

ARMY OF CHILE  
MILITARY GEOGRAPHIC INSTITUTE OF CHILE

**NATIONAL REPRESENTATIVE  
TO THE  
INTERNATIONAL CARTOGRAPHIC ASSOCIATION**

**REPORT ON CARTOGRAPHY  
IN THE REPUBLIC OF CHILE  
1999 – 2003**

**SUBMITTED TO THE TWENTY-FIRST GENERAL ASSEMBLY  
OF THE INTERNATIONAL CARTOGRAPHIC ASSOCIATION**

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## **1. INTRODUCTION**

The International Cartographic Association - ICA, as a federation of member nations, requests those member nations to provide summary reports on their cartographic activities, covering periods specified by the ICA. The latest call for reports concerns the period 1999 to 2003. These reports are destined to be presented at the Twenty-First General Assembly of the ICA, programmed to take place in August 2003.

In Chile responsibility for drafting the national report lies with the Military Geographic Institute of the Army of Chile (I.G.M. - see point 3.1 below). The Director of the IGM represents Chile before the ICA. The current IGM Director, General of Brigade Pablo Gran L., has already attended the previous General Assembly of the ICA (the Twentieth General Assembly held in August 2001 at Beijing, China) where presentations about the IGM and about the Chilean INDE-SNIT (see point 2.2 below) was made. However, so far as the concept of this national report has been understood at the IGM, the scope covers cartographic activities in the whole of Chile.

This report summarizes those activities where original cartographic material and equivalent geo-spatial or territorial content is created, transformed or updated. Those organisations which merely use, consult, interpret, buy, sell or re-distribute this material without significantly modifying its content or structure are not covered.

A wide range of governmental agencies in Chile produce or develop cartography. Section Two of this report concerns those activities performed jointly by groups of institutions and organisations. Section Three covers the three agencies attached to the Chilean Armed Forces which are entrusted with the cartography of Chilean territory in terms of physical relief (I.G.M.), coastal and maritime geography (S.H.O.A.), and aerial navigation and aerial-photograph-based cartography (S.A.F.). These three produce the primary, official and topographically-accurate cartography of Chile. Regarding the civilian agencies (in Section Four), only some of these are named. There may be a certain amount of cartographic activity in other Ministries, Government-owned agencies and the Regional, Provincial and Municipal levels of Government, however, this mostly tends to be the overlaying of thematic or project-specific data onto existing cartographic bases and frameworks rather than the creation of new cartography.

## **2. ACTIVITIES AT NATIONAL LEVEL**

### **2.1 Activities at National Level – Overview**

Certain activities, projects and institutional commitments related to the development of cartography are sustained by the joint efforts of several institutions acting together at an inter-institutional or national level, or in coordination with international organisations.

### **2.2 INDE – SNIT**

Chile has participated in the global tendency towards spatial data infrastructures as envisaged and encouraged within the network of initiatives known collectively as the “Global Spatial Data Infrastructure” – GSDI. The GSDI includes several regional committees, including the Permanent Committee for Spatial Data Infrastructure of the Americas (CP-IDEA in Spanish initials). Representatives of Chilean institutions have attended meetings of the GSDI and of CP-IDEA, where the essential concepts have been transmitted and efforts coordinated. These included the Seminar on National Spatial Data Infrastructures at Bogota, Colombia in February 2000, and the “Global Spatial Data Infrastructure” conference at Budapest, Hungary (September 2002).

Within the general framework of the GSDI and CP-IDEA, Chile has made steps towards a National Spatial Data Infrastructure (INDE in Spanish initials). The project which is intended as the concrete expression of the INDE is known as the National Territorial Information System (SNIT in Spanish initials). The SNIT has the legal backing of a Presidential Instruction (dated 25<sup>th</sup> September 2001). Numerous meetings, seminars and conferences related to the INDE and the SNIT which furthered the coordination among the entities involved have already been held. At the National Congress of Chile in August 2000 a seminar titled “Towards a National Territorial Information Policy” the basis for a national policy on the development and use of a national SDI was laid out.

The SNIT initiative aims to make the exchange of spatial data among various bodies easier, simpler, and more efficient. Improved, wider access to spatial data, the consolidation or linkage of different data resources, and standardization programs are also within the scope of these initiatives.

The SNIT is supervised at ministerial level by a committee of Ministers. A ‘SNIT Technical Secretary’ (based at the Ministry of Public Assets and Resources) reports to this committee and facilitates the functions of a Technical Committee made up of experts which coordinates the tasks of the workgroups.

Within the SNIT several thematic workgroups are organized; that most closely related to the field of cartography is the 'Basic Territorial Information' workgroup, of which the following governmental bodies are active members :

- Military Geographic Institute – IGM (Chair)
- Hydrographic and Oceanographic Service of the Navy of Chile - SHOA
- AeroPhotogrammetric Service of the Air Force – SAF
- Natural Resources Information Centre – CIREN
- National Institute for Statistics - INE
- Chilean Space Agency – ACHE

The needs of a wide range of governmental and public bodies has been surveyed by means of a questionnaire. To gain recognition and support from the public, the SNIT organisation has distributed informative booklets and set up a web page ([www.snit.gob.cl](http://www.snit.gob.cl)), whilst the Basic Territorial Information workgroup held workshop events in April and October 2002.

### **2.3 PAIGH Committees and Projects**

The Pan American Institute of Geography and History (PAIGH) is an international agency reporting to the Organization of American States (OAS). Chilean organisations participate in the PAIGH. A "Chilean National Section" of the PAIGH is led by a local chairman, coordinating a series of four committees made up of suitable professional people in Chile from various institutions. These committees are the local counterparts of the major PAIGH thematic commissions and a number of international committees, and include a Cartography Commission. The members of the PAIGH Chilean section, in coordination with institutions in other countries also linked to the PAIGH, contribute to PAIGH-sponsored international committees and projects.

One such international committee is the 'Committee for Digital Imagery and Geospatial Data Applications (CAIDE). A CAIDE meeting, with representatives from various countries, was held in Chile in August 2000 at the Earth Sciences Congress of that year (see point 2.4).

In 2000 the PAIGH hydrography committee received reports of a large number of activities in Chile oriented towards nautical cartography; these included hydrographic surveys, nautical charts, routes for nautical navigation, a tide table for the Chilean coast, articles and other publications. In March 2002 personnel from organisations active in the PAIGH Hydrography Committee, including representatives of the SHOA (see point 3.2) in Chile, attended a workshop in the U.S.A. on the capture and processing of bathymetric data, organized by the South Mississippi Oceanography Office.

The PAIGH Thematic Cartography Committee continues to back the performance of research projects in the Americas. Two major international projects have significant Chilean participation.

One is the project titled “Tactile Cartography in Latin America : Training, Society and Multimedia Technology for the Blind in the Twenty-First Century”, planned to run for four years (2002 – 2005) and under development since 1999. Members of the staff of the Metropolitan Technological University (UTEM) and of the University of Chile have participated in the creation of a South American Atlas, that is, the part relating to Chile. Research into the needs of teachers, educational entities and blind persons was performed first, so as to determine those areas where materials with three dimensional solid elements and braille text can most usefully be applied. The first prototype topographic models and learning aids have been made, while research continues into design and production methods.

The other project is that titled “Cartography of subjective spaces, an alternative methodology for the understanding of the spatial behaviour of the urban population”, which involves research by professionals from Chilean, Argentine and Peruvian universities covering aspects of database structure, cartographic design and analysis criteria.

## **2.4 International Earth Sciences Congress**

Since the year 1991 the International Earth Sciences Congress has been held at two-year intervals in Santiago, Chile. This event draws together scientists, technicians, academics, and managers active in both public and private institutions in order to discuss and spread the results of their studies and advances in the fields of geography, cartography, geospatial data capture, geodesy and geo-informatics. It is the largest event of its kind in Chile and a major international forum for experts active in these fields.

The sixth Congress in this series was held in August 2000, and the seventh in October 2002. The Congress is organised in overall terms by the Military Geographic Institute of Chile, however, within the framework of the Congress, meetings and seminars organised by other organisations, both Chilean and international, in conjunction with the IGM, have taken place. At the Congress of October 2002, there was a symposium titled “Recent Deformation in the Earth’s Crust in South America and Neighbouring Areas”, under the auspices of the International Geodesy Association, also a seminar-workshop titled “Geographic Information systems for Cadastral Applications”.

## **2.5 Survey and Evaluation of Native Vegetational Resources of Chile**

This project was carried out during the years 1995 to 1997, culminating in the publication in 1997 of a report with statistics and a series of thematic maps at different scales. The date is previous to the scope of this ICA report (1999 – 2003), however, it deserves mention because the cartography generated in that survey still acts as a very important baseline and reference source for several government agencies.

Titled in Spanish “Proyecto Catastro y Evaluación de los Recursos Vegetacionales Nativos de Chile”, this body of information was researched by a group of government agencies, including two of those named in section 4 below, CONAF and CIREN. The cartography generated in the project is organised into two main series, one showing a continuous coverage of areal information classifying all of Chilean territory in a system called “Land Use”, another showing areal units locating and classifying all stands of natural forest and tree plantations.

Thematic information obtained mainly from interpretation of aerial photographs, from satellite images for certain areas of far northern and far southern Chile, and from some ground surveys and other sources was combined and overlaid onto an accurate cartographic base (from the IGM, see point 3.1). The information was represented in two series of maps; one representing a comprehensive classification of all terrain into a series of terrain types and vegetation categories called “Land Use”. A second series shows the location of all tree cover types, including natural forests, managed plantations, and woodland reserves.

The Land Use information covers a large part of Chile at 1:50.000 scale. Both map series exist showing all Chilean territory region by region (13 regions), some at 1:1,000,000 scale, others at 1:500,000.

## **2.6 Surveying in Antarctica**

Surveying of land in the ‘Chilean Antarctic Territory’ has been performed through coordinated efforts of several Chilean institutions involved in Antarctic activities, including the I.G.M. (see point 3.1 below), the Chilean Air Force, a few Universities and most especially the Chilean Antarctic Institute (INACH). In recent years, during successive field campaigns performed in the short Antarctic summer, data has been captured in the Patriot Hills Area sufficient for preliminary cartography to be set up for this area of difficult access, which, at latitude 80° 18' South, is much closer to the South Pole than the majority of Chilean and foreign bases on the Antarctic Peninsula.

### **3. PRIMARY PRODUCERS OF CARTOGRAPHY – ARMED FORCES INSTITUTIONS**

#### **3.1 INSTITUTO GEOGRAFICO MILITAR DE CHILE - I.G.M.**

(Military Geographic Institute)

##### **3.1.1 Mission, Products and Services of the I.G.M.**

The Military Geographic Institute (I.G.M. in Spanish initials) is the official authority representing the state in all matters involving geography, surveying, and the creation of topographic maps of Chilean territory, having sustained this mission since its creation in 1922. It supplies governmental agencies, the Armed Forces, educational institutions, and the general public with cartography and technical information relating to geographic themes.

The main body of cartography consists of several series of charts representing all the fundamental cartographic elements (topography and relief, drainage, transport features, human artefacts, urban outlines, essential features of land cover and vegetation). The main map series are, in terms of scale :

- 1:500,000 scale (nearly all of Chile covered)
- 1:250,000 scale (most of Chile covered)
- 1:100,000 scale (covers certain areas of Southern Chile)
- 1:50,000 scale (most of Chile covered)
- 1:25,000 scale (covers the more densely populated areas)

The 1:50,000 series is perhaps the most important asset in the IGM's stock, serving to some extent as a source for the other series. The IGM therefore intends to complete the last few remaining areas in the extreme south of Chile still to be mapped at 1:50,000. During recent years most of the existing stock of analogue cartography has been converted to digital media.

In addition to regular cartography, the I.G.M. also creates and markets a wide range of cartographic products such as :

- Large-scale urban cartography
- Atlases
- Texts on Geographic topics
- Interactive multimedia CD-ROM titles
- GIS Software products

The I.G.M. provides services to clients in both public and private spheres involving surveying, photogrammetric restitution, thematic cartography for specific clients and consultancy on projects involving geography, geodesy, surveying and cartography.

### **3.1.2 Surveying and Geodesic Projects at the IGM**

#### Geodetic Networks

Over the last ten years the existing National Geodetic Network (referenced to the PSAD 56 and SAD 69 Datums) has been enlarged, improved, and complemented particularly with the development of a GPS National Geodetic Network. All the GPS network points are within the older National Network. In addition, several specific projects have established new points, all tied to the existing National Network and mostly within the GPS network. Of these, the most important is the development of the SIRGAS program (see below).

The establishment in successive field campaigns of an ever larger number of GPS stations tied into both the existing National Geodesic Network and the GPS network has brought nearer the transformation from the existing data based on PSAD 56 and SAD 69 to SIRGAS 2000. PSAD 56 and SAD 69 are still the official reference systems for official cartography, but the work of the governmental bodies in the context of the “SNIT” projects (see point 2.2) is expected to change this. Most current surveying work is referenced to SIRGAS 2002 (equivalent to WGS-84)

#### Gravity

A ‘Basic Gravity Network’ has been under development in Chile by means of campaigns to re-measure known points and make the coverage denser, with new points. The data constitutes the ‘National Gravity Database’. During February 2000, in conjunction with the same surveyors from NIMA mentioned below, measurements of absolute gravity were made at four points, using the FG5 model of the free-fall apparatus developed by “Micro-G”, in order to validate the existing gravity networks. In September - October 2000 a set of gravity points were captured in the area between La Serena and Rancagua, covering large parts of the Fourth, Fifth, Sixth and Metropolitan (Santiago) Regions.

#### SIRGAS

Over recent years up to the present and beyond, the IGM, as the main representative of Chile, has participated in the initiative called “SIRGAS” in Spanish initials, this is the ‘Intercontinental Geodesic Network System for South America’.

From the late 1990's onwards a gradually increasing number of existing stations in either the National Geodetic Network or the GPS National Geodetic Network have been tied into the SIRGAS system. For example, in May 1999 several SIRGAS points were re-measured, also five tide gauge sites were measured with GPS as a means of strengthening the vertical reference of the SIRGAS and GPS networks.

IGM representatives have attended the SIRGAS meetings at Cartagena, Colombia, February 2001 and at Budapest, Hungary, September 2001. A further SIRGAS gathering was held in Chile itself at the International Earth Sciences Congress in October 2002 (see point 2.4). Here, an institution in Columbia was assigned the task of a vertical adjustment covering the whole of South America, applied to surveying data forwarded by the participating countries. The IGM has begun a plan to modernize the National Geodesic Network, using SIRGAS 2000 as its reference basis, with the aim of enabling the integration of all the national networks into a homogeneous system for the whole continent.

An immediate priority is to provide altitude and gravity values for the existing SIRGAS 2000 points. Eight SIRGAS stations have already been linked by geometric surveying with corrections for gravity to the tide gauges of the SHOA (see point 3.2). There is still some processing of data captured in the field to be done, generally oriented towards SIRGAS.

#### Joint Surveying Projects : IGM and Other Institutions

Many of the points in the National GPS-Geodesic Network are involved in joint projects performed by the IGM in conjunction with other institutions.

In 2000 geodesic surveying of seven of the most important airports of Chile was carried out in order to create digital models as aids to aerial navigation; this was in collaboration with the Chilean 'National Civil Aviation Authority'.

During the period late 1999 to early 2000, work was performed in Chile in cooperation with the National Imagery and Mapping Agency (NIMA) of the U.S.A. In February 2000 joint teams of IGM-NIMA personnel carried out a GPS survey along a line from 17°30' to 42°30', latitude south. The purpose was to provide points as ground truth checks on the SRTM (radar) global survey carried out from the platform of the Space Shuttle. The NASA Space Shuttle mission, carried out later in 2000, captured the data subsequently being processed by the NIMA and associated bodies in the U.S. into a Digital Elevation Model of Global scope with a spatial resolution of 30 m, a model which, once available, will be useful for perfecting the local Geoid.

In 2001, 69 GPS points were measured for the 'Central Andes Project' - CAP in conjunction with the University of Hawaii, USA.

Also in 2001, 34 GPS points were measured for the 'South American Geodynamics' (SAGA) project in conjunction with the Applied Geodesy Institute of Potsdam (GFZ), Germany.

Another project also involving a German institution, the Federal Institute for Cartography and Geodesy (BKG) is that which revolves around the 'Transportable Integrated Geodesic Observatory – TIGO. The IGM, three Chilean universities, and the BKG have been performing a three year project in which a mobile observatory with equipment for GPS and laser measurements to satellites, atomic clocks and a radio-telescope for VLBI astronomical observations has been deployed to collect data related to the 'International Celestial Reference Frame' and the 'International Terrestrial Reference Frame'.

### **3.1.3 Production Process for IGM Regular Cartography**

The main production process for regular cartography, which is the backbone of the technical activity of the IGM, has undergone a long evolution with many changes. Currently the process is under review to find ways to improve internal efficiency and quality.

The inputs to the cartographic process fall into two main groups. A very large part of the regular cartography of the IGM created prior to the introduction in the 1990's of digital techniques, made with traditional techniques but conserving sufficient topographic and positional accuracy, has been used in recent years as a base for newer versions transformed not only in terms of conversion to digital media but also through the re-classification and updating of content. The printed originals were scanned in, georeferenced, vectorized and processed to produce a preliminary digital map in .dgn format.

The IGM also continues to perform fresh surveys to feed the cartographic process. These begin with flights mainly performed by the Aerophotogrammetric Service of the Air Force (see 3.2.3 below) to obtain a coverage of overlapping aerial photographs for each study area. The photosets produced are checked, control points are selected, and a field survey team goes to survey those points on the ground with topographic measuring equipment. With the real coordinates of the control points established, the aerotriangulation process is performed with the photographs, followed by orientation and the restitution process.

On the basis of a stereoscopic pair of photographs in the restitution equipment used, contour lines and a complete model of the 3D image is captured and transferred to digital media, creating a preliminary map in .dgn.

From this point on the cartographic process is the same for both those maps based on converted older material and those deriving from aerophotogrammetrical restitution.

The first checks performed are through a selection of point locations to check positional accuracy. Then, in successive stages of processing, editing, plotting and checking, the preliminary maps are developed : alphanumeric texts and place names are incorporated, attributes are assigned in association with databases, and symbol and graphic design elements are incorporated for visual appearance. The work flow then diverges into two streams; one for digital cartography, the other towards the printing process on physical media. The IGM performs all its own printing in a plant capable of substantial print runs.

The regular cartography thus produced is in UTM projection. For the greater part of Chile down to latitude 43°30' the reference ellipsoid used is the 1924 International Ellipsoid and the Datum is PSAD 1956 (Canoa, Venezuela), whilst from 43°30' southwards it is the 1969 South American Ellipsoid and the SAD 1969 Datum (Chua, Brazil). Additionally, nearly all cartography published since the year 2000 also shows a grid framework referred to the WGS 84 Ellipsoid and Datum (see 3.1.2 above). During the current transitional period both sets of grids appear over the cartography; in the future, only the WGS 84 system will appear.

### **3.1.4 Special IGM Projects**

#### Clearinghouse

At the IGM a database system is being developed as the Chilean node of a clearinghouse network coordinated by the USGS of the USA. The IGM initiative was partly financed by the PAIGH. Metadata records covering a very large porportion of the IGM's series of cartographic coverages have already been stored and indexed in this system. The system is searchable, loaded into a suitable server, and conforms to the standards of the Federal Geospatial Data Committee (FGDC) of the U.S.A. Data entry is achieved mainly with the program "Metalite 1.7.4", endorsed by the FGDC. It is possible to see on web site: [www.igm.cl](http://www.igm.cl)

### Radar Images

A pilot project was performed to create maps based on radar images captured from satellite platforms, in order to develop a technology suitable for the mapping of remote regions difficult to survey by other means. Following an agreement between the IGM, a Canadian company called “RADARSAT International Incorporated” and the Chilean representative of RADARSAT (INCOM S.A.). The project involved the following stages :

1. Data capture from a satellite platform by RADARSAT, covering four sectors of Chilean territory .
2. Pre-processing of the data to produce images, at INCOM
3. Cartography of the sectors covered, produced at various scales at the IGM.

The project involved radargrammetry, Digital Elevation Modeling, orthophoto and vectorization techniques.

### **3.2 SERVICIO HIDROGRAFICO Y OCEANOGRAFICO DE LA ARMADA - S.H.O.A.**

(Hydrographic and Oceanographic Service of the Navy)

The Hydrographic and Oceanographic Service, maintained by the Navy of Chile, is the body responsible for producing nautical cartography, including the official cartography of Chilean maritime territory and the official guides to navigation in cartographic and text media.

The Cartographic Department produces and updates a large resource of nautical charts at various scales but all conforming to a standard and tied to known Datum points. The charts are based on aerophotogrammetric surveys for coastal areas and on bathymetric surveys. Over the last few years these processes have been partly or fully automated; a large part of the map making process is now performed on an “Electronic Charting System” – ECS. The software tools used for the most critical map generation functions are configured in accordance with IHO guidelines.

Coastal waters, coastal areas of land, oceanic areas within the sphere of Chilean influence, the navigable waterways and lakes of continental Chile, and the Antarctic regions are all covered by the available cartography. The charts are used as aids to maritime navigation and as studies of coastal and submarine (bathymetric) terrain, amongst other applications. Some navigation guides showing major maritime transport routes are now available in digital format. Some thematic cartography and other geographic data has also been developed in studies of ocean currents, tidal movements, oceanic meteorology, tsunamis, and other topics.

The cartographic products are available in analogue, digital, and electronic media. (Electronic charts are those configured for display in navigation screens on board ships in combination with real-time GPS-based positional signals and safety-zone limits).

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

- International Union for Geodesy and Geophysics - IUGG
- PanAmerican Institute for Geography and History – PAIGH
- Intergovernmental Oceanographic Commission
- International Hydrographic Organization - IHO

### **3.3 SERVICIO AEROFOTOGRAMETRICO DE LA FUERZA AEREA - S.A.F.** (Aero-Photogrammetric Service of the Air Force)

The Aero-Photogrammetric Service is responsible for providing the aerial photography used in the official cartography of Chile and for creating cartography used in aeronautical navigation, as well as a series of geography and cartography related activities which involve aerial photographs and images as the main input materials.

The main assets of the S.A.F. include :

- Aeronautical cartography of Chile at 1:250,000 and 1:500,000 scales
- A large archive of aerial photographs usable in aerophotogrammetric and aerophotointerpretation studies and the creation of cartography
- A set of digital photomaps
- A set of digital maps of the more densely populated parts of Chile available in several versions for different working environments (ESRI, Intergraph, CAD, etc) which contain layers for contours (at 5 m intervals) street plans, road networks, borough limits, natural drainage, bridges and other objects.

The S.A.F. has worked in conjunction with the I.G.M. and the S.H.O.A. to provide photographic bases for the official updated cartography of a large part of Chile at 1:50,000 and 1:70,000 scales in digital media. It has also worked on surveys to map specific zones for other institutions and clients. The SAF can reference its aerial photography surveys to the WGS-84 system by means of GPS-based data capture on the ground. Research projects have included techniques for combining digital aerial photographs with GIS systems and the use of satellite images for the surveying and cartography of remote areas of Chile and Chilean Antarctica.

#### **4. CIVILIAN MINISTRIES AND GOVERNMENTAL AGENCIES**

##### **CENTRO DE INFORMACION DE RECURSOS NATURALES – CIREN (Natural Resources Information Centre)**

The CIREN has a large and growing archive of cartographic products, including the following types of information :

- Orthophotos
- Geophotos (adjusted in terms of control points only horizontally, not in terms of altitude)
- Aerial photos
- Regular topographic maps
- Thematic maps covering agricultural topics

Three major sets of orthophotos serve as the base and spatial reference for three sets of thematic information. The orthophotos cover central & south-central Chile at 1:20,000 scale and some parts of northern Chile at 1:10,000 scale. These are overlaid with digital cartographic data linked to relevant alphanumeric databases.

The first set of cartography overlaid onto the orthophoto base is the Cadastral information, with property and administrative boundaries. The Administrative limits are of all levels down to the sub-municipal census zones, in accordance with data from the INE (see below). The property data, mainly boundaries between rural lots, farms, estates and other properties, are from the SII (tax office) listings of agricultural properties. A second set of orthophotos is overlaid with information deriving from studies of agricultural and forestry activity and soil types. This series covers those sectors with significant densities of population and/or agricultural activity, and includes soil type and agro-climatic information in its database. The third set is overlaid with irrigation and drainage channels, both natural and artificial, classifications of agricultural land in terms of irrigation regime, flow quantities, and well locations.

There is also small-scale (mostly 1:500,000) cartography of central Chile dealing with the themes of agricultural-climatic zones, adaptation of species to their climatic zones, and evaporation rates.

CIREN has also experimented with combining its existing alphanumeric data with GIS and interactive map media. Finally there is a satellite image processing service able to analyse, interpret and re-classify satellite images obtained from sources such as Landsat, Spot and Radarsat for local clients.

**MINISTERIO DE OBRAS PUBLICAS - MOPTT**  
(Ministry of Public Works)

This Ministry has generated a large amount of precision field surveying data in association with networks of transport, telecommunications and other services. This, in combination with other base cartography has allowed the MOPTT to produce a certain amount of thematic cartography, large scale topographic plans for engineering projects, also road maps and highway guides for the general public. The MOPTT possesses a small 'GIS and Cartography Unit' whose work can be seen showcased at the web site [www.mapas.moptt.cl](http://www.mapas.moptt.cl).

**SERVICIO NACIONAL DE GEOLOGÍA Y MINERÍA - SERNAGEOMIN**  
(National Geology and Mining Service)

This service, under the general supervision of the Mining Ministry, is the main government agency responsible for, amongst other duties, maintaining the official cadastre of mining properties in Chile, also advising on how administrative boundaries affect mining activities. The 'Sernageomin' possesses substantial resources of information dedicated to geology, mining extraction schemes, environmental impact studies and mining property rights, much of this incorporating thematic cartography in two and three dimensions, analogue and digital media. Among its products there are a series of maps of the country on technical subjects such as gravimetry and one Atlas of Mining Works throughout Chile.

**INSTITUTO NACIONAL DE ESTADÍSTICAS – I.N.E.**  
(National Statistics Institute)

The National Statistics Institute is responsible for collecting, maintaining, reporting and analysing official statistics on a series of themes of interest to the government and the public, also for performing state census activities on population and other social and economic realities.

The INE uses a collection of maps representing as a base all the political administrative limits and census districts of Chilean territory, upon which thematic information has been placed representing a wide variety of statistically quantifiable data about economic, population, environmental, social and other topics. Some of the alpha-numeric databases have been linked to digital spatial representations of the territory and its divisions. A small team of cartographers works at the INE.

**MINISTERIO DE BIENES NACIONALES**  
(Ministry of National Assets and Resources)

This Ministry possesses and develops cadastral cartography of government and public property, also covering systems of nature reserves and conservation areas. The secretaryship of the S.N.I.T. project (see point 2.2) is based here.

**CORPORACION NACIONAL FORESTAL - CONAF**  
(National Forestry Corporation)

Main missions are to encourage responsible growth of forestry plantation and commercial exploitation, also protects certain areas and reserves of native-species forest. Maintains cadastral information on Chilean forestry plantations and woodlands, also on reserves, involving a certain amount of forestry-related and environmental cartography. Using the 1997 Vegetational Survey maps (see point 2.5 above) as a foundation, some of their 1:50.000 maps have been updated with detailed information on vegetation and soil types.

**SERVICIO NACIONAL DE TURISMO – SERNATUR**  
(National Tourist Service)

State-owned agency promoting Tourism in Chile. Distributes some thematic cartography related to travel, tourist and cultural infrastructure.

## **5. ACADEMIC AND TRAINING SECTOR**

### **5.1 Overview**

In Chile there are only two Universities that run substantial courses in Cartography as such (5.2 below). It should be pointed out, however, that the graduates of these programs are a minority, albeit a large one, among those who work on cartography-related activities in Chilean institutions and organisations, both those named here and elsewhere.

There is a number of professional geographers trained at other major Universities and Institutions. Three of the most important of these are the following :

- University of Chile - Geography Department
- Catholic University of Chile - Institute of Geography
- University of Santiago – Engineering Faculty

In addition, at the Military Polytechnic Academy (the university of the Army of Chile), some of the Military Engineers specialize for most of their course in Geography and Geo-Informatics.

There is also a large number of graduates at technical and professional levels from courses in topographic surveying, geo-territorial measurement and other engineering courses broadly aimed at techniques of field surveying, aerophotogrammetry and survey-data processing. They are known in Spanish as “Geomensores”.

Finally there are many short courses in both Universities and private organisations aimed at various aspects of geo-informatics, including spatial-data management, graphic engineering design, digital images, and especially abilities with GIS tools.

## **5.2 Universities with Cartography Courses and Research**

### **UNIVERSIDAD TECNOLÓGICA METROPOLITANA – UTEM (Metropolitan Technological University)**

The Cartography Department of this University contains the following activities:

- School of Cartography. This school runs a four-and-a-half year course leading up to graduation as a professional (degree-level) Cartographer. It is the only course of its kind in Chile. Some of the projects performed by students for their graduation presentation have been of real importance to certain institutions.
- Research and Projects Units. A small number of professional staff have worked on projects involving geographic studies, implementation of GIS tools for specific applications, the above-mentioned PAIGH projects, and other projects financed by outside bodies.
- Training programs. A wide range of short courses is offered on cartography-related techniques.

### **UNIVERSIDAD BERNARDO O'HIGGINS**

This University includes an Earth Sciences Faculty, which runs a course for Cartographic Technician, consisting of a two-and-a-half year course followed by a practical apprenticeship (about three months or equivalent time) and a project leading up to the presentation of a graduation document.

## **6. THE PRIVATE SECTOR**

### **6.1 Overview:**

A number of private entities and companies operate in Chile performing cartography-related services. Clients include public and governmental entities, private organisations, the general public and occasionally some foreign (non-Chilean) clients. The most typical activities to be found in this field are listed as follows, followed by a partial listing of some of the major organisations in this field.

### **6.2 Services and Products in the Private Sector**

All of these activities, services and products are or have recently been on offer from at least one and more usually several of the private organisations operating only or principally in Chile:

- Terrain surveying and precise topographic measurements. These include surveys with conventional levelling and theodolite equipment as well as GPS surveying techniques. It should be pointed out that the emergence of purely cartographic services, at least in the private sector, has been strongly influenced by the services for terrain surveying, which is larger and of longer-standing. There are a large number of surveying services available to the demand from local engineering projects, only a few of which are also involved in the generation of cartography rather than large-scale engineering plans.
- Aerophotogrammetric restitution, production of orthophotos, topographic maps and DEMs based on aerial surveying
- Creation of thematic digital cartography for specific applications, for example geology and cadastral mining zones
- Development of GIS-based solutions for client applications such as public utility distribution networks, cadastral records, municipal and public administration systems, business market analysis and natural resources management amongst others.
- Processing of gridded data images and satellite images
- Conversion of cartography from analogue to digital media, sometimes in combination with re-attribution or linkage to alphanumeric data. Some of this has been for non-Chilean clients with cartography of non-Chilean terrain to convert; a few Chilean organizations are capable of performing conversion projects for foreign clients involving input materials and products transferable by Internet.

- Local representation of major international corporations that produce and market state-of-the-art equipment and tools, including aerophotogrammetric equipment, software and complete digital systems. The suppliers represented include trade names such as “Intergraph”, “ESRI”, “ERDAS” and “AutoCAD”. The local representatives of these suppliers not only sell the products, they advise clients in their installation and provide related training services.
- Online cartographic reference services available through the Internet
- Training services in relation to cartographic, geospatial data management and GIS systems.
- Guides aimed at the tourist industry including road maps, maps of cultural, transportational and recreational features

### **6.3 List of Private Organisations**

The following is a partial list of some of the private organisations, firms and companies active in cartography-related services. A comprehensive listing is difficult to determine. The names and their respective contact details given in Annex I are assumed correct at this date, but no guarantee be made that these will be valid for long.

- GEOCEN
- GEOCOM
- GEOINGENIERÍA DIGITAL LTDA.
- GEOSERVICE
- HIDROGRAFIA Y GEOMENSURA S.A. - HIGESA S.A.
- INGENIERÍA Y COMPUTACIÓN S.A. - INCOM
- INGENIERIA Y SISTEMAS GRAFICAS S.A. – I.S.G.
- MAPAS DIGITALES (formerly SOFITEL S.A.)
- ORGANIZACIÓN GEOTECNICA – O.G.T.
- OTAG / SAGAL
- SYGNNUS
- TURISTEL / TURISCOM

## **7. FINAL COMMENTS**

The art and science of Cartography in Chile is sustained by several public and private institutions with the skilled staff and resources sufficient to ensure that its technological level is equal to that of the cartographic sectors in almost any countries of the developed world. The number of people and organisations involved in the creation of original cartographic material is not very large in comparison with the same sector in developed countries, although the users of cartographic bases are quite numerous. The prevailing economic conditions in Chile oblige those organisations involved in Cartography to focus mainly on practical applications of cartographic techniques to immediate, real-world projects and to place most of these projects on a commercially or financially viable footing. Nevertheless, Chilean exponents of Cartography can interact with their counterparts in the rest of the world on an equal footing, absorbing the latest developments.

## **ANNEX I : CONTACT DETAILS**

These are the minimum contact details for the Chilean institutions and organisations named in the report, where these are known, including contact e-mail address, postal address, and, where these exist, Web site or Web page.

### *Armed Forces Institutions*

INSTITUTO GEOGRAFICO MILITAR DE CHILE – I.G.M.  
Santa Isabel 1640  
Santiago  
Región Metropolitana  
[www.igm.cl](http://www.igm.cl)

SERVICIO HIDROGRAFICO Y OCEANOGRAFICO DE LA ARMADA - S.H.O.A.  
Calle Errazuriz 264  
Cerro Playa Ancha  
Valparaíso  
V Región  
[www.shoa.cl](http://www.shoa.cl)

SERVICIO AEROFOTOGRAFICO DE LA FUERZA AEREA - S.A.F.  
Hall Central – Aeródromo Los Cerillos  
Avenida Pedro Aguirre Cerda 6100  
Cerillos  
Región Metropolitana  
[www.saf.cl](http://www.saf.cl)  
[jsoler@saf.cl](mailto:jsoler@saf.cl)

### *Governmental Ministries and Agencies*

CENTRO DE INVESTIGACION DE RECURSOS NATURALES – CIREN  
1164  
Avenida Manuel Montt  
Providencia  
Región Metropolitana  
[www.ciren.cl](http://www.ciren.cl)  
[ciren@ciren.cl](mailto:ciren@ciren.cl)

**INSTITUTO ANTÁRTICO CHILENO**

Luis Thayer Ojeda 814

Providencia

Región Metropolitana

[inach@inach.cl](mailto:inach@inach.cl)

*(Postal address is due to change very soon to an address in Punta Arenas, Twelfth Region, far south of Chile)*

**INSTITUTO NACIONAL DE ESTADISTICAS – I.N.E.**

Avenida Presidente Bulnes 418

Santiago

Región Metropolitana

[www.ine.cl](http://www.ine.cl)

[secretaria.dirección@ine.cl](mailto:secretaria.dirección@ine.cl)

[mariao.monckeberg@ine.cl](mailto:mariao.monckeberg@ine.cl)

[hector.moreles@ine.cl](mailto:hector.moreles@ine.cl)

**MINISTERIO DE OBRAS PUBLICAS - MOPTT**

Morande 59 - Hall Central

Santiago

Región Metropolitana

[www.moppt.cl](http://www.moppt.cl)

[ramon.granada@moppt.cl](mailto:ramon.granada@moppt.cl)

**MINISTERIO DE BIENES NACIONALES**

Juan Antonio Rios 6

Santiago

Región Metropolitana

[www.bienes.gob.cl](http://www.bienes.gob.cl)

**CORPORACION NACIONAL FORESTAL - CONAF**

Avenida Presidente Bulnes 285

Santiago

Región Metropolitana

[www.conaf.cl](http://www.conaf.cl)

SERVICIO NACIONAL DE TURISMO – SERNATUR  
Avenida Providencia 1550  
Providencia  
Región Metropolitana  
[www.sernatur.cl](http://www.sernatur.cl)

*Academic Organizations*

ACADEMIA POLITÉCNICA MILITAR  
Valenzuela Llanos 623  
La Reina  
Región Metropolitana  
[www.acapomil.cl](http://www.acapomil.cl)

INSTITUTO DE GEOGRAFIA (UNIVERSIDAD CATOLICA)  
Avenida Vicuña Mackenna 4860  
Macul  
Región Metropolitana  
[www.geo.puc.cl](http://www.geo.puc.cl)

UNIVERSIDAD BERNARDO O'HIGGINS  
Facultad de Ciencias de la Tierra  
Avenida Viel 1497  
Santiago  
Región Metropolitana  
[www.ubohiggins.cl/carreras/cartografía.html](http://www.ubohiggins.cl/carreras/cartografía.html)  
[cienciatierra@ubohiggins.zzn.com](mailto:cienciatierra@ubohiggins.zzn.com)

UNIVERSIDAD DE CHILE  
Facultad de Arquitectura y Urbanismo  
Departamento de Geografía  
Marcoleta 250  
Santiago  
Región Metropolitana  
[www.uchile.cl/facultades/arquitectura/geo.html](http://www.uchile.cl/facultades/arquitectura/geo.html)

UNIVERSIDAD DE SANTIAGO DE CHILE  
Facultad de Ingeniería – Departamento de Ingeniería Geográfica  
Avenida Alameda Libertador Bernardo O'Higgins 3363  
Estación Central  
Región Metropolitana  
[www.universidaddesantiago.cl](http://www.universidaddesantiago.cl)

UNIVERSIDAD TECNOLÓGICA METROPOLITANA – UTEM  
Departamento de Cartografía  
San Ignacio 171  
Santiago  
Región Metropolitana  
[www.utm.cl/cartografía](http://www.utm.cl/cartografía)  
cartogra@omega.cl

*Private Sector Organisations and Companies*

GEOCOM  
Av. Salvador 1105  
Providencia  
Santiago  
Región Metropolitana  
[www.geocom.cl](http://www.geocom.cl)

GEOCEN  
Padre Mariano 10 of.. 903  
Providencia  
Santiago  
Región Metropolitana  
[infor@geocen.cl](mailto:infor@geocen.cl)  
[www.geocen.cl](http://www.geocen.cl)

GEOINGENIERÍA DIGITAL LTDA.  
Avenida Italia 1861  
Providencia  
Región Metropolitana  
[geeing@entelchile.net](mailto:geeing@entelchile.net)

GEOSERVICE  
Marcoleta 381 of. 41  
Santiago  
Región Metropolitana  
[www.geoservice.cl](http://www.geoservice.cl)

HIDROGRAFIA Y GEOMENSURA S.A. - HIGESA S.A.  
[higesa@chilnet.cl](mailto:higesa@chilnet.cl)

INGENIERÍA Y COMPUTACIÓN S.A. - INCOM  
Amunategui 178 piso 5  
Santiago  
Región Metropolitana  
[info@incom.cl](mailto:info@incom.cl)  
[www.incom.cl](http://www.incom.cl)

INGENIERIA Y SISTEMAS GRAFICAS S.A. – I.S.G.  
San Sebastian 2952  
Las Condes  
Región Metropolitana  
[www.isg.cl](http://www.isg.cl)

MAPAS DIGITALES  
Eduardo Hyatt 583  
Providencia  
Región Metropolitana  
[www.dmapas.cl](http://www.dmapas.cl)

TURISTEL / TURISCOM  
Avenida Santa Maria 0120  
Providencia  
Región Metropolitana  
[www.turistel.cl](http://www.turistel.cl)

ORGANIZACIÓN GEOTECNICA – O.G.T.  
Pasaje El Ombu 196  
El Bosque  
Región Metropolitana  
[gubal@ogt.cl](mailto:gubal@ogt.cl)  
[www.ogt.cl](http://www.ogt.cl)

OTAG / SAGAL  
José Arrieta 7698  
La Reina  
Región Metropolitana  
[sagal@cmet.net](mailto:sagal@cmet.net)

SYGNNUS – Soluciones Tecnológicas  
División Sistemas de Información Geográfica y Cartográfica  
Avenida Chile – España 717  
Ñuñoa  
Región Metropolitana  
[www.sygnnus.cl](http://www.sygnnus.cl)  
[sig@sygnnus.cl](mailto:sig@sygnnus.cl)