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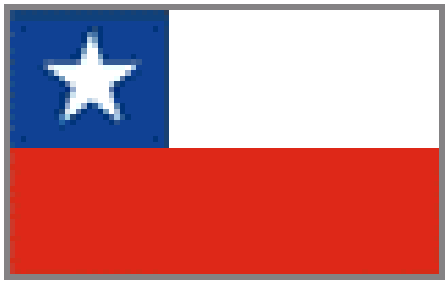
MILITARY GEOGRAPHIC INSTITUTE OF CHILE



CHILEAN NATIONAL COMMITTEE OF THE
INTERNATIONAL CARTOGRAPHIC ASSOCIATION

REPORT ON CARTOGRAPHY IN THE REPUBLIC OF CHILE 2003 - 2007

SUBMITTED TO THE TWENTY-THIRD GENERAL ASSEMBLY
OF THE INTERNATIONAL CARTOGRAPHIC ASSOCIATION

JULY 2007

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1. Introduction

1.1 Preface from the ICA National Committee

"On behalf of the Chilean National Committee, of the cartographic practitioners and institutions of my country and of the Republic of Chile, it gives me great pleasure to submit this National Report, in addition to maintaining the tradition of contributing to the ICA that my predecessors at the IGM have always upheld.

The ICA plays a fundamental role in the fields of activity and the sciences in which I have personally been active throughout my career. My experiences as an engineer in the geographic sciences, as a long-standing member of the main cartographic agency of Chile, the IGM, and as an active participant in key international organizations, have all led me to recognize the importance of the ICA in the progress of cartography and related sciences as essential aids to human and social development.

Chile as a country participates in this progress, as I trust that this report demonstrates, so much so that this nation is proud to welcome the International Cartographic Association to the ICC 2009 conference to be held in Santiago, Chile, two years after the date of this report. I look forward to greeting you all to this conference."

RODRIGO BARRIGA VARGAS
COLONEL

DIRECTOR OF THE MILITARY GEOGRAPHIC INSTITUTE OF CHILE

CHAIRMAN OF THE CHILEAN NATIONAL COMMITTEE OF THE INTERNATIONAL CARTOGRAPHIC ASSOCIATION

1.2 The ICA National Committee of Chile

The Republic of Chile is represented as a member of the ICA by the Military Geographic Institute of Chile (IGM). The IGM is responsible for the National Committee of the ICA in Chile because it is the official authority and mapping agency representing the Chilean State in all matters involving geography, mapping, and the representation of the territory of Chile in topographic cartography. This mission includes the responsibility of representing the State and the Nation in all those international organizations which relate to geography and geographic or geo-spatial information[1]. This representation is assigned specifically to the Director of the IGM. The ICA is considered to be one of these organizations, so it is the Director of the IGM who leads the ICA National Committee in Chile and who acts as official representative to the assemblies of the Association.

The IGM[2] acts as local secretariat for the ICA National Committee, while technical, academic or scientific activities related to Cartography are open to the involvement of appropriate Chilean organizations outside the IGM.

1.3 National Reports from Chile to the ICA

The previous report from the National Committee in Chile covered the period 1999 – 2003 in a document of about 28 pages. For the 2003 – 2007 period, a more substantial report is required, including new chapters and information provided especially for the report by other Chilean organizations outside the IGM[3]. This report is due to be presented to the ICA Executive Committee and to the 23rd General Assembly in August 2007 [4]. In addition, two of the papers being submitted to the ICC 2007 complement this report[5].

1.4 Activities of the ICA National Committee during 2003 - 2007

Since the year 2003 the National Committee of the ICA in Chile has deepened and extended its cooperation with the ICA.

During the year 2003, the Chilean Committee participated in a project of the ICA Map Production Commission; this was the initiative to draft a “Manual of Cartographic Production” that combined the technical criteria of cartographic processes with quality and cost control criteria. The Director of the IGM directed the drafting of recommended improvements to the text provided to the project coordinator[6].

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[1] The overall mission of the IGM is defined in the Decree–Law Nº 1664 of August 1922, while the obligation to represent Chile in international relations is stated in Defence Ministry Decree Nº 18 of January 1979.

[2] From here onwards only the initials of organizations are given. Full names for these are listed in Annex Nº 3.

[3] Images of cartographic products are not included, due to the need for conciseness and to the availability of abundant sample images at the web sites of the institutions described. Annex 1 has the relevant URL addresses.

[4] The Report has been drafted by the Geographic Secretariat of the IGM during the period January – May 2007.

[5] These papers describe cartographic projects at the IGM and may be considered informally as extensions to this Report. See last paragraphs of point 4.2.5.

[6] The coordinator was Mr Erkki-Sakkari Harju of Finland.

In the year 2005, Mr. William Cartwright, Vice-President of the ICA, came to visit Chile and the IGM to discuss ICA business and conferences with the ICA National Committee of Chile.

Other activities of the National Committee have involved the ICC conferences. The offer of the Chilean National Committee to host the ICC of 2009, accepted in 2005, was intended as a concrete measure of assistance to the ICA and as a way to deepen the cooperation between the ICA and its Chilean counterparts. The National Committee has begun to prepare for the ICC of 2009. The participation of a delegation in the ICC of 2007 is a major milestone in this respect[7].

Also this year, a significant development is the candidacy of Eng. Pablo Gran L. for the position of ICA Vice–President in the Executive Committee. Mr Gran has been active in the ICA at both an international level and in the management of the National Committee during the period 2000 – 2004 when he was Director of the IGM. He hopes that the 23rd General Assembly of the ICA will give him approval to make a substantial contribution to the tasks facing the ICA[8].

Mr Pablo Gran proposes that the ICA renew its alliances with other organizations in both public, international and private sectors, and also improve the general coordination of the work of the committees and commissions. He believes that the ICA may provide backing to those individual organizations capable of performing projects valuable to geo-spatial data infrastructures, to society and to the environment, but require additional international backing, particularly from the ICA, in order to obtain the recognition, cooperation and resources they require from their respective local communities.

[7] See also point 7.1 and 7.2 about the ICC conferences.
[8] Full information about the candidacy of Eng. Pablo Gran L. is due to be posted on the ICA web site.

2. State of Cartography in Chile – General Trends

2.1 Background Context for Cartography in Chile

2.1.1 Social Context

Chile has a distinctive profile among developing countries and in the South American region as a society capable of achieving significant economic growth, political stability, gradually-improving living standards, and progress in its physical infra-structure. The country shares with other developing nations the challenges posed by social and economic ills such as poverty and unemployment, also environmental degradation and limitations on resources available for investment. However, the Chilean community has a capacity to respond to, minimize and eventually overcome these difficulties. Two key factors in this capacity are a relatively high standard of education and training coupled with a relatively rapid adoption of new technology, with Information Technology (IT) at the forefront of this technological emergence.

It is in this context that advances in geo-spatial information and cartography become both necessary and possible. Necessary because the very change and growth that Chile is undergoing makes geo-spatial data all the more vital as an aid to ongoing analysis and management at all levels and in al sectors. Possible because new technology, particularly informatics[9], provides the platform on which geo-spatial data handling techniques can develop.

2.1.2 Importance of Geo-cartographic Information for Management

Geo-spatial information has in recent years become ever more widely used in the sectors of public administration, economic applications, also the educational, academic and scientific fields. This is not to say that geo-cartographic applications have reached their full potential; there remain opportunities for cartography to modernize, improve quality or to find and fill new niches. One example of future development may be cadastral information[10], still essentially isolated from the potential of accurate cartography and GIS systems. This context forces the practice of cartography in Chile to evolve even as it responds to current requirements.

2.1.3 Transfer of Technology, Skills and Data to Chile

Chilean organizations are open to the acquisition, adaptation and implementation of new technology, skills and information from outside the country, thus fuelling advances in technological capacity, data access, expertise, and physical facilities. These transfers occur by means of :

- formal cooperation agreements between Chilean organizations and their counterparts in other countries or in international organizations
- contracts and purchases carried out on a commercial basis

[9] Not forgetting other technologies in the fields of surveying, remote sensing and communications.
[10] Specifically legal cadastral records about properties for ownership and taxation functions. Cadastral systems oriented to agricultural uses (see point 4.5) are in a different situation.

- research through informal, personal contacts and use of free on-line resources

The impact of these transfers can be seen especially in the field of geo-cartographic information, since the tools, input data and products for the cartographic industry are now largely dependant on digital or computerized media, transfer of materials to Chile is relatively easy in logistical terms. The number of trained technicians and professionals capable of implementing and using state-of-the-art tools and data products is not large in Chile, but it is just enough for the necessary tasks. A significant restriction in some cases is the necessary funding for major programs.

The transfer of the minimum necessary skills, technology and information products to Chile has enabled cartographic practitioners to achieve a level of technical expertise and technological potential close to that of equivalent institutions in developed countries, even where limitations on resources restrict the physical size and the volume production capacity of local organizations to much lower levels.

2.2 Developments and Tendencies in Cartography

2.2.1 Standardization and Quality Management

There is a general trend towards standardization in the geo-cartographic field in Chile, where an increasing reliance on digital, on-line and computerized media obliges a certain level of compatibility at least in cartographic product formats if not in content. This trend is most evident in the public sector, where a major government-backed initiative is close to establishing an all-embracing spatial data infrastructure[11].

Modernization and Quality Management programs also contribute to the need for standardization. Quality issues have also become increasingly important for the field. Two of the main state cartographic agencies of Chile, IGM and SAF, have implemented quality management systems based on the ISO 9000 model.

2.2.2 Poverty Mapping

There have been some initiatives involving thematic cartography and GIS applications as aids in the management of the response to poverty in local communities and related socio-economic issues.

First, a socio-economic atlas of the Metropolitan Region (including Chile's capital) was released in 2004 by the University of Chile and the Regional Government[12].

The Planning Ministry – MIDEPLAN – has in recent years started to analyse statistics concerning several social variables, including quantifiable and spatially referenced poverty

[11] See Chapter 3 point 3.1.
[12] "Atlas Socio-economico de la Región Metropolitana de Santiago", Univ. of Chile & Metropolitan Regional Government, 2004

indicators, using GIS-based techniques. Some of the results can be seen at the web site resource mentioned in the following point, 2.2.3.

Two papers and a poster presented to the GSDI-9 conference[13] in 2006 report work in this field. A project performed by the 'Natural Resources Information Center' - CIREN titled "Rural Territorial Information System for Poor Communities"[14], involved trials with field data (geo-referenced information and statistics) from a few boroughs known to be very poor in several quantifiable social, economic and agricultural parameters. The data was processed in a new tool or system with GIS capabilities for analyzing social problems from a spatial or territorial perspective, with the aim of facilitating decision-making for economic development and countering poverty. The intention is to distribute the tool further among other communities.

Another paper[15] described a socio-spatial analysis of irregular encampments of poor families near the town of Vina del Mar[16]. The poster at GSDI-9 deals mainly with a method of spatial analysis aimed at data for desertification in agricultural areas, also with aiding measures to recover the land and thus counter-act poverty in rural communities[17].

In one of the poorest boroughs in Chile, Lota[18], the municipal authorities have recently entered into an agreement with the IGM to cooperate within the framework of one of the SNIT programs (the cartographic model[19]) on information gathering and concept development oriented specifically towards developing spatial data that assists social action in this community[20].

The local office of a United Nations agency called the Economic Commission for Latin America and the Caribbean – ECLAC - has been active in advising local organizations such as MIDEPLAN and INE on how to analyse social development statistics and poverty indicators. One of their achievements has been to introduce a digital tool for this purpose known as "REDATAM", that enables a combination of spatially-referenced and census data to produce cartography based on statistical processing.

[13] See point 3.4.
[14] "Sistema de Información Territorial Rural para Comunas Pobres", H. Pinto, Nov. 2006, CIREN
[15] "Diagnóstico socio-espacial de los asentamientos ilegales en la comuna de Viña del Mar utilizando SIG y REDATAM" (Social – spatial análisis of illegal settlements in the borough of Vina del Mar using GIS and 'REDATAM'"); Felipe Livert Aquino, Nov. 2006
[16] Vina del Mar is a resort town on the coast of central Chile near the major port of Valparaíso.
[17] "Proposición de metodología de análisis espacial para combatir la desertificación y la pobreza rural en la comuna de Punitaqui" , C. Meneses, J. Carrasco, Nov. 2006, Univ. of Chile & Municipality of San Felipe.
[18] Located on the coast in the Eighth Region (central Chile) to the south of the city of Concepción. Lota used to be a town of major industrial importance due to the coal mines until the 1990's when the mining business gradually collapsed, thus becoming a unique and well-known socio-economic case in Chile.
[19] Specifically known as the "Modelo Cartográfico para la Gestión de la Información Territorial en Chile" (Cartographic model for the management of territorial information in Chile). For more about the SNIT, see point 3.1.
[20] As reported in an IGM article on its Web site in early 2007; see the "Noticias" section.

2.2.3 On-line Sources of Cartography

In recent years a certain amount of cartography representing Chilean territory has become available at Internet sites with web-mapping interfaces; those providing material on-line and free of charge include the following three sites :

In 2006 a web map was established within the site at //siit.bcn.cl/ [21] which concerns the territorial information issues managed by the Congress of the Republic. The service provides a continuous digital map of the country, run by the Library of the Chilean Congress in conjunction with the IGM. The digital dataset is relatively simple, intended for use as a general introduction to the territory. The interface enables users to select specific zones for download to be used in GIS environments.

Two government Ministries have established on-line resources providing maps and spatial data reporting their respective studies. The CONAMA[22] has a site dedicated to its "National Environmental Information System" – SINIA. This site[23] includes a sector with a collection of cartography provided as a mixture of cartographic images presented directly in a web mapping interface, files for download, metadata and catalog entries. The maps mostly concern themes of geography, environment and conservation. There is also a collection of aerial photograph images at the CONAMA facility[24]. The MIDEPLAN[25] provides data in a similar system[26], the maps being oriented mainly to social and statistical themes.

The "Mapcity" firm provides an on-line interface through its web site at www.mapcity.cl to two large-scale street maps – one of Santiago, the other of Valparaiso. These can be searched by street name or by a catalogue of objects of interest to visitors and linked to the map.

2.2.4 Accuracy in Data from Aerial Photography and Field Surveys

The positional accuracy of all features referenced to any valid horizontal and altimetric reference frameworks in any cartography is only as good as the source materials it depends on, obtained (at least in the cases mentioned below) from aerial photography and field surveys. Certain studies have been performed in Chile to check and quantify accuracy and error in these base materials; three of them can be cited here.

Firstly, in 2004 an article was published[27] on the results of a trial to quantify the error present in a sample sheet of the thematic map series representing the vegetation and land use surveyed during the 1990's[28]. The classification of terrain into polygons had been achieved in central Chile largely by photo-interpretation and photogrammetric analysis in 3D of objects, backed up by some field checks. Problems including radial displacement around the edge

[21] The web map facility is at pages http://siit.bcn.cl/bcn2/viewer.asp and http://siit.bcn.cl/descarga/viewer.asp
[22] See point 4.8
[23] Sinia home page at www.sinia.cl, with access to the map and aerial photo sectors of the site
[24] At the associated site aerofotos.sinia.cl
[25] See point 4.8
[26] The relevant interfaces can be accessed through http://sider.midelplan.cl
[27] Victor Sandoval, in the Journal "Bosque" and in association with the "Universidad Austral"; see bibliography.
[28] The survey of vegetation resources by CONAMA, CONAF and CIREN, described in the 1999 – 2003 report to ICA.

areas of the aerial photographs used and the resolution of the scanned-in photographs were suspected to have reduced accuracy in the placement of polygon boundaries onto the map base.

In the trial, an area[29] in the Eighth Region (central Chile) was mapped again under the same classification criteria, using methods equivalent (i.e., comparable) to those of the original survey but with different tools at a much higher precision and reliability in terms of accuracy. The comparison between the new map and the corresponding sector of the old survey produced figures for error in positions, leading to a statistical analysis and quantification of the overall error.

Secondly, in 2005 an article was published[30] about a comparison between two methods of correction and control used to adjust a mosaic of aerial photographs. The intention was to see which method produces the mosaic most useful as a base for geometrically and positionally accurate cartography, with all distortions reduced to a minimum.

Using the same mosaic of a trial area[31], two versions were adjusted using control points. For one version, the control points were obtained from the vector coverage portraying point features identifiable in the terrain with positions derived from the original restitution of the aerial photographs making up the mosaic. Corrections are only horizontal in this case. For the other version, the control points were obtained by GPS measurements in the field and a Digital Elevation Model (DEM) was also used to adjust the vertical component. By quantifying the difference between positions for the same locations in the two versions of the mosaic and applying a statistical analysis, indicators of relative accuracy could be determined. The mosaic that was ortho-rectified with GPS control points and geo-referenced with a DEM was found to be more accurate.

Thirdly, in a study performed within the IGM[32], a method for quantifying errors measured in aerotriangulation of aerial photo mosaics was developed and applied. The sequence starts with the identification of supporting aerotriangulation points in the photo-mosaic, expressed in instrument or photograph coordinates. Separately, control points are measured by GPS techniques in the terrain. The control points are used in aerotriangulation and coordinate adjustment to geo-reference the whole block to UTM coordinates, previous to photogrammetric restitution of the correctly-geo-referenced stereoscopic models.

In the stages immediately prior to aerotriangulation, there are always small errors generated, arising from small but accumulated human, machine and system errors. In other words, each individual position has a small error that can be detected and quantified in the phase of aerotriangulation, adjustment and transformation. It cannot be eliminated completely, but it can be reduced to an acceptable minimum, thus improving accuracy in the subsequent phases of restitution and cartography. The study performed during the year 2005 determined

[29] Defined by the boundaries of a sheet in an IGM map series
[30] In the Journal "Terra Australis", Nº 50; the authors are members of the University of Talca; see bibliography.
[31] The town of Constitución on the coast of central Chile and some surrounding terrain.
[32] The study was performed by an intern from the University of Santiago – USACH – as a graduation project, thus entering the public domain; see bibliography.

a statistical method for analyzing these errors, observing tendencies in the sources of error, and suggested acceptable margins or tolerances for error.

3. Activities at National Level

3.1. S.N.I.T. and the National Spatial Data Infrastructure of Chile

3.1.1 Introduction and Objectives

The governmental institutions of Chile have made substantial progress towards establishing a comprehensive geo-spatial data infrastructure at a national level, integrated with the global tendency towards SDI. The program for creating a Chilean SDI is called the "National Territorial Information System" or S.N.I.T. The initial startup phases and the overall structure were outlined in the previous report[33].
Formed as a cooperative alliance of those government agencies and public institutions that develop and use land and territorial information, the S.N.I.T. has the primary objective of modernizing the management of territorial information, enabling the introduction of a new style of management, the creation of solutions for obstacles to development, and the implementation of supporting technological resources[34].

3.1.2. Structure and Achievements 2003 - 2007

Formally the S.N.I.T. is under the supervision of a governmental committee[35] and a technical secretariat. The structure includes an advisory committee, regional (local government) committees, a technical support unit and a group of seven thematic committees[36] made up of representatives from appropriate institutions. Several of the institutions named in this report participate in one or more of these thematic area committees.

One of these thematic area committees is the "Basic Territorial Information Group" or G.I.T.B.. The G.I.T.B., made up of contributions from the IGM, SHOA, SAF, CIREN, INE and ACHE, has achieved the following for the SNIT and Chilean SDI :

- Draft version of a catalogue of cartographic entities, with definitions and portrayal methods for all objects likely to be represented in spatial data
- Endorsement of the SIRGAS system[37] as the standard reference framework in which all cartographic and spatial data should be positioned
- Proposed standards for data dictionaries[38]
- Identification of those sectors where cartography is lacking[39]
- Creation of a central on-line depository of metadata files for a very large number of cartographic data and products.

[33] National Report to ICA covering 1999 – 2003, point 2.2.
[34] These resources include the geo-referencing of spatial data, interaction through on-line networks and the use of GIS tools.
[35] This committee is managed directly and jointly by several government ministries.
[36] These seven areas are : Social, Infrastructure, Property, Territorial Planning, Heritage, Natural Resources, and Basic Territorial Information.
[37] See point 4.2.2
[38] The starting point for the standard has been the study of the FACC/VMAP2 system from United States agencies
[39] That is to say, those areas of Chilean territory where cartography at larger scales than is currently available should be created as a priority

3.1.3 Impact of S.N.I.T. on Cartography

The last-named achievement of the GITB, the metadata catalogue accessed though the SNIT web site, is especially significant for the ICA. Since startup, most of the state and public institutions of Chile at all levels and in all sectors have cooperated, providing metadata files for their holdings. This catalogue is close to becoming the most authoritative, comprehensive and extensive listing of maps that ICA members can use to access Chilean cartography, past and present.

Although the scope of territorial information management in the S.N.I.T. goes far beyond strictly cartographic issues, there is a major impact on the development of cartography in Chile. The standardization encouraged by the SNIT is improving inter-operability among geo-cartographic datasets. New cartography will be generated as gaps in holdings are identified, update programs are required and the needs of the Chilean community for spatial data are detected. Efficiency in cartographic production will improve as institutions cooperate with each other and avoid duplicating efforts.

3.1.4 S.N.I.T. and SDI Around the World

The SNIT is fully integrated with the global trend towards regional and world spatial data infrastructures. Cooperation has been established between the SNIT and supporting national institutions on the one hand and on the other the Global Spatial Data Infrastructure Association" – GSDI, also with the. The GSDI Association, in recognition of the progress made in Chile and the example it constitutes for the rest of Latin America, decided to hold its Ninth International Conference in Chile. The GSDI-9 conference[40] gave an opportunity for contributors to the SNIT to interact with SDI practitioners from around the globe.

At regional level, the SNIT has links with the network known as "Permanent Committee of the Spatial Data Infrastructure of the Americas" – CP-IDEA, also with the project known as IDEDES[41] an initiative backed by the CYTED program[42].

3.2 Pan-American Institute for Geography and History

The Pan-American Institute for Geography and History (PAIGH) is a specialized agency[43] active in promoting scientific, technical and academic activities of a diverse nature in the four key fields of Geography, Cartography, Geo-physics and History. The activities of the PAIGH are structured around four Commissions, one for each of the above fields. Naturally the Cartography Commission is of greatest interest to the ICA. PAIGH achieves international cooperation by means of a network of National Sections active in each of the 21 member states.

[40] See point 3.4
[41] The full title of this project is "Evaluation and Strengthening of Spatial Data Infrastructures in Sustainable Development for Latin America and the Carribbean". It involves several Latin American countries.
[42] CYTED ("Science and Technology for Development") is a program of support for projects based in Spain.
[43] The PAIGH is one of the agencies reporting to and supervised by the Organization of American States (OAS).

The PAIGH National Section in Chile[44] is supported by several appropriate local institutions. Support is especially strong for the Cartography Commission[45]; in fact the Presidency and secretariat[46] of the PAIGH Cartography Commission have been located in Chile since the year 2005, thus presenting Chilean institutions with a historic opportunity to make a major contribution to Cartography throughout the region of the Americas.

Several committees, working groups and projects attached to the PAIGH Cartography Commission are strongly supported by Chilean organizations and individual specialists. Three of these, like the Cartography Commission itself, are being coordinated from Chile; these are :

- The Aeronautic Charts Committee
- The Tactile Cartography Working Group[47]
- Americas Global Map Project

Some other programs, such as SIRGAS[48], although led by other countries in the PAIGH network, are receiving significant contributions from Chilean organizations.

The "Revista Cartogáfica" (Cartographic Journal), one of the highly-respected journals published by the PAIGH, is edited in and coordinated from Chile[49]. The Chilean organizations contributing to the PAIGH Cartography Commission include the IGM, UTEM[50], SHOA, SAF, DIFROL, PUC and INACH.

3.3 Research and Surveys in Antarctica

Chile has an active presence in the continent of Antarctica and in the scientific activities performed there[51], sustained through the activities and resources of several institutions working in conjunction. For cartography, the significant institutions here are the Chilean Antarctic Institute – INACH[52] - and the three geo-spatial / surveying agencies of the Armed

[44] The National Section was established by agreement between the Government of Chile, through the Foreign Affairs Ministry, and the OAS. It has its Presidency in the IGM as mandated by the same Decree already mentioned in Note 1.
[45] There is also cooperation in Chile with the other Commissions, especially the Geography Commission.
[46] The leadership and secretariat of each of the four PAIGH Commissions consist of a President, a Vice-President and a Technical Secretary. The four Commissions are renewed and rotated between member states of the PAIGH every four years; thus Chile is due to host the Cartography Commission Presidency and secretariat until 2009. For comparison, Mexico now hosts the Geography Commission during the same period.
[47] See also point 5.3
[48] See point 4.2.2.
[49] Specifically, at the IGM; the current Editor is also active in the ICA National Committee.
[50] The UTEM (see point 6.1) maintains the secretariat of the local Cartography Commission, which is that part of the Chilean National Section of PAIGH corresponding with the PAIGH Cartography Commission. The local Cartography Commission is fully aware of the ICC conferences and is willing to cooperate with the ICA.
[51] Coordination with the international community on cartographic issues is achieved through the Scientific Committee on Antarctic Research – SCAR - and its Geodesy and Geographic Information Working Group, which receives cooperation from Chile through the INACH and IGM.
[52] See point 4.8

Forces (IGM, SAF and SHOA)[53]. The "Scientific Studies Center" - CEC[54]- has also participated in some specific projects.

The most important field survey conducted recently was a campaign in the December 2004 – January 2005 season in which some of those Chilean institutions named above cooperated to send a group of surveyors and scientists on a trek which made progress overland from the Chilean base at Patriot Hills[55] to the South Pole, making GPS and gravimetric measurements as it went and acquiring knowledge of the ice relief and landscape. The knowledge of the terrain acquired is useful as an aid to cartography of the area between the Antarctic Peninsula and the South Pole.

The Chilean institutions active in Antarctic Cartography have, since 2003, produced eight accurate map sheets covering specific zones of scientific interest at large scales using data surveyed in the field and/or obtained by remote sensing. Four of these are adjacent and cover the Byers Peninsula; the others individually cover Cape Shirreff, Deception Island, Rugged Island and the Ardley Peninsula.

3.4 Conferences

Several important conferences have been held in Chile, attracting attendees representing a wide variety of institutions and activities. While the majority of attendees are from Chile, there have also been significant numbers from other countries around the world. The most important conferences were :

Name or type of event	*Organization*	*Local Hosts & Location*	*Dates*
8th International Earth Sciences Congress	IGM	IGM	18th – 22nd October 2004
33rd General Assembly	International Association of Seismology and Physics of the Earth's Interior – IASPEI	University of Chile[56] & IGM	2nd – 8th October 2005
XI Latin American Remote Sensing Symposium	Latin American Society for Remote Sensing - SELPER	Chilean chapter of SELPER	22nd – 26th November 2005
GSDI-9, UNGIWG-7, ISCGM-13, others	GSDI, PAIGH, UNGIWG, CP-IDEA, ISCGM (see below)	IGM	30th October – 16th November 2006

The last of these, a major cycle of conferences, meetings and workshops taking place in the period late October to mid-November 2006, deserves a more detailed description. The initial impulse came from the decision of the Global Spatial Data Infrastructure Association (GSDI) to hold its ninth international conference in Chile. Around this major conference, several other

[53] The work of these institutions is made possible by logistical and institutional support received from the Chilean Air Force and from the Antarctic Command of the Chilean Army.
[54] The CEC is a small scientific research entity based in Valdivia, southern Chile.
[55] At Latitude 80" 18' south and Longitude 81" 21' west, near the Ellsworth Mountains.
[56] Department of Geophysics within the Univ. of Chile

international organizations programmed their events to be held in Santiago, Chile, either on or very close to the dates of the GSDI-9 conference. The main events[57] were:

Permanent Committee for the Spatial Data Infrastructure of the Americas – PC-IDEA
SDI Training Workshop. 30th October to 3rd November

United Nations Geographic Information Working Group – UNGIWG :
7th Plenary Meeting. 2nd to 4th November

Global Spatial Data Infrastructure Association – GSDI :
GSDI-9 International Conference. 6th to 10th November

Ninth Earth Sciences Congress – ESC :
Conference sessions in conjunction with GSDI-9. 6th to 10th November

Food and Agriculture Organization – FAO (UN) :
Workshops of the Global Land Cover Network (GLCN). 3rd and 8th November

Americas Global Map project (MGA) :
2nd Annual Meeting. 10th November

International Steering Committee for Global Mapping - ISCGM :
13th Annual Meeting. 11th November

Pan – American Institute for Geography and History – PAIGH :
XXXIX Council Meeting. 13th to 16th November

The IGM began preparing the conferences in early 2005; by October 2006 several other Chilean organizations were contributing logistical services, venues, and accommodation, under the general coordination of the IGM. Several hundred attendees participated in these events, achieving the distribution of substantial volumes of high-quality knowledge and expertise through the technical papers and practical workshops. Many important decisions affecting the geo-spatial data and cartographic field around the world were taken.

The web site for GSDI-9 will remain in place at www.gsdi9.cl until the end of 2007. The experience demonstrated the capacity to organize major international conferences that will be applied to preparations for the International Cartographic Conference of 2009[58].

[57] Excluding some of the smaller meetings
[58] See point 7.2.

4. State and Public Institutions

4.1 Introduction

Cartography in Chile is sustained first and foremost by the state and public institutions[59] of the nation. The official cartography of the country has its origins in the products of the three agencies attached to the Armed Forces; IGM, SHOA and SAF. These three, together with the CIREN, create and maintain the fundamental geo-cartographic data of the community and NSDI of Chile[60]. CIREN, SERNAGEOMIN and CONAF produce important thematic cartography. The six agencies named above have provided information specifically for this report, given in points 4.2 to 4.7. Points 4.8 and 4.9 summarise cartographic activites in certain other public institutions capable of spatial data management at a specialized level.

4.2 Military Geographic Institute - IGM

4.2.1 Introduction

The Military Geographic Institute of Chile (IGM) is the principal cartographic agency of Chile due to :

(a) The official function of the IGM as official authority representing the state and Republic of Chile in all matters involving geography, surveying and the creation of maps of Chilean territory.
(b) The responsibility of the IGM for creating and maintaining the fundamental base cartography of Chilean terrestrial territory in several series of topographically-accurate maps.
(c) The capabilities of the IGM in terms of professional expertise, technological resources, production capacity and range of services and activities.

In formal terms the IGM is attached to the Army of Chile[61]. Its staff contains a mix of civilian and uniformed personnel[62], with a high proportion of professional and technically competent specialists in spatial data and the earth scientists[63], all located in a single complex of buildings in central Santiago.

[59] This includes governmental ministries and dependant bodies, official cartographic agencies, and other public organizations that are not in either the private sector nor the academic sector.
[60] It is for this reason that the IGM, SHOA, SAF and CIREN are grouped together in the GITB of the SNIT; see point 3.1.2.
[61] The IGM is one of a group of industrial/technical establishments under the management of the "Military Engineering and Industrial Command", part of the Army command structure.
[62] The majority of the staff are civilians, however, uniformed personnel include the senior management and some key professional experts in the fields of activity of the IGM.
[63] The earth sciences specialists are mainly cartographers, surveyors, photogrammetrists and geographers. These are aided by specialists in information technology, printing techniques, technical drawing, multimedia IT, and in management of quality, commercial and administrative functions.

4.2.2 Geodesy and Reference System

The standard reference framework for accurate positioning of cartography in Chile is the "National Geodesic Network" (RGN in Spanish initials). The IGM has been progressively modernizing this network, adding more control points so that there are now more than 500 points measured and marked with monuments, which are distributed at 50 kilometer intervals so as to guarantee the usefulness of these points to the users of the network. In addition, complementing this network, there are 15 continuous–monitoring GPS stations (CGPS), which give daily information used in the measurement of deformations of the terrestrial crust, in the calculation of velocities and, as a network, to support the differential measurements of GPS users.

The network has been enhanced using GPS techniques[64] and is integrated with the international geodesic project covering the whole of the American continents called "Geocentric Reference System for the Americas" or SIRGAS in Spanish initials[65].

The network enables IGM cartography to position control points and thus all the surrounding terrain into the WGS 84 Datum[66]. Given that most of the IGM's primary topographic cartography base, the 1:50,000 series, and virtually all of the maps in the smaller-scale series now contain one or more of the RGN control points, IGM cartography can thus place geometrically precise geographic and UTM coordinate grids to scale and position in them terrain features to a very high level of horizontal positional accuracy.

Before 2001, the main topographic map series of the IGM had been referenced to RGN points referenced to two older Datums[67]. With the re-measurement and transformation of these RGN points towards SIRGAS parameters, this in turn enabled the IGM to transform its base cartography[68] to the WGS 84 Datum. The period 2003-2007 saw the greater part of this major ongoing task performed.

While work among SIRGAS contributors now focuses on the vertical component, the IGM has been able to improve its capacity to determine accurate altimetric data for its spot height and contour symbols. Measurements of gravimetric data (absolute gravity) contribute to development of the altimetric system, so the National Gravity Database begun in the previous period has been densified with further surveys. The first trial maps showing gravimetric data[69] were produced during the 2004 – 2006 period. The IGM has also cooperated with organizations from other countries [70] on geodesy-related projects performed in Chilean

[64] Such as double-frequency GPS receivers, antennas approved by the International GPS Service, data captured in continuous-period measurements and processed with special software.
[65] SIRGAS is an international project based on a reference system (International Terrestrial Reference System – ITRS, initially proposed by the I.U.G.G. and the I.A.U.) and an ellipsoid (GRS 80 of the I.A.G.) for use throughout the region, also maintaining a reference network and a Datum throughout the region.
[66] WGS 84 is entirely compatible with ITRS, being almost the same.
[67] PSAD 56 and SAD 69
[68] Starting with the 1:50,000 series
[69] Covering some key areas in Chilean territory.
[70] These projects include the "Central Andes Project - CAP" in conjunction with the University of Ohio, USA, and the " South American Geodymanic Activities – SAGA" in conjunction with GFZ of Germany.

territory which are partly focused on monitoring crustal deformation in terms of continental plate tectonics, but also enable the re-measuring and updating of many RGN points.

4.2.3 Main Map Series

The backbone of the cartographic processes and products is a group of five series of maps portraying the relief and major physical terrain features within the positionally-accurate framework of the RGN[71]. These series follow a common format in line with PAIGH[72] cartographic portrayal conventions and with the requirements of the Chilean state for the official representation of territory.

The primary map series is the 1:50,000 series, of which 1145 sheets are available to the general public; these maps cover most of continental Chile[73]. Much of the remaining territory is covered by datasets that, for various reasons, are not yet available for general release. The maps under development include those based on the project mentioned in point 4.1.5.

The 1:50,000 series serves as a framework and source of data for the other map series at smaller scales. The 1:250,000 scale series is important; for example, 1:250,000 maps have provided the basis for two projects for cooperation with other organisations[74]. Currently 66 maps at 1:250,000 scale and 17 maps at 1:500,000 scale are available to the general public; again, these cover the greater part of continental Chile.

It should be pointed out that most of the areas not available to the general public as individual map sheets at 1:50,000, 1:250,000 and 1:500,000 scales occur in the extreme south of Chile[75] where population density and other human activity is comparatively sparse.

There are 660 maps at 1:25,000 scale. This series is intended to show only those areas with significant density of human activity[76], so this covers about 12 % of the continental territory. This series may expand to cover more sectors, if demand from users arises.

The 55 maps in the 1:100,000 series were intended to cover only part of the extreme south of the country, about 15 % of the total, in areas which, at the time of their creation, mostly were not present in the other series.

The principal group of cartographic processes of the IGM for data capture, creation, re-conversion and general maintenance are focused mainly on these five map series, the

[71] For RGN see previous point, 4.2.2.
[72] See point 3.2 about the PAIGH.
[73] The term “continental Chile” refers to that part of Chilean territory on the South American continent and on nearby coastal islands (which are numerous). It excludes Chilean territory on Pacific islands and in Antarctica that are further away from the South American land mass.
[74] These are the web site resource in conjunction with the Chilean Congress noted in point 2.2.3 and the cooperation with the international Global Mapping program led by the ISCGM.
[75] These areas are in remote regions that are difficult to reach for ground survey and do not possess significant human populations nor economic interest in the terrain. Some sectors also are difficult to photograph adequately from the air due to prevailing weather conditions (cloud cover).
[76] Such as settlements, agriculture, economic activities, nature conservation and transport routes

1:50,000 above all, although most parts of these processes are used for other projects. The general process is summarized as follows :

4.2.4 Main Cartographic Process

New production projects begin with detailed planning, matching requirements with available resources[77] and setting technical specifications. The starting points for most cartographic work in general fall into two basic categories; capture of original field data from aerial photographs or the re-conversion and modernization of older, existing maps. Both processes converge on a digital editing sequence and a centralized cartographic database before diverging again for the different output formats; digital media and printing to analog media.

For aero-photogrammetric projects, the basic input material is a mosaic of photographs covering the area of interest and suitable for photogrammetric restitution[78]. These are inspected and a regular series of control points and supporting points for aerotriangulation are selected. A survey team visits the area covered and measure the locations of the control points selected, tying them to the RGN.

Aerotriangulation and coordinate adjustment operations are performed, using the control points from the field to geo-reference the whole mosaic[79]. A stereoscopic model is created with pairs of photos from the mosaic and photogrammetric restitution begins to capture contours and spot elevations, recorded to digital media with CAD-type tools. There is then some editing and checking before the resulting files leave the photogrammetric specialists, mainly proceeding as a base for standard cartography[80].

Information needed to determine the symbology of non-altimetric data[81] is obtained from a combination of photo-interpretation with observations recorded in the field by the survey team. The data captured so far enters an editing process where the map body is developed, adding standardized symbology and toponyms[82].

The IGM has, since 2001, been steadily converting its pre-existing stock of 1:50,000 scale digitized maps from the original CAD-type media[83] to new requirements. Much more than just a change of file format, the project has involved substantial revision and correction to each map sheet[84], also the conversion to the WGS 84 Datum noted above. At the time of the 1999 – 2003 report to ICA only a small proportion of the 1:50,000 series had been converted. To date, the majority of the sheets have now been converted, though some remain to be done.

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[77] Resources here refers mainly to personnel and time quantified together in man-hours and costs, also to technical equipment, sometimes also to source (imput), reference and supporting data.
[78] Most sets of aerial photographs are supplied to the IGM by the SAF; see point 4.4.
[79] See also point 2.2.4., final paragraphs.
[80] Apart from cartography, elevation data from the photogrammetric restitution facility sometimes goes as input to projects for digital terrain models.
[81] For example; watercourses, roads, settlements, lakes, aerodromes, dams.
[82] A geographic names unit assists with verifying texts inserted into the main map body and providing reliable sources for them.
[83] Input maps are basically the drawings mainly in .dgn ("Microstation") format originally created in the 1990's.
[84] This includes checks such as those on linear connectivity and geometry and map sheet edge matches.

For both the new maps from aerial photos and those based on old digital stock, the digital editing processes becomes progressively similar, involving systematic checks and improvements to content, underlying structures and surface presentation, the development and population of attribute tables attached to each map sheet[85], and conversion to database structure.

The Geo-spatial database is where the fundamental base cartography of the IGM resides as continuous coverages of terrain. From this central database, cartographic editors can extract map sheets for further correction, quality management, conversion and publications tasks. For the IGM, 'publications' means building up the marginal data around the central map body and preparing the visual presentation of the map for printing and final use. Extracts from the DB are converted to the formats of clients requiring digital products. For analog products, further processing takes the map sheet to the printing plant machinery.

The process is still broadly similar to that reported to ICA in 2003, but since then there have been significant improvements and changes affecting most stages.

4.2.5 Modernization of the Cartographic Process

Previous to 2004 most photogrammetric restitution was performed on analog machines for stereoscopic modeling and restitution with elevation data captured into digital media. In 2004 a fully-digital process was introduced and most of the photogrammetric restitution then migrated to a chain of linked workstations, where the work is coordinated to enable the work on the mosaic of photo images to be shared out among operators. Each workstation has a set of hardware accessories and a digital system[86] providing a working environment in which the scanned-in images can be handled and the fundamental set of cartographic elements deriving from the physical relief can be captured and drawn. The change has enabled a significant improvement to volume capacity, quality aspects, speed of operation, and compatibility with subsequent cartographic editing processes.

The central geographic database has become the depository and editing workspace for the 1:50,000 and 1:250,000 scale digital data. In the future, the other map series will be converted and loaded to this database. It is run by the "Oracle Spatial" system, with the "Arc-SDE" (ESRI) system providing the interface to the database for cartographic operations by operators on-line. The systems impose a standardized data dictionary using the feature class concept on the handling of all attributes, data structures and graphic elements.

In close association with the implementation of the Database, the working environment for publications has changed to "Production Line Tools Sets – PLTS" and "Arc-GIS" from the ESRI line of tools. PLTS standardizes, channels and facilitates the generation of map margin data (symbology, insets, texts) both in terms of the accuracy of its technical content and in terms of the quality of visual presentation.

[85] The model for the attribute system is the Feature and Attribute Coding Catalogue (FACC).
[86] The tools acquired center on a software system called "Digital Image Analytical Plotter" – D.I.A.P. provided by a Canadian supplier.

The effects have been to improve map content and graphic style, also to harmonise the output with the pre-printing process, thus improving the final paper product.

The central cartographic database and also the use of PLTS for publications were researched during 2002 and became operational in late 2003[87]. In 2004 the first 1:50,000 map sheets converted to the GIS / Database structures, referenced to WGS 84 and processed under PLTS became available to the public. The central database, the publications work under PLTS and other digital editing activities are now integrated in a protected, controlled, efficient working environment that prevents unnecessary duplication, incompatible versions, corruption, unauthorized re-distribution, or loss of fundamental data.

Production of printed maps now largely depends on a single, large offset printer[88] that was integrated into the printing process during 2003, capable of 5-colour printing in large volume and/or very rapid print runs. The model is modern, with a computerized control system and compatible with input from the cartographic processes. The IGM is thus capable of faster printing at higher print quality.

The production process as a whole has now been transformed by the implementation of a complete quality management system based on the ISO 9000 model. During the year 2006 the documentation, auditing and other mechanisms were developed, then the quality management system was audited by accredited external auditors, achieving certification under the ISO standard.

The capacity of this evolving process has been demonstrated by the creation of cartography for a large part of southern Chile in a project which at this date is nearing completion. Elevation and terrain data from two sources have been combined : elevation data[89] obtained from agencies in the United States of America and from conventional aerophotogrammetric restitution. This project is an innovation for the IGM, enabled by state-of-the-art processes and an international partnership, and provides base mapping data for much of the area not previously covered by the 1:50,000 and 1:250,000 scale series[90]. It allows contours, spot heights and elevation datasets to be generated at a faster rate than before.

Full descriptions of the quality management system and of the southern Chile mapping project are available in two papers due to be presented to ICC 2007; these are “The Quality Management System of the Military Geographic Institute” by Colonel Rodrigo Barriga and “Cartography of the Southern Zone of Chile Using SRTM” by Mrs Cintia Andrade.

4.2.6 Other IGM Products and Services

The products of the IGM (apart from the formal map series described above) oriented to the general public include :

[87] Drafting of the 1999 – 2003 report to ICA occurred while implementation of the database and PLTS was still in progress.
[88] The printer is a “SpeedMaster” model made in Germany.
[89] DTED 2 / SRTM elevation data
[90] See point 4.2.3

- Atlases oriented to the general public and the educational sector
- Orthophotos, orthophotomaps and digital terrain maps[91]
- Multimedia products sold on CD[92]
- Small-scale paper maps of Chile and the continents
- Books on geographic topics
- The "Terra Australis" journal[93].

Among the products published recently, the "Atlas de la Republica" (atlas of the republic of Chile) stands out as a showcase for the art of presenting cartography and geographic information. The special edition of 2005 presents a comprehensive set of new maps portraying the terrain and all the key themes that make up the natural and human geography of Chile[94].

The services provided by the IGM to clients include :

- Large-scale maps of specific areas to order[95]
- Surveying services performed in the field[96]
- Surveys and datasets produced through aero-photogrammetric restitution and orthophotomaps[97]
- Aerotriangulation services

4.2.7 Other IGM Activities

The IGM participates in several multi-institutional organizations in Chile and in international organizations, due to its official duties[98] and to its interest in contributing to and learning from these organizations. In recent years the organization in Chile with most significance for the IGM has been the S.N.I.T., the NSDI of Chile[99]. The formal duties require the IGM to represent Chile in the following organizations :

- International Cartographic Association (ICA).
- Pan-American Institute for Geography and History (PAIGH)[100].

[91] These products are from a facility for work based on remote sensing products and image processing.
[92] Products published recently on CD include the "Iorana Korua" CD ROM, a multi-media guide to the geography and native culture of Easter Island, including maps and images of this unique island in the Pacific Ocean.
[93] "Terra Australis" is a technical journal open to contributions from qualified specialists in the fields of geography and cartography.
[94] The Atlas contains 380 pages at a size of 30 x 40 cm. The content of the 2005 edition has been completely renewed and re-organized in comparison with the previous edition of the "Atlas of the Republic" (1982).
[95] An important group of clients for large scale mapping services are municipal authorities needing detailed mapping of their borough.
[96] A range of surveying services are provided, including leveling surveys, gravimetric measurements, geodesic surveying using mainly GPS techniques and referenced to the RGN, and topographic surveying providing relief data as field support to mapping processes and monographs for reference points.
[97] These services differ from the similar activities applied in the main IGM production process in that specific zones are surveyed and delivered to individual clients to their specifications.
[98] See point 1.2 about the legal responsibility of the IGM as representative of the State.
[99] See point 3.1 about the S.N.I.T. and S.D.I. The IGM also participates in the PC-IDEA, the regional network associated with GSDI in the Americas.
[100] See point 3.2 about the PAIGH

- International Geographic Union (UGI).
- International Union for Geodesy and Geophysics (IUGG).
- International Society for Photogrammetry and Remote Sensing (ISPRS).

The international organizations and projects which the IGM participates in, contributes to and benefits from include :

- Global Spatial Data Infrastructure Association (GSDI)[101].
- Permanent Committee for the Spatial Data Infrastructure of the Americas - CP-IDEA[102]
- GeoSur[103]
- International Steering Committee for Global Mapping - ISCGM

The IGM has the capacity to host public events related to its mission, from small seminars up to major conference cycles[104]. Currently the IGM is preparing for its next major challenge; organizing the International Cartographic Conference of 2009 in conjunction with the ICA.

4.3 Hydrographic and Oceanographic Service of the Chilean Navy – SHOA

4.3.1 Introduction[105]

The Hydrographic and Oceanographic Service of the Navy (SHOA), created in 1874[106], has had as its main mission since its beginnings the assurance of safety in navigation. This has been done by producing nautical cartography of various types and formats, these complying with the technical standards established by international hydrographic cartography organizations. To perform this production, the SHOA has a staff of 274 highly-trained persons including Officers, Seamen and civilian personnel[107].

4.3.2 Cartographic Products

The cartographic products and the main production stages associated with them are listed as follows :

A. Nautical Cartography on Paper at Various Scales for Various Purposes

To make this cartography, field work is performed to obtain bathymetric and oceanographic data and to measure geodesic and photogrammetric points. Subsequently, all the information captured in the field is processed at the central office. Once all the information has been validated, digital editing of the corresponding nautical chart begins, having been previously

[101] See point 3.1 about SDI in Chile, also point 3.4 about the GSDI conference of 2006 in Chile.
[102] In Spanish, "Comité Permanente de la Infraestructura de Datos Espaciales de las Americas" – CP-IDEA. This network of contacts is the regional equivalent of GSDI at global level.
[103] A Project for Spatial Data Infrastructures in South America under the coordination of the "Corporación Andina de Fomento" – CAF.
[104] See point 3.4.
[105] Points 4.3.1, 4.3.2 and 4.3.3 are the text of the letter received from the SHOA for this report, translated directly.
[106] Created by Presidential Decree Nº 329 of the 1st of May in the year 1874.
[107] Located in the city of Valparaiso, Chile's principal seaport.

planned. The standardized toponyms, symbols and colours are added, then being finally printed on paper.

B. Reduced Nautical Cartography on Paper

All the nautical charts printed are associated with a miniature version (reduced format), used normally for educational purposes.

C. Electronic Nautical Cartography at Various Scales for Various Purposes

This being a more modern version at world level of the nautical chart, which is made on the basis of the digital information of the of the paper charts, referenced to WGS 84 and constituting a database that is standardized in form and content so as to be used in electronic navigation systems.

D. Special Nautical Cartography

Maps made with information useful as aids to navigation, to route planning or to other activities.

E. Thematic Nautical Cartography

General maps providing various types of information that is not necessarily for use in navigation.

F. Cartography of Flooding by Tsunamis

Special maps of the main coastal urban centers, created by restitution at large scales, with dense topographic and planimetric information, over which the projected movements of water caused by the occurrence of a Tsunami of certain characteristics are portrayed graphically.

4.3.3 Atlases

Other products related to cartography that this service produces include :

A. Antarctic Atlas
B. Scientific Oceanographic Atlas
C. Hydrographic Atlas of Chile
D. Hydrographic Atlas of Chilean Antarctic
E. Oceanographic Atlas for Education

4.3.4 International Cooperation

The S.H.O.A. participates in or interacts with several international organisations, including the following :

- International Hydrographic Organization – IHO
- PanAmerican Institute for Geography and History – PAIGH

- Intergovernmental Oceanographic Commission - IOC
- National Oceanic and Atmospheric Administration – NOAA (USA)
- Naval oceanographic institutions in several countries around the world

4.4 Aero-Photogrammetric Service of the Air Force – SAF

4.4.1 Introduction[108]

The Aerophotogrammetric Service[109] is the body responsible for providing the photogrammetric coverage used in the processes for creating the official cartography of Chile, and for making and updating aerial navigation cartography. It also gives support to activities related to geography and cartography.

The main activities of the SAF include :

- Creation of aeronautical cartography of Chile at 1:250,000, 1:500,000 and 1:1,000,000 scales under the ISO 9000 standards[110].
- The creation of large-scale digital plans with information appropriate to these scales, such as : elevation contour lines, center-lines of roads and highways, drainage networks, built objects, etc.
- The establishment of a historical archive of images from the nation, the main objective being the provision of aerial photographs for various uses such as photo-interpretation, the creation of cartography and of other plans.

4.4.2 Overview of Current Cartographic Production

Currently the SAF is working jointly with the IGM and the SHOA, providing the cartographic bases for updating the official cartography at 1:50,000 and 1:70,000
scales. It also assists other institutions and clients at other scales. The SAF is able to reference its photographs to the WGS – 84 system by means of the capture of GPS-supported data in the field. Moreover, research projects have included techniques for combining digital aerial photographs and satellite images with GIS systems in order to study and create cartography of areas away from Chile and the Antarctic.

The Aeronautical Cartography department has 15 people, mostly cartographers. The base topographic information is at 1:50,000 scale, provided by the IGM. In this department the map is compiled, generalized, attributed and published in accordance with rules set by institutions such as the Pan - American Institute for Geography and History (PAIGH), the International Civil Organization, the General Civil Aviation Authority - DGAC[111], to name a few. Updates are based on aerial photographs and satellite images. The computer equipment is state-of-the-art and the software used come from the “ESRI” and “Bentley” product lines.

[108] Points 4.4.1 and 4.4.2 are the text of the letter received from the SAF for this report, translated directly.
[109] Formally part of the Chilean Air Force, the SAF cooperates with many civilian organizations, most especially with those named in point 4.4.2.
[110] SAF has established a quality management system for this process, certified under the relevant ISO standard.
[111] In Spanish, this is the “Dirección General de Aeronautica Civil - DGAC

4.4.3 Production Units[112]

The principal teams or facilities of the production process are :
Data Capture and Processing : Coordination of aerial photo surveys, initial checks on aerial photographs obtained from flights.
Restitution : Photogrammetric restitution of elevation data and generation of initial topographic bases.
Aeronautical Cartography : Editing and publication of aeronautical navigation charts, mainly at small scales.
Digital Handling and Analysis of Aerial Photographs : Scanning-in of photographs, digital processing of images.

4.4.4 New Cartography 2003 – 2006

The following table lists the maps published by the SAF in recent years :

Project Name[113]	Scale	Hectares	Publication date
Locations in VIII Region	1:2,000	61800	2003
Antofagasta	1:1,000	4300	2003
La Serena	1:2,000	6400	2003
Temuco	1:2,000	5118	2004
Estacion Central	1:1,000	1500	2005
Pampa Elvira	1:1,000	5500	2005
Digital map of central and western Santiago	1:5,000	188800	2006
Digital map of Chacabuco	1:5,000	128000	2006
Chiloe	1:2,000	2272	2006
Valparaiso – Placilla	1:1,000	3000	2006
SERVIU – Santiago	1:5,000	8237	2006
INE – Santiago	1:5,000	160000	2006
INE – Concepción & surrounding area	1:5,000	31498	2006
INE – La Serena & surrounding area	1:5,000	14795	2006
INE – Valparaiso & surrounding area	1:5,000	26722	2006

All of these maps are in digital media, having been obtained through digital photogrammetry using analogue restitution instruments[114] tied to workstations to produce CAD-type base maps[115] containing elevation data and symbology for standard planimetric objects. Most of them[116] have been further processed[117] to be adapted to GIS environments, with vector objects and associated attribute tables. A feature of these maps is that road and highway symbols are given attributes for class, names and other characteristics.

[112] Point 4.4.3 is based on the article “Aportes del Servicio Aerophotografico en la Producción y Actualización de Cartografía” – see bibliography.
[113] Project titles refer to cities in Chile, a sector in the country (Pampa Elvira), a large island adjacent to southern Chile (Chiloe), neighbourhoods close to major cities (Placilla & Chacabuco), a Region (VII Region), a borough within the city of Santiago (Estacion Central) and two client organizations of the SAF (INE and SERVIU)
[114] Of the “Galileo” type
[115] Using “Intergraph” and “Microstation” software.
[116] The only exceptions are the Pampa Elvira and Chiloe maps.
[117] Using Arc-View and Arc-Info (ESRI)

4.4.5 Additional Products and Services[118]

In addition to the principal product line described above, the SAF also provides products including :

- Aerial Photographs (colour, B/W, digital, film or other physical media)
- Digital Raster maps
- Services to individual clients : aerophotogrammetric surveys, GPS / topographic surveys, digital image processing, digital cartography

4.5. Natural Resources Information Center - CIREN

4.5.1 Introduction

CIREN is a state institution dedicated to creating, gathering, maintaining and updating information about natural resources existing in Chile. It a Corporation under the administration of the Agriculture Ministry. Over the past 42 years of its existence it has combined experience and the most modern technologies in order to process and organize territorial information that aids decision-making in processes for assigning public and private investment.

The institution has an inventory of organized information about climate, soils, water, fruit and wine growing, agricultural cadastre, and the forestry sector, all of this making up part of the assets of the nation. Users and clients include the public sector of agriculture, through the Agriculture Ministry, the National Assets and Resources Ministry, and other state services requiring territorial information, also the private sector requiring information to guide its resource allocation and investment decisions.

4.5.2 Development of Orthophoto Catalogue

CIREN has a stock of 2338 orthophotos covering a substantial proportion of continental Chile, in total 257,057.52 km^2, covering most of those areas of interest to agriculture, to natural resources management and other significant human activity.

This has been built up since 1980, gradually replacing an older stock of photo-mosaics. Up until the mid-1990's the scale of the printed product was 1:20,000, based on panchromatic photographs, then a transition to 1:10,000 scale began. The result has been that the areas covered in central and southern Chile down to the Eleventh region are at 1:20,000, while the sectors in the north (from the Fourth region northwards) are currently available are at 1:10,000 scale.

The process begins with aerial photographs, obtained mainly from the SAF, with IGM topographic information used as a reference framework. Production of orthophotos is followed by editing of vector and alphanumeric data with GIS tools[119].

[118] Source : SAF web site.

Progress was made by working on successive blocks or mosaics covering a large area and made up usually a large number of individual photographs. The block with the largest number of photos and the largest total area was the 527 photos covering 76,889.30 km^2 in the Tenth Region (Lakes Region) in 1994.

The orthophotos which individually covered the largest area were those which showed 208.80 km^2 each in the mosaic of 527 orthophotos covering a total of 27,770.4 km^2 in the Eleventh Region (Aisen Region) in 2002. The project in Aisen was the first in this sequence in which digital versions of the images were produced at the same time, suitable for printing on plotters. It was also the first to include contours at 20 m intervals to portray relief.

In 2005 a group of 321 orthophotos covering 13,369.65 km^2 of agriculturally important land in the Coquimbo Region used a mix of panchromatic and, for the first time, color photographs as input, each photo showing 41.65 km^2 of terrain. In 2006, 125 color photographs were used, each one showing 42. km^2 and in total covering 5,250. km^2 of the Atacama region. The products of both projects have been made available in 3' 45" x 3' 45" format at 1:10,000 scale on paper. They include contours at 10 m intervals.

Currently work is in progress on sets of ortho-images covering a large part of the Fifth and Sixth regions in central Chile. For the first time, the input material consists of QuickBird II satellite scenes with a spatial resolution of 1 meter. Output is to be at 1:10,000 scale, including superimposed contour lines at 10 m intervals (20 m over 200 m height). The results, due in the near future, will expand and, in effect, update the existing orthophoto coverages in the same sector.

4.5.3 Products Based on Orthophoto Series

There are four series of products based on the orthophotos described in point 4.4.3 :

(a) Orthopohotos : these can be provided by themselves, without vector-structure information overlaid, in either printed or digital media.

(b) Property boundaries : The orthophotos in this version are overlaid with vector-structure data representing property boundaries; in other words cadastral information, with an emphasis on agricultural properties. Other data included is :
- Each farm, tract of land or property is identified with a code belonging to a register of agricultural units managed by the Internal Revenue Service - SII[120].
- Administrative limits (Region, Province, Borough)
- Census districts (from INE)

(c) Soils and aptitude for agricultural use : The orthophotos are overlaid with vector-structure data representing boundaries between zones that class the land according to the principal soil classification system used by organizations in Chile involved with agriculture and the natural sciences. Attributes are attached to each classification polygon to indicate, for each sector :
- the corresponding soil type
- the type of agriculture that is most appropriate for that sector

[119] Such as TNT-MIPS

[120] In Spanish "Servicio de Impuestos Internos" – SII. This is the governmental taxation service.

- climatic information

(d) Hydrographic network : The orthophotos are overlaid with vector-structure data representing features related to hydrography, including :
- artificial irrigation networks
- reservoirs, lakes and other water bodies
- wells
- natural drainage
- some classification of agricultural land in terms of irrigation regime

4.5.4 Other Products and Information Services

The aerial photographs used for the orthophoto series can also be obtained individually as either a reproduced aerial photograph or as a 'Geo-photo', in which the photo positions are adjusted horizontally.

Information about climate patterns and conditions of interest to agriculture has been represented on a series of small-scale maps (paper and digital). There are various maps to differentiate between species or types of agriculture in describing the effects of climate on them, also differentiating between the climatic parameters such as evaporation rates and temperature.

Some relief information has been processed and made available as Digital Terrain Models (DEM) and as "Virtual Flight" animations in 3D.

The 'Digital Products Area' can develop GIS applications as tools provided to clients for specific spatial data needs. Some of these involve GIS-type data managed with orthophoto or satellite image backgrounds.

4.5.5 Satellite Data

CIREN has been using satellite images in a small remote sensing team since 1996 for an increasing number of specific study projects and for offering some image processing services[121] to clients. Sources of images for processing have included Landsat TM, RADARSAT, SPOT, and IKONOS. The use of Quickbird is noted above. To determine temperature and climate data, information from NOAA is used. The information obtained is for both physical relief and for themes based on radiometric data[122]. Some maps with satellite images as backgrounds are publicly available.

4.5.6 Research Projects and Special Studies

CIREN performs research projects and studies for both the public and private sectors, responding to tenders and to public programs with finance for specific projects. CIREN is able to combine spatial data of various types, subjects and formats with specialist knowledge of

[121] Services include geo-referencing, analysis, interpretation and classification of terrain.
[122] Usually related to vegetation cover, some classification of soils and water areas.

agricultural, vegetation and other geographic disciplines. Projects performed in recent years include :

- "Determination and Characterization of Suitability for Vines and Wine Production" : This study re-combined several sources of spatial information of differing themes to classify a large part of the Seventh Region in terms of potential and real suitability for cultivating vines and developing the production of wine. The results were shown on thematic maps.
- "Rural Territorial Information System for Poor Communities" : See point 2.2.2 about Poverty Mapping.
- Studies in specific localized sectors to define zones of erosion and soil degradation.
- Hydrology-related studies (ground water, irrigation systems) to support optimal use of water resources

4.6 National Geological and Mining Service – SERNAGEOMIN [123]

4.6.1 Introduction

SERNAGEOMIN is the State organization with the legal responsibility for creating basic geological knowledge of Chilean territory and of the processes that have been the conditions of its formation. This institution carries out studies to define the genesis, geological characteristics and distribution of metallic and non-metallic minerals, energy resources and underground waters. It also performs studies of environmental geology aimed at supporting territorial planning.

The results of these geological studies are shown in basic and thematic maps, also in various specialized documents and databases. The geological cartography of the country is a fundamental support for the various studies aimed at knowledge of non-renewable resources and at the conservation of the environment. It constitutes, moreover, the main source of geological information available to public and private institutions active in the fields of mining, housing, urban development, water resources, environmental management and public engineering works.

4.6.2 Methodology

One of the main strengths of the Sernageomin consists of its capacity to create new information. For that, it has about fifty specialized professional staff (geologists, cartographers, chemists, etc.) who obtain the information by field surveys, analyze and process the data, supported by tools applicable directly or indirectly (remote sensing, chemical analysis, radiometric dating and other methods of analysis and processing), background information from available bibliography and from in-house databases. The information captured in the field is based on the official topographic data of the Military

[123] SERNAGEOMIN should be considered author of points 4.6.1 – 4.6.4. The text they provided fits directly into this report without major changes apart from the translation.

Geographic Institute, ortho-rectified aerial photographs and geo-referenced satellite images. The results, mainly cartographic ones, are published on both printed paper and digital media.

Sernageomin possesses several published map series, the main ones being the Geological Map of Chile and the different map series titled Basic Geology, Mineral and Energy Resources, Environmental Geology, Hydro-geology, the Magnetic Map of Chile and the Gravimetric Map of Chile. The program for geological cartography gives emphasis to progress in covering the territory and focuses the updating of available knowledge on the Geological Map of Chile (1:1,000,000 scale).

4.6.3 Geological Cartography

Sernageomin produces thematic maps in standard formats which combine international standards for the earth sciences with the internal standards of Sernageomin.

Printed maps are made using using geographic information systems; ArcGis, ArcInfo PC and MapInfo. Thematic cartography is projected in UTM, zones 19 or 18, datum PSAD-56 or PSAD-69, for continental and island Chile. For Antarctic territory bipolar projection is used.

The digital cartography of Sernageomin is in shapefile format and “Access” databases. The projection used for digital products is in UTM, datum WGS84, zone 19 for continental and island territory and bipolar projection for the Antarctic territory.

The digital products, in GIS formats or as images, are available for acquisition on-line at the site http://sigeo.sernageomin.cl . Between the years 2003 and 2007, Sixto-four new digital maps have been made covering various topics.

Sernageomin has a team of 12 specialists (cartographers, geologists, information tech. specialists) responsible for creating digital cartography and maintaining the Internet publication system called “SIGEO”.

Main Publication Scales :

LEVEL	**SCALE**
National	1:3,000,000 1:1,000,000
Regional	1:500,000 1:250,000 1:100,000
Detailed	1:75,000 1:50,000

Scales by map type :

MAP TYPE – scale	*Basic Geology*	*Mineral and Energy Resources*	*Environmental*	*Hydro – geological*	*Magnetic Field*	*Gravimetric Field*
1:3,000,000						
1:1,000,000						
1:500,000						
1:250,000						
1:100,000						
1:75,000						
1:50,000						

Publication scale Surveying Scale

4.6.4 Map Categories

As follows a brief description of each type of map.

- *Basic Geology*: maps showing the distribution over areas of lithological and stratigraphic units, their structural, and geo-chronological and fossil features. These portray the information serving as a basis for the following thematic maps.
- *Mineral Resources*: maps that show the distribution of mineral deposits, both metallic and non metallic, in relation to the various geological units, highlighting the lithological and structural features most relevant to the classification of mineral resources and which define the geological environments suitable for certain types of deposits.
- *Environmental Geology:* This term covers maps of various themes:
  - *Volcanic Hazards:* maps that identify, define the boundaries of and characterize the sources, effects and potential ranges of volcanic activity.
  - *Geo-environmental:* maps that show the combination of various geological factors that affect recommendations for and the planning of land use.
  - *Large-volume earth removals and flooding:* maps that show graphically, describe and categorize the hazards associated with large piles of material removed and deposited and with flood areas.
  - *Seismic Activity :* map with zones of the response by the terrain to seismic activity.
  - *Base Soils :* maps that describe the geotechnical and geomechanical features and/or properties of subsurface soils.
  - *Vulnerability of aquifers:* maps that define the zones of and characterize the potential for contamination of underground watercourses and water bodies.
- *Hydrogeology:* maps that identify, define the boundaries of and characterize the hydro-geological potential of the soil and rock units present in the area. These include maps of thermal springs (including those with mineral content), showing their distribution, characterization and relationship with the surrounding geology.
- *Magnetic Field:* maps showing the values of the intensity of the magnetic field of the earth, which varies in accordance with the lithology and the structural characteristics of the land.

Gravimetric Field: maps that show the variations in the density of the rocks making up the earth's crust.

4.7 National Forestry Corporation – CONAF

4.7.1 Introduction

The "Corporacion Nacional Forestal" (National Forestry Corporation – CONAF) is the institution[124] responsible for implementing the laws of the state and the policy of the government in the forestry industry[125] and in the management of resources from forests, woodlands and many habitats. It also manages the SNASPE[126] system of reserves and managed areas[127] for the conservation of biodiversity.

4.7.2 Thematic Cartography

The principal map series managed by CONAF represents vegetation and land use themes and covers all of Continental Chile. This series began as part of the vegetation survey performed in the 1990's by CONAMA, CONAF and CIREN, described in the 1999 – 2003 report to ICA. Every year part of Chile – about 3.5 million hectares – is updated, meaning a renewal cycle of ten years for the whole of Continental Chile. It is to this ongoing update program that the main data capture and cartographic process of CONAF is applied.

Other spatial data represents types of woodland and also terrain within the SNASPE system, covering selected zones and specific reserves and plantations.

4.7.3 Data Capture and Cartographic Process

The team working on the cartographic processes includes about nine Engineers specializing in Forestry techniques, a geographer, a draughtsman for technical drawing and an information technology specialist. Their tasks include map design, processing of source remote sensing data, change detection and database updates.

The capture of source data for maps begins with using colour photographs taken by vertical aerial photography at scales between 1:70,000 to 1:115,000 scales. These are scanned in to digital media, orthorectified in most cases, then photo-interpretation is applied. To a lesser extent, images of satellite scenes are also used.

For the update program, the images are compared with the digital (vector) maps of the vegetation survey performed around 1996[128] , with data obtained from recent field inspection campaigns and with other sources of information to detect changes to vegetation and land

[124] In formal terms CONAF is attached to the Agriculture Ministry
[125] This includes the economic sectors involving plantations, timber and woodland products, also the sustainable use of natural habitats and forests.
[126] This is the "Sistema Nacional de Areas Protegidas – SNASPE" or National System of Protected Areas, Chile's network of reserves and areas under protection or mixed-regime management.
[127] Some areas of the SNASPE system combine certain sustainable commercial, agricultural or human community uses with the protection of biodiversity interest under a regime of mixed management.
[128] The vegetation survey of the 1990's will continue to be the reference for change detection until the cycle of updates is complete for the whole country within a few years.

use types, both in terms of type (attributes) and location (polygon boundaries). IGM official terrain maps[129] are used for accurate positioning reference, overlaid with data organized by the "Land Use Map"[130] methodology and consisting of digital classification polygons created in the editing stages and associated with tables of attributes. The final maps intended for users exist both as digital shape (ArcView – "ESRI") files and on paper.

5.4 Scales and Minimum Mappable Units

The scales and minimum mappable units applied during the preparation of the cartography created for the Vegetation & Land Use Survey of the 1990's were :

Region of Chile	*Scale*	*Minimum Mappable Area*
Northern & north-central Chile	1:250,000	156.25 ha
Central Chile, most of southern Chile	1:50,000	6.25 ha
Part of extreme south of Chile (around Magellan straits)	1:250,000	6.25 ha
Part of extreme south of Chile (inc. islands)	1:100,000	25.0 ha
Protected areas within the SNASPE system	1:50,000	6.25 ha

This is now being progressively replaced in the update program; the newer datasets created so far have been worked at 1:50,000 scale with a minimum mappable unit of 1 square hectare. In parallel, CONAF also applies the concept of the 'homogenous cartographic unit', associated with the smallest possible feature made up of a single type of vegetation. The final maps provided in these cases are at either 1:50,000 or 1:100,000 scales.

5.1.5 Methodology for Thematic Data

In the "Land Use Map" methodology, the attributes assigned to classification polygons are mainly those of the Land Use classification system, which has been applied to Land Use maps at CONAF, CIREN and CONAMA since the Vegetation Survey of the 1990's[131]. The system describes vegetation in terms of its structure, dominant species and degree of management or intervention by humans. Land use categories are applied where there is no vegetation.

The following table summarises this system :

Main Category	**Number of Sub-Categories [132]**	**Attributes**
1. Urban & Industrial Areas	2	
2. Agricultura	2	

[129] See point 4.2.3.
[130] Translation of their term "Carta de Ocupación de Tieras" or "C.O.T."
[131] Reported in the 199 – 2003 Report to ICA, point 2.5.
[132] These Categories all have further sub-divisions or sub-categories . For example, the 3 sub-categories for Nº 7., Permanent Snow and Glaciars are : 7.1 Snow, 7.2 Glaciars, 7.3 Ice Fields

3. Grasslands	7 (1 of these with 6 further sub-divisions)	% Horizontal coverage in 6 sub-categories, density of vegetation in 3 sub-categories
4. Woodland / Forest	3 (all with further sub-divisions, 3, 4 and 2 respectively)	% Horizontal coverage and tree density in 2 of the 3 sub-categories
5. Wetlands	7	% Horizontal coverage
6. Bare areas without vegetation	8	% Horizontal coverage
7. Permanent Snow and Glaciars	3	
8. Water bodies	3	
9. Unclassified areas	2	

Many datasets locating woods, plantations and SNASPE sectors, in addition to the Land Use Map system, also carry attributes for woodland classed by forest structure or type, by slope or incline, and by altitude.

4.8 Government Ministries and Specialized Agencies

Several Chilean government ministries and public bodies dependant on the state manage and distribute cartographic information at a specialist level. Among the Ministries and their dependant bodies, special mention can be made of the Ministry of Public Works, CONAMA, and DIFROL. Among the public agencies, INE, INACH, and ACE should be mentioned. Most of these Ministries and Agencies participate in the coordination networks of the SNIT (see point 3.1).

The Ministry of Public Works (MOP) includes a Roads and Highways Division[133] that in turn contains a Cartography and GIS Unit, which contributes to the road maps published by the MOP[134]. This and other MOP units use and sometimes create accurate geo-spatial data for engineering and surveying purposes.

The National Statistics Institute[135] – INE – is the governmental agency that manages provides official statistics and census data. On existing base maps it defines census districts and some thematic cartography representing the spatial distribution of its economic, social, administrative and other statistics. It has some capacity to manipulate this type of spatial data in digital environments.

The Chilean Antarctic Institute ("Instituto Chileno Antartico" – INACH) is the official agency of the state responsible for coordinating and checking all scientific and technological activities in Antarctica, also for advising the government on how to fulfil the obligations of Chile under the international systems of the Antarctic Treaty. The INACH cooperates with other Chilean

[133] Names in Spanish are the "Ministerio de Obras Públicas" – MOP – and the "Dirección de Vialidad" respectively.
[134] The GIS & Cartography Unit maintains an on-line map server providing map images of Chile's highway network and related information of use to travelers and drivers; this is at www.mapas.mop.cl.
[135] In Spanish, 'Instituto Nacional de Estadistica'

institutions in the creation and development of cartography covering Antarctic zones[136], moreover it has some internal capacity to use cartographic bases and develop thematic maps as components of its own scientific research programs and the portrayal of their results[137].

The Ministry for international relations and foreign affairs[138] contains the 'Department for Frontiers and Limits' ("Departamento de Fronteras y Limites" – DIFROL) which includes cartographic specialists who check maps, charts and other geo-spatial products circulated in Chile in order to ensure that they comply with Chilean laws[139].

The National Environmental Commission ("Comisión Nacional del Medio Ambiente" – CONAMA)[140] manages thematic spatial data involving environmental impact studies and the nature conservation system of reserves and protected areas[141].

[136] See point 3.3.
[137] Some idea of the range of scientific activities of the INACH and the involvement of maps to support some of them can be gained from the INACH bulletin "Programa de Investigación Cientifica y Tecnológica – PROCIEN 2006-2007" (Scientific and Technological Research Program – 2006-2007) at the date of this report for download from the INACH web site.
[138] This is the "Ministerio de Relaciones Exteriores" in Spanish.
[139] All geo-cartographic materials from any organization that show any part of the Chilean international boundary (terrestrial or maritime) are, by law, subject to checks, modifications and authorization by DIFROL before they can be distributed or published in Chile.
[140] CONAMA was one of the co-sponsors of the Vegetation Resource Survey performed in the 1990's and described in the previous report to the ICA.
[141] This system is known formally as the "Sistema Nacional de Información Ambiental" – SINIA, being a series of reserves and protected areas around Chile managed partially or wholly with the aim of conserving natural resources and biodiversity value. The SINIA has its own on-line public map server at the www.sinia.cl web site.

The Planning Ministry – MIDEPLAN – is responsible for development planning and for determining the needs of communities throughout society. It has begun to apply spatial data analysis to the available information as support for these tasks[142].

The Chilean Space Agency ("Agencia Chilena del Espacio" – ACE) has started to develop space-related studies and policy-development on behalf of the government and in coordination with several Chilean organizations. The understanding and use in Chile of satellite-based remote sensing technology for the capture and processing of spatial data should benefit from the activities of the ACE in the coming years.

4.9 Regional and Local Government Bodies

Alongside the central government of the Republic, there are three levels of local government :

- Regions
- Provinces[143]
- Borough or Municipal units[144]

Regional and local government administrations need to handle maps and large-scale plans for planning purposes. Some specialized spatial data handling has begun to evolve in certain Regional and Municipal administrations. All these administrations are entitled to participate in the S.N.I.T. structure[145] and a few have become active in spatial data infrastructure issues.

As an example of this evolution, there was for a few years[146] (up to 2006) a small unit specializing in GIS and spatial data services called the "Borough Information System Unit"[147] – USIC – attached to the AMRBB[148] an association of the municipal authorities of the Eighth Region[149], in central Chile. Its purpose was to help municipal administrations to use spatial data, mainly for zoning, planning and territorial management functions, by means of re-distributing existing cartography in digital media, creating some new plans and datasets, and training local government staff in the use of the information. The program was based on the concept of shared resources, given the lack of resources that prevent each municipal organization from individually sustaining a similar unit[150].

Annex 4. describes a change to some of the boundaries that has occurred recently.

[142] See points 2.2.2 and 2.2.3.
[143] All Regions are divided into at least two provinces, usually several.
[144] Known as "Comunas" in Spanish
[145] See point 3.1
[146] The unit was conceived as a trial or project, not as a service to continue on a permanent basis.
[147] In Spanish, "Unidad Sistema Informacion Comunal" – USIC.
[148] In Spanish, "Asociación de Municipalidades del Región del Bio Bio" (AMRBB), an association of boroughs that is part of the "Chilean Association of Municipalities" – ACHM.
[149] Also known as the "Bio Bio Region".
[150] The USIC itself required support from outside Chile, received from the 'German Social-Technical Cooperation Service' – DED.

5. Academic Sector

5.1 Cartography at Universities

5.1.1 Metropolitan Technological University – UTEM

The Metropolitan Technological University (UTEM) has a Cartography Department and a School for Cartography[151] where the following courses are run :

- Course in cartography leading to a degree as qualified professional cartographer[152], consisting of five years of class-based instruction followed by an internship and a graduation research project.
- Two-year Post-Graduate Degree in "Cartography for Environmental Studies"[153]
- Diploma-level courses with a duration varying between two and three months in Geomatics. The title and plan of studies varies from year to year, but in general they deal with information technologies for geography and spatial data handling.

Besides the courses, the Cartography Department and School run other activities :

- A small research and consultancy unit known as the "Development, Consultancy and Training Unit" – UDAC[154] - that cooperates with organizations outside the University to assist with issues involving spatial data handling and cartography.
- Cooperation with the Pan-American Institute for Geography and History (PAIGH)[155], in particular by undertaking organizational duties on behalf of the PAIGH Cartography Commissions at both international and local levels[156].
- Partnership with the Tactile Cartography Center[157].
- Seminars and other outreach events on cartographic themes oriented to the general public with appropriate invited guests.

5.1.2 Bernardo O'Higgins University

The Bernardo O'Higgins University has an Earth Sciences School with two main specializations : cartographers and topographic surveyors. Previous to the year 2004, students were trained up to technician level. Then these courses were expanded, allowing cartographers and surveyors to either qualify as technicians after two years or to continue for

[151] In practice, the Department and School are closely allied.
[152] The title in Spanish is "Licenciado en Ciencias Cartográficas", or 'degree qualification in cartographic Sciences'
[153] The title in Spanish is "Magíster en Cartografía de Estudios Ambientales"
[154] In Spanish, the "Unidad de Desarrollo, Asesoría y Capacitación" (UDAC)
[155] See point 3.2
[156] In both the PAIGH Cartography Commission and in its local counterpart, the Cartography Commission of the National (Chilean) Section of the PAIGH.
[157] See point 5.3

two more years and qualify as engineers in Cartography[158]. A few seminars on issues related to cartography have also been held at this University.

5.2 The Earth Sciences in the Academic Sector

5.2.1 Military Polytechnic Academy

The principal center for the training and education in engineering at university level that the Chilean armed forces provide to their own officers is the 'Military Polytechnic Academy' (ACAPOMIL)[159]. This academy runs five-year full-time courses for officers[160] equivalent to University engineering courses.

For the first two years of the courses, those intending to specialize in geographic information must first undergo basic engineering background training in subjects shared with other engineering courses. From the third year onwards, officer-students can specialize in a set of subjects relating to geography, cartography, geo-informatics and allied disciplines. The final qualification is titled "Military Polytechnic Systems Engineer Specializing in Geo-Informatics". Those who qualify acquire knowledge of spatial data disciplines very similar to that of a civilian cartographer at engineer level, with some additional knowledge of cartography in defence applications.

5.2.2 Surveyors and Remote Sensing

For surveyors, there are a large number of courses in Universities and training institutes at technician and engineering levels in topographic and engineering surveying, fulfilling the substantial demand for qualified surveyors[161]. For example, the establishments running substantial programs for surveyors include :

- Metropolitan Technological University – UTEM
- Bernardo O'Higgins University
- University of Santiago - USACH
- University of Concepción
- National Training Institute - INACAP[162]

Photogrammetric operators at IGM and SAF obtain their basic training through internal training programs. Some University students have performed graduation research projects in remote sensing topics at the Space Studies Center (CEE). Otherwise, specialists in photogrammetry and remote sensing obtain their training in other countries.

[158] Whether qualifying as technician or engineer, in both cases there is an internship and a graduation research project following on from the formal two or four year course before graduation.
[159] While formally dependant on the Chilean Army, the ACAPOMIL has recognition and cooperation agreements with several civilian institutions and universities in the academic sector of Chile and internationally.
[160] The majority of officer-students are from the Chilean Army, some are from the Navy and Air Force, and a few are from the Armed Forces of other countries outside Chile.
[161] The courses are known in Spanish as "Geomensura", and surveyors are called "Geo-mensuristas" ("mensura" = measurement). Sometimes the term "topografo" (topographer) is also used.
[162] In Spanish, "Instituto Nacional de Capacitación" - INACAP

5.2.3 Geography, Geo-Informatics, and Geo-Engineering

Cartography and related disciplines are taught as course components and subjects within many courses of the Earth Sciences. The most important of these are the courses in geography and geographic information technology run by geography departments or schools. Some of the most important of these are listed as follows :

University	*Department, School or Institute*	*Course Title*	*Course Duration*[163]
University of Chile	School of Geography	Geographer	5 years
		Diploma in Geographic Information Systems – GIS	14 weeks
University of Santiago - USACH	Geographic Engineering Department	Civil Engineer in Geography	6 years
		Post-graduate Diploma in Geomatics	7 months (330 hours)
Catholic University of Chile – PUC [164]	Geography Institute	Geographer	5 years
		Post-graduate degree in Geo-Informatics	1 year
University of Concepcion	Geography Department	Geographer	5 years
	Topography Department	Geomatics Engineering	5 years
Catholic University of Valparaiso[165]	Geography Institute	Geographer	5 years

Many of these geography units at the Universities are active in research into geographic issues, often as cooperation with various non-academic institutions that require geographic studies and projects. Most of these units publish geography-related articles and the results of research in technical journals; two of them publish their own journals dedicated specifically to geography[166].

5.3 Organizations Associated with the Academic Sector

5.3.1 Tactile Cartography Center

The Center for Tactile Cartography performs research, training, production and development in the area of tactile cartography and visual communication. As a result, the Center encourages and facilitates the development of cartographic skills in students of the

[163] Refers to the formal courses of classes at University campuses. In the case of the first University degree courses however, this period is usually followed by a period of variable length in which students complete a graduation research project and a practical internship before graduating.
[164] In Spanish “Pontificia Universidad Católica de Chile”
[165] In Spanish “Pontificia Universidad Católica de Valparaiso”
[166] These are “Investigaciones Geograficas” (geographic research) from the Geography School of the University of Chile and the “Revista de Geografía” (geography journal) from the Geography Institute of the Catholic University.

cartography, design and information technologies courses of the UTEM. It works with international interdisciplinary research teams in the area of geo-cartography, in order to serve the communities in Latin America which have varying levels of visual, aural or intellectual handicap.

The Center has available professional and technical staff , highly qualified in areas such as tactile cartography, differential education, design, librarianship / information management, geography, psychology, sociology, architecture and all those disciplines that have contributed over the last ten years to those projects which have been performed at the UTEM. The Center has its origins in a joint project between the UTEM, which provided the physical infrastructure, and the PAIGH, which provided sponsorship and facilitated the international linkage.

5.3.2 Center for Space Studies

The Center for Space Studies – CEE[167] - is a facility near Santiago dedicated to providing services to other countries around the world for satellite tracking, telemetry and command. It has a Remote Sensing and Environmental Laboratory that works on projects in conjunction with other organizations involving analysis and processing of remote sensing data from satellites[168], along with some work on GIS applications.

5.3.3 Center for Geomatics - Talca

The University of Talca[169] has recently established a “Center for Geomatics” – CENGEO - which provides resources for studying GIS, GPS, remote sensing and similar topics in the geo-sciences as components of the degree courses of this University[170].

[167] In Spanish, “Centro de Estudio Espaciales” - CEE. The CEE is attached to the University of Chile (see point 6.2) and thus to the academic sector, but is mentioned here for convenience.
[168] Data such as AVHRR radiometry data.
[169] Central Chile, between Santiago and Concepción.
[170] Mainly the programs in forestry, agronomy, and architecture.

6. Private Sector

6.1 Organizations Directly Active in Cartography

Cartography as a business and trade is sustained both by the state and public organizations named in this report (operating at least in part on a commercial basis), and by private organizations. In the private sector, the business is led by a group of firms that continue to evolve with the market and keep level with the state of the art in the rest of the world. A tendency in several of these organizations is to offer both cartographic and surveying services. A few operations are associated with or belong to organizations that operate internationally. The products and services offered by these firms have been listed in the 1999 – 2003 report to ICA[171].

As follows a list of some of the private organizations known to be active in this field[172] :

- AEROTOP
- EAGLE MAPPING CHILE[173]
- ESRI – CHILE[174]
- GEAINTEC LTDA.
- GEOCEN
- GEO INFORMACIÓN
- GEOINGENIERIA
- GEOSOLUCIONES
- MAPAS DIGITALES
- MAPCITY[175]
- SERVAPRO LTDA.
- SOLFA
- TURISCOM-TURISTEL[176]

[171] These are : Terrain surveying and precise topographic measurements, aerophotogrammetric restitution, production of orthophotos, topographic maps and DEMs based on aerial surveying, creation of thematic cartography, development of GIS-based solutions for client applications, processing of gridded data and satellite images, conversion of cartography from analogue to digital media, local representation of international corporations that market cartographic and surveying tools, training services.

[172] A full, comprehensive list of commercially-oriented organizations in Chile cannot be given here. The listing is for reference only and does not constitute an endorsement or recommendation of the organizations named for commercial purposes. Contact details for these organizations are given in Annex 1.

[173] Mainly based in Canada with an operation in Chile.

[174] In the 1999 – 2003 report to ICA with the name “Ingenieria y Computacion S.A. – INCOM”. ESRI-Chile is the local firm representing the “ESRI” trademark, among other activities.

[175] See point 2.4.3. In the 1999 – 2003 report to ICA with the name “I.S.G.”

[176] Specialises in guides for the tourist industry; including maps oriented to travellers, visitors and tourists.

6.2 Private Organizations with Specialized Capabilities in Cartography

Several sectors of the Chilean economy and infrastructure require specialized use of geo-cartographic processes and products; in some cases, cartographic products may arise from these activities.

In the publishing sector, distributing printed materials to the general public, a few firms design and print atlases oriented towards schools and the educational sector, also maps and guides oriented towards the tourist and travel industry.

Requirements arising in various sectors of Chile for accurate land surveying by means of topographic measurements, geodesic and GPS-based techniques, and remote sensing are provided by a range of skilled services available, mainly from private firms. The demand comes mostly from requirements in industry, engineering works, and public administration; however, the expertise available and the spatial data generated from the various surveying activities also helps to reinforce, improve and provide content to Chilean cartography.

The mineral extraction industry and also the forestry and timber products industry, are two of the most important sectors of the economy. Most of the industrial organizations dedicated to mineral and petroleum extraction, also some of the larger organizations that manage large woodland plantations possess capabilities for accurate topographic land surveying and for analysis of remote sensing data. Some of the larger organizations also have specialized capacity to manipulate thematic spatial data involving several geographic disciplines. In the case of the mining sector, this thematic data is similar to that handled by SERNAGEOMIN[177], while in the forestry sector it may be similar to the data of CONAF[178].

[177] See point 4.6
[178] See point 4.7

7. Chile and the ICA Conferences

7.1 Past ICC Conferences

Many of the International Cartographic Conferences (ICC) organized by the ICA have been attended by delegations from Chile. This, together with a growing capacity for hosting international conferences and a desire to assist the ICA in a practical fashion led the National Committee to formally propose that the ICC of 2009 be held in Chile. At the ICC of 2005, held in Spain, the Director of the IGM provided full documentation and a presentation about the proposal. The ICA accepted and ratified the proposal to hold ICC 2009 in Chile.

7.2 Future ICC Conferences

7.2.1 ICC 2007

The Chilean National Committee of the ICA is currently preparing for ICC 2007, due to take place in August 2007, at the city of Moscow in the Russian Federation. Attendees from Chile will include representatives of some of the institutions named in this report[179].

For the Cartographic conference, two papers are being presented from members of the IGM staff[180]. In the exhibition area, there will be a booth managed by the ICC 2009 Organizing Committee which will be the official ICA point of contact for ICC 2009, providing information and enabling ICC 2007 attendees to begin their preparations for ICC 2009.

7.2.2 ICC 2009

Since ICC 2005, preparations have begun in Chile for ICC 2009. The ICC 2009 Organizing Committee works very closely with the Chilean National Committee of the ICA, since both are based at the IGM. The current stage of overall planning will conclude with participation in ICC 2007 (August 2007); then a full program of detailed preparations covering the technical conference, sponsorship, and logistical arrangements will be worked through, always in close cooperation with the ICA Executive Committee.

The ICC 2009 Organizing Committee draws on previous experience with international conferences[181]. Provisionally, the contact persons are those indicated in Annex 1 point A.1.3, but this list may change over time as preparations advance. Once a contact e-mail address for the conference is set up and indicated on the web site, please use that rather than the addresses given here for conference-related correspondence.

The venue will be a specialised, suitable conference building within the Santiago urban area. Following the current evaluation of sites, a decision will be announced in early 2008. A

[179] These are likely to include staff from IGM, SAF, SHOA, UTEM, and the University of Chile.
[180] See Point 4.2.5., final paragraphs
[181] Particularly the recent cycle of events in November 2006; see point 3.4.

conference web site is expected to be in place during late 2007 at the address **www.icc2009.cl**.

The ICC 2009 Organizing Committee invites cartographers around the world to present their papers, maps and posters, also to give their presentations, and, apart from the conference activities, to get to know the country and people of the Republic of Chile. The Committee also recommends that organizations in public and private sectors consider their participation in ICC 2009, particularly the opportunity to run a booth, make contact with the international community of cartography and the earth sciences, and to support that community around the world through sponsorship of this event. Formal contacts related to papers, participation, and sponsorship may begin from September 2007 onwards[182].

The Chilean National Committee of the ICA, the ICC 2009 Organizing Committee and several of the organizations named in this report all look forward to giving you a warm welcome at the International Cartographic Conference that will be held in Santiago, Chile during the 15th to the 21st of November, 2009.

[182] Excepting ICC-2007 (Moscow) attendees who should visit the ICC 2009 booth in August.

8. Closing Observations

Having summarized the cartographic activity of this country, it can be said that Chilean cartography has striven to maintain itself at a level with the best practices in the field in terms of technical expertise, absorbing and taking advantage of new resources available in the rapidly evolving technology and techniques of this field. Chilean cartography is driven forward by the current requirements of public administration, many sectors of the economy, and developments in the infrastructure, business, education, social and defence sectors. Meeting these demands with practical geo-cartographic solutions must be given priority, given the limitations on resources that are inevitable in a developing nation. Within this scenario, a degree of order and coordination, at least among public or state entities, is being imposed through the SNIT (Chilean SDI) programs.

At an international level, integration of Chile with the ICA will become stronger, impelled most particularly by the International Cartographic Conference of 2009, where the respective communities of cartographic practitioners of Chile and of the world will meet.

Annex 1. Directory of Organisations[183]

A.1 International Cartographic Association – Chilean National Committee

A.1.1 Representative to the ICA of the State of the Republic of Chile :

Colonel Rodrigo Barriga Vargas
Director of the Military Geographic Institute of Chile - IGM
rbarrigav@igm.cl
(56) – 2 – 4109410 / 4109301 / 4109302

A.1.2 Secretariat of the Chilean National Committee

Major Carlos Neira Mendez
Head of Geographic Secretariat of the IGM
cneira@igm.cl
(56) – 2 - 4109312

Mr Hermann Manriquez Tirado
Geographic Secretariat - International Relations Section
hmanriquez@igm.cl
(56) – 2 - 4109314

A.1.3 International Cartographic Conference 2009 - Organizing Committee

Colonel Rodrigo Barriga Vargas
Chairman of Organizing Committee

Major Carlos Neira Mendez
General Secretary

Mr Pedro Mahuzier
General Coordinator
pmahuzier@igm.cl
(56) – 2 - 4109422

Mr Luis Prieto
Executive Secretary
lprieto@igm.cl
(56) – 2 - 4109316

Edwin Hunt
Communications Sub-Committee
ehunt@igm.cl
(56) – 2 - 4109314

183 Contact details for institutions other than the IGM are valid at the date of this report; July 2007. All mail addresses given are located in Chile, South America; the majority are in the “Región Metropolitana”, the region containing the capital city, but not all.

A.1.4 Contact Details for National Committee of ICA

Postal address :	Secretaria Geográfica INSTITUTO GEOGRAFICO MILITAR Avenida Santa Isabel 1640 Santiago Centro Region Metropolitana Chile South America
Fax :	(56) - 2 – 6990948
IGM web site :	www.igm.cl
ICC 2009 web site :	www.icc2009.cl

A.1.2. Public and State Institutions

Name	*Address*	*Telephone*	*E-mail*	*Web site*
Agencia Chilena del Espacio – ACE	Avenida Bernardo O'Higgins N°292 Departamento 23, Santiago, Región Metropolitana	(56)-2–6651495 / 6652102	agencia@espacio.tie.cl	
Centro de Información de Recursos Naturales – CIREN	Manuel Montt 1164, Providencia, Región Metropolitana	(56)-2–2008900 / 2230651	ciren@ciren.cl evojkovic@ciren.cl	www.ciren.cl
Comision Nacional del Medio Ambiente - CONAMA	Teatinos 254/258 Santiago Región Metropolitana	(56)-2–2405600 *(Reception)* (56)-2–2411800 *(Information Office)*	conama@conama.cl	www.sinia.cl www.conama.cl
Corporación Nacional Forestal – CONAF / Departamento de Prospección Sectorial	Avenida Presidente Bulnes 285, Santiago, Región Metropolitana	(56)-2–3900000 / 3900210 (56) 2 – 3900268 *(contact for this report)*	consulta@conaf.cl voyarzun@conaf.cl	www.conaf.cl
Instituto Chileno Antartico – INACH	Plaza Munoz Gomero 1055, Punta Arenas, XII Región	(56)-61–298100	oirs@inach.cl	www.inach.cl
Instituto Nacional de Estadísticas - INE	Avenida Presidente Bulnes 418, Santiago, Región Metropolitana	(56)–2–3667777 (56)–2–6961929 / 6712169 *(fax)*	ine@ine.cl	www.ine.cl
Ministerio de Obras Públicas – MOP / Dirección de Vialidad	Morande 59 – 71 piso 2, Santiago, Región Metropolitana	(56)–2–4494000	ramon.granada@mop.gov.cl	www.mapas.mop.cl www.vialidad.cl
Ministerio de Planificación - MIDEPLAN	Ahumada 48 Piso 7, Santiago, Región Metropolitana	(56)–2–675 1400		www.mideplan.cl sider.mideplan.cl
Ministerio de Relaciones Exteriores / Departamento de Fronteras y Limites - DIFROL	Teatinos 180 piso 7, Santiago, Región Metropolitana	(56)–2–698 3502 / 671 4110 (56)–2–697 1909 (fax)	jadministrativo@minrel.gov.cl	www.difrol.cl

Servicio Aerofotogrametrico de la Fuerza Aerea – SAF	Encomenderos 270, Las Condes, Santiago, Región Metropolitana	(56)–2–7829300	saf@saf.cl ventas@saf.cl	www.saf.cl
Servicio Hidrográfico y Oceanográfico de la Armada – SHOA	Errazuriz 254, Playa Ancha, Valparaíso, V Región	(56)-32–2266666	shoa@shoa.cl	www.shoa.cl
Servicio Nacional de Geología y Minería - SERNAGEOMIN	Avenida Santa Maria 0140, Santiago, Región Metropolitana	(56)–2–7375050 / 7356956 (56)–2–2385332 (fax)	sngm@sernageomin.cl pgana@sernageomin.cl	www.sernageomin.cl

A.1.3. Academic and Training Institutions

Name	*Address*	*Telephone*	*E-mail*	*Web site*
Academia Politécnica Militar – ACAPOMIL	Valenzuela Llanos 623, La Reina, Santiago, Región Metropolitana	(56)-2–2994300	academia.politecnica@ejercito.cl	www.acapomil.cl
Centro de Cartografia Tactil	Dieciocho 414 piso 2, Santiago, Región Metropolitana	(56)-2– 7877361 (56)-2–7877388 *(fax)*	contacto@ctactil.cl	www.ctactil.cl
Centro de Estudios Espaciales – CEE	Avenida Tupper 2007 piso 6, Santiago, Región Metropolitana	(56)-2-9780630 *(management)* (56)-2-9780631 *(geomatics)*	infocee@ing.uchile.cl	www.cee.uchile.cl
Pontificia Universidad Católica de Chile – PUCC / Instituto de Geografía	Av. Vicuña Mackenna 4860, Macul, Santiago, Región Metropolitana	(56)–2-6864716 / 3544716	mlagos@uc.cl / dsabag@uc.cl	www.geo.puc.cl www.uc.cl
Universidad Bernardo O'Higgins	Avenida Viel 1497, Santiago, Región Metropolitana	(56)-2–4774100 / 4774141 / 4774135	cstierra@ubohiggins.cl info@ubohiggins.cl	www.ubo.cl
Universidad Católica de Valparaíso / Instituto de Geografía	Edificio Isabel Brown Caces. Avda. Brasil 2241, Valparaíso, V Región	(56)-32-274081 (56)-32-274090 *(fax)*	dirgeo@ucv.cl	www.geografia.ucv.cl www.ucv.cl
Universidad de Chile – Escuela de Geografía	Av. Portugal 84 Torre Chica 3° piso, Santiago, Región Metropolitana	(56)-2-6783095 (56)-2-6783100	garmijo@uchile.cl, ccornejo@uchile.cl	www.uchilefau.cl
Universidad de Concepción / Departamento de Geografía	Calle Victoria – Barrio Universitario, Concepción, VIII Región	(56)-41–2203233 (56)-41–2207396 *(fax)*	foro@udec.cl	www.udec.cl / www2.udec.cl
Universidad de Concepción / Departamento de Topografía	J.A. Coloma 0201 Los Angeles VIII Región	(56)-43–405200 (56)-43–405223 *(fax)*	elrivera@udec.cl	
Universidad de Santiago de Chile – USACH / Depto. de Ingeniería Geográfica	Avda. Lib. Bernardo O'Higgins 3363, Estación Central, Santiago, Región Metropolitana	(56)-2-6811213 / 7769134 / 6819043	psanhueza@lauca.usach.cl	www.digeo.cl
Universidad de Talca / Centro Tecnológico de Geomática – CENGEO	Casa Central 2 Norte 685, Talca VII Region	(56)–71-200200	fberrios@utalca.cl ymorales@utalca.cl	www.utalca.cl

Universidad Tecnológica Metropolitana - UTEM	Escuela de Cartografía / Departamento de Cartografía, San Ignacio 171, Santiago Centro, Región Metropolitana	(56)-2–7877630 / 688 82 78 *(Cartography Department)* (56)-2–78775 07 / 688 42 71 *(School of Cartography)*	cartogra@utem.cl direcap@utem.cl	www.cartografia.utem.cl

A.1.4. Private Institutions

Name	*Address*	*Telephone*	*E-mail*	*Web site*
Eagle Mapping Chile	Encomendero 2006 of.12, Las Condes, Santiago, Región Metropolitana	(56)-2–2330679 (56)-2–3354272 *(fax)*	info@eaglemapping.com gsalas@eaglemapping .com *(manager in Chile)*	www.eaglemapping.com
ESRI Chile S.A.	Marchant Pereira 201 Piso 9, Providencia, Santiago, Región Metropolitana	(56)-2–4819000 / 4819099 (56)-2–4819999 *(fax)*	info@esri-chile.com	www.esri-chile.com
Geaintec Ltda..	Laguna Redonda 2055 of. 41-D, Concepción, VIII Región	(56)-41–786451	info@geaintec.cl	www.geaintec.cl
Geocen	Nueva Los Leones 07 Piso 3, Providencia, Santiago, Región Metropolitana	(56)-2–2337008 (56)-2–2336649 *(fax)*	infor@geocen.cl	www.geocen.cl
GISconsultores / GeoInformación	Santa Victoria 0317 piso 2, Providencia, Santiago, Región Metropolitana	(56)-2-2227206	infogis@gisconsultores.cl proyectos@geoinfo.cl geoinfo@geoinfo.cl	www.gisconsultores.cl www.geoinfo.cl
Geoingeniería Digital Ltda.	Avenida Italia 1861, Providencia, Región Metropolitana	(56)-2-3418780		
GeoSoluciones	Pedro de Valdivia 1783 Of.188, Providencia, Santiago, Región Metropolitana	(56)-2-2091431 / 88885165 (56)-2-2091431 *(fax)*	wedwards@geosoluciuones.cl	www.geosoluciones.cl
Mapas Digitales S.A.	Avenida Manquehue Sur 520 Of.222, Las Condes, Santiago, Región Metropolitana	(56)-2–2460303 / 2222260 (56)-2–2425602 *(fax)*		www.dmapas.cl
Mapcity	San Sebastián 2952 Piso 3, Las Condes, Santiago, Región Metropolitana	(56) 2 – 3330488	contacto@mapcity.com	www.mapcity.cl

Servapro Ltda.	Bellavista 0864, Providencia, Santiago, Región Metropolitana	(56)-2–7359065 / 7380580	servapro@servapro.net	www.servapro.cl
Solfa S.A	Jose Domingo Cañas 560, Ñuñoa, Santiago, Región Metropolitana	(56)–2–2045936 / 2045981 / 2046083	solfa@solfa.cl	www.solfa.cl
Turiscom-Turistel	Avenida Vicuña Mackenna 1962, Providencia, Santiago, Región Metropolitana	(56)-2–5507955	tsanchez@copesa.cl rodrigo.lopez@copesa.cl	www.turistel.cl

Annex 2. Bibliography and Acknowledgements

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"Proposición de metodología de análisis espacial para combatir la desertificación y la pobreza rural en la comuna de Punitaqui" , Claudio Meneses, Juan Carrasco, November 2006, University of Chile & Municipal Authority of San Felipe.

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"Sistema de Información Territorial Rural para Comunas Pobres", Heriberto Pinto, November 2006, CIREN.

"Cartografía elaborada con un método fotogramétrico simple versus un método digital", Victor Sandoval, April 2004, journal 'Bosque (Valdivia)', vol.25, no.1, p.87-94. ISSN 0717-9200.

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- SERVICIO HIDROGRAFICO Y OCEANOGRAFICO DE LA ARMADA – SHOA
- SERVICIO AEROFOTOGRAMETRICO DE LA FUERZA AEREA – SAF
- CENTRO DE INFORMACIÓN DE RECURSOS NATURALES - CIREN
- SERVICIO NACIONAL DE GEOLOGIA Y MINERIA - SERNAGEOMIN
- CORPORACIÓN NACIONAL FORESTAL – CONAF

For responding to informal research queries :
- One staff member at UTEM
- One staff member at the Tactile Cartography Center
- Three authors of the articles cited in point 2.2.4 (one of them now at CENGEO)
- One former member of the USIC / AMRBB (now at "Geaintec Ltda.")

Annex 3 : List of Acronyms Used

A.3.1 Spanish language acronyms

ACE - Agencia Chilena del Espacio
AMRBB – Asociación de Municipalidades de la Región del BioBio
CEE – Centro de Estudios Espaciales
CENGEO - Centro Tecnológico de Geomática
CIREN - Centro de Información de Recursos Naturales
CONAF – Corporación Nacional Forestal
CONAMA - Comisión Nacional del Medio Ambiente
CP-IDEA – Comité Permanente de la Infraestructura de Datos Espaciales de América
DIFROL – Departamento de Fronteras y Limites
IGM – Instituto Geográfico Militar
INACH - Instituto Antártico Chileno
INE - Instituto Nacional de Estadísticas
MIDEPLAN - Ministerio de Planificación
MOP - Ministerio de Obras Públicas
PUC - Pontificia Universidad Católica de Chile
SAF - Servicio Aerofotogrametrico de la Fuerza Aérea
SELPER - Sociedad de Expertos Latinoamericanos en Percepción Remota
SERNAGEOMIN - Servicio Nacional de Geología y Minería
SHOA - Servicio Hidrográfico y Oceanográfico de la Armada
SNIT - Sistema Nacional de Coordinación de Información Territorial
USACH - Universidad de Santiago de Chile
UTEM - Universidad Tecnológica Metropolitana

A.3.2 English language acronyms

ECLAC - Economic council for Latin America and the Caribbean
GSDI - Global Spatial Data Infrastructure
ISPRS - International Society for Photogrammetry and Remote Sensing
PAIGH - Pan-American Institute for Geography and History
SCAR – Scientific Comittee of Antarctic Research

Annex 4 : Notice on Change to Administrative Boundaries

A.1 Introduction

The internal political-administrative divisions of a state at second and third levels are of importance to many types of Cartography, including official map bases and themes of human geography. The project of the United Nations with the title “Second Administrative Level Boundaries” – SALB – defines the concepts of levels and has communicated to the cartographic community the importance of full, updated data about administrative boundaries below the level of international limits.

For this reason the National Committee in Chile should inform the cartographic community of a major change occurring in its political divisions, enacted this year of 2007 in legislation by the government and congress of the Republic of Chile, which affect two Regions at the second level and two provinces at the third level.

A.2. New Region in the North of Chile

The Region known as the First Region or the Tarapaca Region, located in the extreme north of Chile, has now been divided into two. The boundary between the two regions follows the boundaries of the three provinces that previously made up the Region.

The southern portion, with its capital at the city of Iquique, retains the original name of “First Region of Tarapaca”. This area previously was a single province, the Province of Iquique.

The northern portion now constitutes a new Region, with the title of “Fifteenth Region of Arica and Parinacota”. This is made up of the provinces of Arica and Parinacota and includes the international boundary with the countries of Peru and Bolivia.

A.3. New Provinces in the North of Chile

The new configuration of the “First Region of Tarapaca” corresponds exactly to the area of just one former province. Due to the requirement for each Region to contain at least one sub-division into provinces, the First Region has now been divided into two provinces. Two boroughs in the west of the Region, Alto Hospicio and the city of Iquique, now make up the province of Iquique, thus conserving the previous name for their province. The remainder of the Region, made up of several boroughs, constitute the new province of Tamarugal with its administrative center at Pozo Almonte.

A.4. New Region in the South of Chile

The Region known as the “Tenth Region of the Lakes”, located in southern Chile, has been divided into two. The Tenth Region previously contained five provinces.

The new Region, called the “Fourteenth Region of the Rivers”, consists of what was previously the province of Valdivia, the northernmost province in the Tenth Region. This Region now has its capital at the city of Valdivia. The region extends from the Pacific Ocean to the international boundary with Argentina.

The remainder of the Tenth Region, made up of the four provinces of Osorno, Chiloe, Palena and Llanquihue, maintain the same name and continue with Puerto Montt as its capital city. The new regional boundary runs along the previous provincial boundary between the province of Osorno and the former province of Valdivia.

A.3. New Provinces in the South of Chile

For the same reason as in the case of the First Region of Tarapaca, the new Region has been divided into two provinces. The southern part of the Region, made up of the boroughs of La Union, Futrono, Lago Ranco and Rio Bueno, constitutes the new province of Ranco with its center at La Union. The northern part of the Region, made up of the remaining boroughs in the region, constitutes the province of Valdivia, with its center at the city of Valdivia.