromagnetic spectrum.
(2) Thematic cartography: classifying land cover of interest by tone-colour-pattern-context-texture to those which appear in the image. Landcover or ground surface occupation are the most common type of thematic map generated from remotely sensed data, utilising both visual (Chuvieco and Martinez, 1990) and digital analysis methods (Chuvieco, 1985c). In this respect the European Project, CORINE LAND COVER (Sancho,J. 1989-91 and López Vizoso, 1989) must be highlighted.
(3) Multi-temporal analysis: the arrangement of layers which enables remote sensing systems to track certain dynamic processes which affect the geographical milieu. Frequency of coverage depends upon sensor specifications, from every thirty minutes with Meteosat, to twenty six days using the SPOT sensors. This factor permits a wide variety of studies to be undertaken; from the consequences of episodic phenomena (floods, fires) to others more temporally constant (urban growth). Changes can be detected by visual comparison of images captured on different dates, or by technical digital means of change detection.
(4) Landscape description: a satellite image can also be considered as a mosaic of the spacial distribution of the parcels which form a determinate landscape. Processing digital images one can undertake a numerical description of the spacial structure, eventually study its evolution and compare it to other regions. Examples of spacial variables include the diversity or dominance of particular categories, the compactness of the shapes, and the connectivity with other «parcels». These examples are all of great importance in the distribution and dispersion of species. In this respect it is important to highlight the production of orthophoto images by the IGN (National Geographic Institute) (1:100 000 and 1:250 000 series from Landsat satellites) as well as other institutions (Catalonian Cartographic Institute, Madrid Autonomous Region, Environmental Agency of Andalusia, etc.).

With recent syllabus changes a great number of universities are incorporating these subjects into their academic curricula; on occasion as specific subjects and sometimes

along with other subjects associated with Geographic Information Systems (GIS). Various researchers from Seville, Barcelona Autonomous University, Valencia, Madrid Autonomous and Complutense Universities, Malága and Zaragoza have carried out work of great interest on geographical applications of remote sensing. However, almost always this is a question of isolated efforts which at this point do not seem to be a collective effort. Perhaps the only exception in our discipline is the University of Alcalá, which has consolidated a post-doctoral program concentrating upon remote sensing, GIS and thematic cartography.

The limited use Spanish geography has made of remote rensing is perhaps due to the considerable investment required, in both equipment and images, and, above all, in training. An investment very often far removed from a traditional Geographical curriculum in our country. Geographers were the pioneers in the use of this kind of data, participating in the first remote sensing projects in Spain (Sanz, 1976; Chicharro, 1976). Despite this, subsequent activity has been minor. However, the growing availability of low cost digital information processing systems, of images with teaching discounts, and particularly the interest generated by GIS have, in recent years, stimulated remote sensing research by Geographers (Ocaña et al., 1992). Subjects most undertaken have been mapping of landcover (Chuvieco, 1985c; López-Vizoso 1986) and of crop cultivation (Prados 1995), the study of landscape dynamism (Sancho and Chuvieco, 1986), coastal and marine zones (López, 1991), and the cartography and prevention of forest fires (Salas and Chuvieco, 1995; Martin and Chuvieco, 1994; Alonso et al., 1995).

2. NEW POSSIBILITIES TO STORE AND PROCESS CARTOGRAPHIC INFORMATION

Geographic Information Systems have been converted into a tool of great scientific and technical value. Teaching institutions promote its teaching; private and public institutions have at their disposal powerful IT resources actively utilising spacial databases. In short, an important market has opened in response to the escalating use of GIS.

a) Dissemination and teaching of GIS in Spain (1991-1995)

Various facts illustrate the widespresd expansion occurring in GIS technology throughout Spain. Foremost is the publication of numerous manuals and textbooks for its study and teaching at various educational levels as well as in professional training. Specifically, since 1991, fifteen books have been edited regarding this question. Some, more general, provide an introduction to the subject, discussing the creation of geographic databases and the GIS analysis procedures, (Guimet Pereña, 1992; Bosque Sendra, 1992a; Cebrián de Miguel, 1992 and 1994; Calvo Melero, 1993; Comas and Ruiz, 1993; Gutiérrez Puebla and Gould, 1994; Gamir Orueta, Ruiz Pérez and Segui Pons, 1995 and Moldes 1995). In other cases the textbooks concentrate on practical description of the application of the more widespread IT software (Bosque Sendra and others, 1994) or of the most significant applications of a GIS (Gould, 1994). Equally, a more detailed textbook analysing the characteristics of Digital Terrain Models, a particular type of GIS, has also been published (Felicisimo, 1994). Lastly, and given the size of the community of GIS users and growing complexity of the terminology, a pair of dictionaries of GIS terms have appeared (AESIGYT and González Aguayo,

1994). Additionally a cartographic dictionary has recently been published which includes abundant references to GIS questions (Otero, 1995).

Many of these publications have been undertaken by members of geography departments from diverse Spanish universities: Gerona, Alcalá de Henares, Madrid Complutense, and by the Council of Higher Scientific Research (Consejo Superior de Investigaciones Científicas - Institute of Economics and Geography). What stands out, as we have already indicated, is the significant role played by geographers in these matters.

The consistent production of digital geographic databases by official bodies illustrates the widespread distribution of GIS within Spanish society. One of the most obvious examples is the completion of the *Base Cartografía Numérica* or Digital Base Map (BCN) 1:200 000 by the National Geographic Institute, a product which is now facilitating work via means both rapid and economic. Nevertheless in this sense there is still much to be done. However this organisation and others, the National Institute of Statistics (González de Zuleta, 1994), Centre of Census Management, the Cartographic Institutes of the autonomous regions etc have planned the production of new, more precise digital databases.

Finally, from a more institutional point of view the previous five years have witnessed the creation of the *Asociación española de Sistemas de Información Geográfica* (AESIGYT) or Spanish Geographic Information System Association which, since its apparition in 1991, has developed various GIS activities. In particular its four subsequent annual congresses (1992 to 1995) have facilitated contact between diverse interested groups and the dissemination of new features and advances in the field.

b) Investigation of questions outstanding, and new applications of GIS

With respect to GIS studies carried out in Spain, still mostly unrecognised, and given the volume of topics dealt with and the limited space we can dedicate to their description, it is necessary to carry out quite a stringent selection. Because of this, brief details will only be mentioned of work published in writing and with active participation from members of geography departments from Spanish universities, or of the CSIC.

GIS research carried out in our country, which have been collected in the following transactions, can be summarised in five broad areas (Congresos de la AESIGYT - Madrid, 1992; - Barcelona, 1995; Coloquios de Geografía Cuantitativa - Zaragoza, 1992; Conferencia Latinamericana sobre Sistemas de Información Geográfica - Viña del Mar, 1991; The European Conference on Geographical Information Systems - Munich, 1992 and Congreso Nacional de Geografía - Salamanca, 1995):

— The analysis of landscape and rural population using a GIS.
— Integration of GIS with other analytical techniques, such as lineal programming or «multi-criteria evaluation», mathematical modelling for location allocation, and more precise measurements of territorial accessability; all in all to carry out territorial planning projects.
— Production of thematic cartography using a GIS.
— Integration of GIS with hydrological modelling.
— Production of inventories and environmental resource management.

3. CARTOGRAPHY: GEOGRAPHICAL SCIENCE AND TECHNIQUE

It is well known that the two state organisations which have the responsibility for the production of base maps, the National Institute of Geography (Instituto Geográfico Nacional or IGN) and the Armed Forces Geographic Service (Servicio Geográfico del Ejército or SGE), demonstrate clear evidence of the close relationship betwen cartography and geography. The cartographic services of the autonomous regions and institutes have recently become part of this close relationship.

The cartographic information collected by the two aforementioned organisations is staggering. Significant changes are being produced in which both endeavour to accomodate their aims to the existing situation. Apart from its Series 5V (at scale 1:25 000), the Armed Forces Geographic Service completed its national landcover project in 1986. The five scales produced (1:50 000 —L—; 1:100 000 —C—; 1:200 000 —2C—; 1:400 000 —4C—; and 1:800 000 —8C—) represent, in four contiguous sheets the series at the immediate higher scale. The law of cartographic organisation (7/86), the emergence of new technology and our membership of NATO have necessitated the modification of the military map series. The series 5V, 2C, 4C, and 8C have been discontinued; the series L and C are being maintained, gradually moving to the ellipsoid W65-84, and a new scale is to come out, 1:250 000 (5L) on the basis of previous series.

The introduction of digital systems has, at the same time, allowed the SGE to use geographic databases in both cartographic publishing and with other associated applications. In this way, having digitised the altimetry of the L series (1:50 000), they have obtained three-dimensional anaglifs and are presently creating digital terrain elevation models, for general circulation, with a 25 metre grid matrix. Another highly significant product is the Carta Digital de España or Digital Map of Spain including altimetry, a 100m grid matrix, planimetry and place-names (toponymy), at a scale of 1:250 000. There are multiple applications for this product: visualisation of terrain in 2 or 3 dimensions; visible and hidden zones, as well as slope maps. Additionally, operational requirements are quite accessible (486 PC or better, VGA or better colour monitor and graphic card, 8Mb of RAM, 5Mb free on hard disk, Windows, CD-ROM drive, and mouse).

The National Geographic Institute is continuing with the important development of its national landcover project at a scale of 1:25 000. At the beginning of this year 1756 sheets were published, approximately equivalent to 30% of the territory. On the other hand new updated editions of the MTN 1:50 000 are also being published. It is important to state, nevertheless, that the most significant changes in this organisation have been the production of thematic cartography and the creation and widespread circulation of digital products.

Regarding the last point, it is important to mention the digital products limited to municipal boundary lines which are generated at scales 1:500 000, 1:200 000, 1:50 000, and 1:25 000, together with the provinces and autonomous regions at a scale of 1:1000 000. Databases include BCN1000, with communications, hydrology, centres of population, and altimetry at a scale of 1:1000 000; BCN200, including transmission lines, construction work and individual buildings at a scale of 1:200 000, and BCN25 which contains only planimetry and altimetry at 1:25 000.

Terrain Evaluation Models corresponding to the three aforementioned databases have also been produced. In this line of digital products the Visual MAP series must be highlig-

hted which now includes guides to Barcelona, Madrid, Spain and the Pyrenees as well as two others for global positioning and professional applications.

Thematic cartography today constitutes an area of great interest to the National Geographic Institute (or IGN). It is also worth remembering that the national landcover and land use information is now available (CORINE LAND COVER), at 1:1000 000, in digital format and the imminant completion of the National Atlas of Spain. At the beginning of this year thirty nine volumes of the fourty eight constituting the Atlas had been completed. At its presentation, collected in five volumes, interactive videodisk and CD-ROM media will be combined; with volumes dedicated to Biogeography, Flora and Fauna, and protected Natural Reserves in the former, and in the latter the Organisation of the State will be presented. Of the aforementioned options, CD-ROM format would seem the more convenient of the two.

In connection with the preceding point, it is important to point out the growing interest in regional and thematic atlases. Presently most autonomous regions and many provinces are either in the process of producing one or have published a thematic atlas. Examples abound, for instance the recent publication of Atlas del Territorio de Castilla y Leon (1995), the «Atlas de la Provincia de Cádiz» (1995) and others which are about to be published like the «Atlas de Andalucía» or presently being compliled as the «Atlas de Galicia». This trend also reveals other new themes, such as those in relation to the environment (in this respect the «Atlas Geocientífico del medio natural de la Communidad de Madrid» (1988) or more recently of the province of Leon (1995), seeking a more integrated structure and exploiting the new multimedia technology (for instance the «CD Atlas de Catalunya» or the «Atlas Electrónico de Vizcaya»). In the immediate future it would seem that we are heading for an even greater profusion of interactive maps. Regional development agencies, teachers, and the general public will consequently have cheaper and easier access to a more accurate resource of images, which always arouse admiration, and which today have become a necessity.

BIBLIOGRAPHY

AESIGYT (W): *Diccionario glosario de términos SIG*, Madrid, Estudio gráfico, 93 pp.

AESIGYT (1992, 1993, 1994 y 1995): *Actos de los respectivos Congresos sobre Sistemas de Información Geográfica y el Análisis Territorial*, AESIGYT, Madrid.

AGUIRRE, I. (1993): *Atlas Electrónico de Vizcaya*, Departamento de Geografía, Universidad de Deusto, Bilbao.

ALONSO.M, CAMARASA, A., CHUVIECO, E., KYUN, I., MARTÍN, P., SALAS, J.: Estimating fuel moisture and fire danger from NOAA-AVHRR data, *Remote Sensing and G.I.S. applications to forest fire management*, Alcalá de Henares, Departamento de Geografía, Universidad de Alcalá, pp. 123-128.

ASOCIACIÓN DE GEÓGRAFOS ESPAÑOLES (1995): *XIV Congreso Nacional de Geografía*, Salamanca.

BARRAGÁN, J.M. (1995): *Atlas de la Provincia de Cádiz. Geografía, Sociedad y Economía*. Diputación de Cádiz, Cádiz, 1950 pp.

BOSQUE SENDRA, J. (1992a): *Sistemas de información geográfica*. Madrid, Ediciones Rialp, 451 pp.

BOSQUE SENDRA, J. (1995a): *Organización Territorial de la Población de la Comunidad*

Autónoma de Madrid. Informe monográfico sobre el Tomo X de las publicaciones del censo de Población y Vivienda de 1991 Madrid, Comunidad de Madrid. Consejería de Economía. Departamento de Estadística. 125 pp. + 1 mapa.

BOSQUE SENDRA, J. (1995b): Aplicaciones de los Sistemas de Información Geográfica a la gestión catastral y al planeamiento urbanístico en *Jornadas técnicas sobre Sistemas de información geográfica y Teletección espacial aplicados a la Ordenación del territorio y el medio ambiente*, Centro de estudios ambientales, Ayuntamiento de Vitoria-Gasteiz, Vitoria-Gasteiz, pp. 33-40.

BOSQUE SENDRA, J. ESCOBAR MARTÍNEZ, F. J., GARCÍA HERNÁNDEZ, E. y SALADO GARCÍA, M.J. (1994): *Sistemas de Información Geográfica: prácticas con PC ARC/INFO e IDRISI*, Madrid, Editorial RA-MA, 478 pp. y dos discos de ordenador.

CALVO MELERO, M. (1993): *Sistemas de información geográfica digitales. Sistemas geomáticos*. Oñati, IVAP, 616 pp.

CEBRIÁN DE MIGUEL, J.A. (1994): *GIS concepts*. Cáceres, INFOCARTO/Dept. de Geografía y O.T., UEX/Grupo de Métodos cuantitativos, A.G.E./FUNDICOT. 265 pp.

CEBRIÁN DE MIGUEL, J.A. (1992): *Información geográfica y sistemas de información geográfica*, Santander, Publicaciones de la Universidad de Cantabria.

CEDEX (1994): *Curso sobre utilización de los Sistemas de Información Geográfica en Hidrología*. Madrid, CEDEX, Escuela de Formación técnica.

MASÓ, J. (1993): CD *Atlas de Catalunya*. Institut Cartografic de Catalunya, Barcelona.

COLL, C. CASELLES, V. SOBRINO, J.A. Y VALOR, E. (1994): On the Atmosphere Dependence of the Split Winclow Equation for Land Surface Temperature, *International Journal of Remote Sensing*, vol. 15, pp. 105-122.

COMAS, D. y RUIZ, E. (1993): *Fundamentos de los Sistemas de Información Geográfica*. Barcelona, Ariel, 295 pp.

CONFERENCIA LATINOAMERICANA SOBRE SIG (1991 y 1995). Viña del Mar (Chile) y Mendoza (Argentina).

CHUVIECO SALINERO, E. (1993): Integration of linear programming and GIS for land-use modelling *Int. J. Geographical Information Systems*, vol. 7, nº 1, pp. 71-83.

CHICHARRO, E. (1976b): Application of Landsat-2 data to land use mapping in Central Spain, en *Thematic Mapping, Land Use, Geological Structure and Water Resources in Central Spain*, (R. Nunez, Ed.), NASA Project 28760, Madrid, pp. 216-219.

CHUVIECO, E. (1985): Aportaciones de la teledetección espacial a la cartografía de ocupación del suelo, *Anales de Geografía de la Universidad Complutense*, vol. 5, pp. 29-48.

CHUVIECO, E. Y MARTÍNEZ, J. (1990): Visual versus digital analysis for vegetation mapping: some examples on Central Spain, *Geocarto International*, vol. 5, pp. 21-30.

ESTEBAN TUDELA, J. (1994): Sistema de información para la planificación hidrológica (SIPH). Un caso práctico: la cuenca del Duero en ESRI-España, *El uso de los sistemas de Información Geográfica. Aplicaciones con ARC/INFO*, Madrid, ESRI-España, pp. 91-100.

FELICÍSIMO, A.M. (1994): *Modelos Digitales del Terreno. Introducción y aplicaciones en la Ciencias ambientales*. Oviedo, Pentalfa, 222 pp.

GAMIR ORUETA, A., RUIZ PÉREZ, M. y SEGUÍ PONS, J. (1995): *Prácticas de análisis espacial*. Barcelona, Oikos-Tau, 384 pp.

GONZÁLEZ AGUAYO, R.E. (1994): *Diccionario de términos SIG*. Madrid, CSIC-IEG, 159 pp.

GONZÁLEZ DE ZULUETA, M. (1994): ARC/INFO en el INE en ESRI-España, *El uso de los sistemas de Información Geográfica. Aplicaciones con ARC/INFO* Madrid, ESRI-España, pp. 151-166.

GOULD, M. (Coordinador) (1994): *Aplicaciones de los Sistemas de Información Geográfica. Aplicaciones con ARC/INFO*, Madrid, ESRI-España Geosistemas, S.A. 187 pp.

GUIMET PEREÑA, J. (1992): *Introducción conceptual a los Sistemas de Información Geográfica (SIG)*, Madrid, Estudio gráfico, 139 pp.

GUTIÉRREZ PUEBLA, J. y GOULD, M. (1994): *SIG. Sistemas de Información Geográfica*, Madrid, Ed. Síntesis.

GRUPO DE GEOGRAFÍA CUANTITATIVA DE LA AGE (1992): *Actas del Coloquio de Geografía Cuantitativa*, Servicio de Publicaciones Universidad de Zaragoza. Zaragoza.

AYALA CARCEDO, F.J. (1988): *Atlas Geocientífico del Medio Natural de la Comunidad de Madrid*, Instituto Tecnológico y Geominero, Madrid.

AYALA CARCEDO, F.J. (1995): *Atlas Geocientífico del Medio Natural de la provincia de León*, Instituto Tecnológico y Geominero, Madrid.

LÓPEZ, M.J. (1991): *La temperatura del mar balear a partir de imágenes de satélite*, Departamento de Geografía, Universidad de Valencia.

LÓPEZ-VIZOSO, J. M. (1989): La observación de la Tierra desde el espacio: el mapa de ocupación del suelo de la Comunidad Económica Europea, *Estudios Geográficos*, vol. 50, pp. 409-434.

MARTÍN, M.P. Y CHUVIECO, E. (1995): Mapping and evaluation of burned land from multitemporal analysis os AVHRR NDVI images, *EARSeL Advances in Remote Sensing*, vol. 4 (3), pp. 7-13.

MÉRIDA RODRÍGUEZ, M., GALACHO JIMÉNEZ, F.B. y PERLES ROSELLO, M.J. (1994): Grado de concentración del poblamiento y relieve. Metodología de análisis a partir de un SIG en *Perfiles actuales de la Geografía cuantitativa en España*, Málaga, Dept. de Geografía, Univ. de malaga/Grupo de métodos cuantitativos de la AGE, pp. 403-416.

MÉRIDA RODRÍGUEZ, PERLES, M.J. y GALACHO, F. (1993): Metodología de análisis del grado de poblamiento apartir de un SIG. Aplicación práctica. *Inmigración extranjera y planificación demográfica en España*, Tenerife, Universidad de la Laguna, pp. 267-274.

MÉRIDA RODRÍGUEZ, M. (1994): Metodología de análisis y clasificación del paisaje mediante SIG y análisis multivariante en *Perfiles actuales de la Geografía cuantitativa en España*, Málaga, Dept. de Geografía, Univ. de Malaga/Grupo de métodos cuantitativos de la AGE, pp. 387-401.

MOLDES, F.J. (1995): *Tecnología de los Sistemas de Información Geográfica*, Madrid, RA-MA, 190 pp.

MORENO JIMÉNEZ, A. (1992b): Socio-spatial impact analysis and site selection for controversial public facilities with GIS, EGIS'92 (Third European Conference on Geographic Information Systems), Munich, marzo, 1992. Publicada en *Proceedings*, Utrecht, EGIS Foundation, 1992, p.

OCAÑA, C., ALEGRE, P., CEBRIÁN, J.A. Y SANCHO, J. (1992): Nuevas técnicas en la

investigación geográfica (Sistemas de Información Geográfica, Cartografía automática y teledetección, en *La Geografía en España (1970-1990)*, Madrid, Real Sociedad Geográfica, Asociación de Geógrafos Españoles, pp. 231-240.

OTERO PASTOR, I. (Coordinadora): *Diccionario de Cartografía*. Madrid, Ediciones de Ciencias Sociales, 266 pp.

PERLES, M.J., GALACHO, F. y MÉRIDA, M. (1993): Metodología de análisis del grado de poblamiento apartir de un SIG. Aplicación práctica. *Inmigración extranjera y planificación demográfica en España*, Tenerife, Universidad de la Laguna, pp. 207-211.

PRADOS, M.J. (1995): La utilización de imágenes Landsat-5 TM para la estimación y seguimiento de áreas de monocultivo arrocero y su vinculación a espacios naturales, *Revista de Teledetección*, vol. 5, pp. 44-48.

RAMÍREZ, G. y MAURO, J. (1995): *Atlas del Territorio de Castilla y León*. Junta de Castilla y León, Valladolid, 142 pp.

SALAS, F.J. y CHUVIECO, E. (1994): Sistemas de Información Geográfica y Teledetección en la prevención de incendios forestales: un ensayo en el Macizo Oriental de la Sierra de Gredos, *Estudios Geográficos*, vol. 40, pp. 683-710.

SANCHO, J. (1988-89): El proyecto Corine Land Cover, *Boletín de la Real Sociedad Geográfica*, Tomo CXXIV-CXXV, nº 1 a 12, Enero-Diciembre, pp. 261-268.

SANCHO, J. y CHUVIECO, E. (1986): *Castellón desde el espacio*. Caja de Ahorros y Monte de Piedad de Castellón 93 pp.

SANCHO COMÍNS, J., BOSQUE SENDRA, J. y MORENO SANZ, F. (1993b): Crisis and permanence of the traditional Mediterranean landscape in the central region of Spain, *Landscape and Urban Planning*, 23, pp. 155-166.

SANCHO COMÍNS, J., BOSQUE SENDRA, J. y MORENO SANZ, F. (1993a): La dinámica del paisaje: aplicación de un SIG raster al ejemplo de Arganda del Rey en Las Vegas de Madrid, *Catastro*, pp. 35-51.

SANCHO COMÍNS, J., BOSQUE SENDRA, J. y MORENO SANZ, F. (1995): Les mutations du paysage agraire dans les régions méditerranéennes: l'exemple de Morata de Tajuña en *Les mutations dans le milieu rural* Caen, Presses Universitaires de Caen, pp. 275-288.

SANZ, J.J. (1976): Some geomorphological aspects of Landsat-2 images over central western Spain, en *Thematic Mapping, Land Use, Geological Structure and Water Resources in Central Spain*, (R. Nunez, Ed.), NASA Project 28760, Madrid, pp. 208-214.

THE EUROPEAN CONFERENCE ON GIS (1992, 1994), Munich (Alemania), La Haya (Holanda).