



Chilean Hydrographic Surveyors' Contribution to Coastal Zone Management

Captain Hugo Gorziglia, Chilean Navy Hydrographic Engineer, Advisor at SHOA for International Affairs

The paper starts with a description of the Chilean coast's characteristics and peculiarities. From this a statement of the need to manage and regulate the use of the coastal zone is generated, the responsibility to develop different regulations being that of the Chilean Government and its technical bodies.

The management of the coastal zone, a space both complex and dynamic, requires a cartographic representation that might show the administrator the space to be regulated and controlled. Special consideration should be given to elements such as maritime and aquaculture concessions and the definition of other areas of preferential use.

Hydrographic surveyors have a broad participation in the phases of planning, execution, processing and production of marine charts, including the preparation of Technical Reports. The marine chart resulting from these activities, the coastal zone maritime chart, has been accepted to be the main document needed by the Coastal Zone Administrator.

In a country with a coast exceeding 84,000 linear kilometres, the provision of this type of chart cannot be successfully achieved if not approached co-operatively by the central and regional governmental authorities, the Navy Hydrographic and Oceanographic Service (SHOA) and the private sector.

The procedure followed to put together the capabilities of the different participants has generated findings, which may be of interest and value to others. It is hoped that this paper, will provide some useful suggestions to those Hydrographic Offices that have not yet been exposed to activities of this nature.

Chilean Coast - Characteristics and Peculiarities

General Description

Chile is privileged to have a long coast that represents –linearly –, over 84,000 kilometres in its continental sector. For the purpose of this work, we will consider the Chilean Coast as comprised of four zones: Northern and Central; Southern and Austral; Oceanic Islands and the Antarctic.

Northern - Central Zone

The northern boundary of this part is the international border with the Republic of Perú, and extends southward to the Chacao Channel.

In this section, the coastline provides only limited shelter to shipping as there are only a few inlets, and no chain of islands exists to protect the coast from the open ocean. It should be kept in mind that under these conditions, the only way to take

advantage of the few existing bays is by building costly and huge protective structures. For that reason, all ports may be called 'artificial ports'.

In this zone, the ports provide service to trade, - imports and exports of goods -, as well as national shipping needs. Cargo transfer is mainly related to mining and fishing products, together with fuel, grain and other general supplies.

Naval industry, farming, aquaculture, nautical sports, local fishing and recreational tourism are also using this coast. Chile's biggest coastal cities are located in this part of the coast, and their development has been directly related to the existence of ports. For that reason, these so-called 'city-ports' are heavily populated with almost a 100 per cent increase in population during summer time.

Southern - Austral zone

This part starts at the Chacao Channel and extends southward to Cape Horn. The coast in this region is totally indented and irregular, with thousands of islets and islands that generate archipelagos, narrows, gulfs, bays, inlets and other particular geographic features.

These peculiarities provide great protection for all activities that are conducted in the interior waters. Nevertheless, outside this protected area the sea state normally prevents any commercial or recreational activities.

Due to the prevailing severe climate in this region and the distance from populated and goods distribution centres, very few people live in it. The economic activity is centralised in very few and small ports, and consists mainly of fishery, forestry, aquaculture, mining and tourism.

Oceanic Islands

This zone is constituted by three groups of islands: Juan Fernandez archipelago; San Felix and San Ambrosio islands, and Eastern and Salas y Gomez Islands.

Due to the volcanic formation of the islands, they do not provide natural inlets able to sustain a port. Moreover, due to the long distance that separates them from the mainland, their activities in the coastal area are limited to fishing and tourism.

Antarctica

In line with the Antarctic Treaty, the principal activity that takes place in the Antarctic is of a scientific character. Nevertheless tourism is a new activity that is growing rapidly, exercising pressure over the ecosystems during summer time.

The Need to Regulate and Manage the Use of the Coastal Zone

After this brief description of the Chilean coastal zone, it can be concluded that this zone provides a variety of important economic resources. Within them, we can highlight the following: the port infrastructure that supports shipping and trade as well as fishing industry. The scenic resource that encourages tourism, nautical sports and through both, the real-estate industry. Special mention should be given to the increasing aquaculture and algae farming, both very attractive economic activities.

All these activities exercise a strong pressure over the coastal zone and therefore the need to adopt measurements to regulate and manage that space arises. In the northern part of Chile where the climate is mild but the coast does not provide many protected bays, the interest of all actors is to use the same few protected spaces, where not always all activities can be conducted at the same time. Moreover, some activities are not compatible with others and this situation clearly constitutes the origin of difficult problems that must be solved.

On the other hand, in the southern part, the increase of aquaculture and farming activities forces the need to adopt regulations to prevent sea water saturation and health problems.

It also has to be taken into account, that due to the topographic and hydrographic characteristics of Chile,

the sea constitutes the natural deposit of residues coming from any productive and human activity developed in the coastal zone and also in the hinterland. All this demonstrates that ecosystems located in the coastal zone are placed in a fragile situation, due to human or natural action.

It should be understood that the adoption of regulations and management resolutions seem to be essential to assure a sustainable and rational exploitation of the coastal zone.

Principal Related Legal Regulations

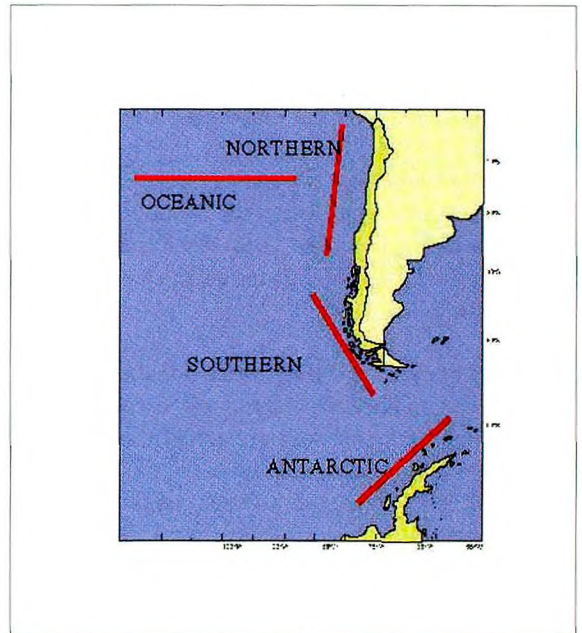
Maritime Concessions' Regulation

Maritime concessions are those that are granted over public use of national real estate or government real estate under the control and supervision of the Ministry of Defence, no matter the use given to the concession. This faculty is exercised over the beach, backshore (80 metres), sea bottom, seawater and rocks. Concessions granted for a period less than one year are known as permissions, requiring less sophisticated procedures than those exceeding that period which require a special decree issued by the government. The period granted would depend on the type of activity to be conducted and the value of the infrastructure to be built, related to that activity. When a concession is requested by a government agency, it is called a destination. In this case there is no cost involved.

This regulation determines the procedures to request a maritime concession, including the information, applicants must submit and the follow up actions thereafter. It also establishes the procedure by which the authority gives the concession, cost, taxes, and other relevant matters, such as the procedure to terminate and causes the concession to expire.

One of the documents that the applicant must submit is a plan that illustrates the area requested. If the concession is for the construction of a pier, wharf or any other work of similar dimension, the applicant must include studies and plans illustrating the characteristics of winds, tides, tidal currents and waves, as well as a complete bathymetric survey and details of the sea bottom.

All these documents must carry a seal indicating that they have been reviewed by SHOA.



Zones

Fishing Law

This law provides a reference frame in relation to the Aquaculture concessions, Marine Reserved Areas, Benthonic Resources Management and Exploitation Areas. Also it should be highlighted that this law establishes a strip 5 nautical miles wide reserved for local fishermen, and that this strip is part of the coastal zone.

Aquaculture Concessions

An Aquaculture concession is an administrative act through which the Ministry of Defence, after receiving an approved technical report from the Under Secretary of Fisheries, grants a person the right to use and profit from a particular national real estate by conducting aquaculture activities. These activities are

defined as those whose objective is the man-made production of hydro biological resources. This type of concession can be transferred and is subject to commercial acts. Also it can be transferred or rented following official authorisation.

There are several classes of aquaculture concessions: beach, backshore (80 metres), seawater, sea bottom and rocks.

Aquaculture Concessions are managed by a Regulation. This legal instrument provides definitions, standard procedure for application, transfer, loan and expiration causes. The application, among other documents, must be accompanied by two plans: one that shows the general geographic position of the area requested and a second plan providing clear details of the limits of the requested area, including information on neighbouring concessions. These two plans must be produced following special technical instructions provided by SHOA.

The Fishing Law establishes through appropriate government decrees, appropriate areas for aquaculture. This means that all applications must be within those established areas and no overlap may exist with other concessions already granted. In the case of salmon farming concessions, they must observe a specified distance between them, to prevent adverse environmental problems.

Marine Reserve Areas

These are areas established to protect the hydro biologic resources contained in it, protect the reproduction of species and study their behaviour under controlled natural conditions. The National Fishery Service manages these areas and extractive activities only can take place under its very strict policies.

Management Areas

These areas only apply within the 5 nautical miles reserved for the local fishermen. After granting one of these management areas, local fishermen must follow a research project and are only authorised to exploit particular species under special conditions. The National Fishery Service also exercises control of these activities.

National Policy on the Use of the Coastal Zone

In 1994, on the understanding that the coastal zone was a geographic and physical unit of special importance for the harmonic development of the country, and moreover was defined as a limited resource, able sometimes to handle several activities, and in some cases only one, the need was identified to establish a national policy to assure its best possible use. The general objectives of the mentioned National policy are as follows:

- To adequately consider the particular geographic characteristics of each area
- To encourage the development of resources particular to different areas
- To protect and conserve the environment
- To harmonise the different uses and activities that each area supports
- To lead a balanced development of activities, considering interests from all sectors
- To contribute in the identification of future projects proper to each activity

It is interesting to highlight one of the specific objectives of this policy, which is to propose the establishment of preferred uses to some parts of the Coastal zone. Those special uses are to be determined considering geographic and natural factors, existing resources, developing plans and existing population, as well as specifications already established by competent organisations.

To put this policy into action, a National Commission on the Use of the Coastal Zone was established. One of its first tasks was to work on a proposal for defining zones of all spaces. Other initial tasks were to resolve existing discrepancies on the best use of a particular place and to formulate recommendations to appropriate government agencies on the best use to be made of areas not assigned yet. The Under Secretary of the Navy was designated to act as the Technical Secretary of the National Commission. This

structure was also copied at the regional level, where commissions were established, with nearly the same objectives.

The basis for a proposal on the specification of zones of the Coastal Zone was the early work done independently by several relevant governmental agencies. So far, 5 types of areas were decided:

- Areas reserved for State use
- Areas for ports and other similar constructions
- Areas for shipyards and construction and repairing ships
- Areas for human settlements and local fishermen settlements
- Areas for industrial, economic and development activities

This exercise has, until now, been done utilising the nautical charts produced by SHOA, whose design objective is to satisfy navigation needs. As specialised instruments, nautical charts do not necessarily constitute the best cartographic base to help resolve the coastal zone management issues. It is recognised at a governmental level that nautical charts offer only a transitional solution, and that a new set of charts is mandatory to support coastal zone management.

Marine Environment Pollution

An other important legislation is that related to marine environmental pollution, either originating from marine operations, from the transfer of fluid hydrocarbons or from other sources, that finally affects the coastal zone. For each potential source of contamination, special regulations have been developed, establishing procedures, and requiring studies to be performed before a project is approved and other activities. All these studies require a cartographic base. Moreover, when developing mitigation measurements and plans, this special cartographic base is mandatory. In all these cases, conventional nautical charts were found not to be appropriate.

The Hydrographic and Oceanographic Service (SHOA)

One of the tasks established by law is that SHOA is to act as the State official, technical and permanent Service, in hydrography, hydrographic surveying, nautical cartography and oceanography, among other disciplines. Also SHOA has to contribute through research, to the development and fostering of other national and international activities of national interest, and by providing appropriate information.

It is important to consider that among the multiple functions assigned to SHOA, the following have a direct relation with the subject of this paper:

- Control all hydrographic surveys that take place in the jurisdictional maritime zone
- Issue the technical guidelines that should be used when conducting a hydrographic Survey
- Control, review and approve all hydrographic surveys and marine cartography that have been conducted and produced, respectively, to support port construction, maritime concessions or any other objective. SHOA might verify that those conducting these activities achieve the standards.
- To lead, conduct and control tide and tidal currents observations done in the maritime zone

Clearly, within this framework of missions and functions, SHOA has the responsibility to provide an adequate response to the coastal zone management problems.

The provision of special maritime cartography to support coastal zone management is a challenge that cannot be solved exclusively by SHOA and hence the need to invite the private sector to participate arises.

This new approach was clearly understood by SHOA, which decided to grant priority to the establishment of standards, specially developed to provide guidance in the activities related to the production of this type of maritime

charts. It was envisaged that the private sector should participate in conducting the fieldwork and the processing of the data, while SHOA would keep the responsibility to control all steps, including production of a final product.

Cartographic Scheme and Standards

Cartographic Scheme

After a detailed analysis of the full set of nautical charts, and considering the requirements put forward by government agencies in charge of coastal zone management, it was concluded that an independent standardised cartographic scheme was needed. The objective of the maritime charts belonging to this new scheme would be the following:

'Constitute the supportive base for the study, analysis, administration, regulation and sustainable exploitation of the different activities that take place or would take place in the future in the Coastal Zone. Moreover, would constitute a geo-referenced frame for multidisciplinary application where to relate other information and activities, knowing their relative position, areas of coverage, distance between them, and eventual overlaps. Also would serve any need in which a quantitative dimension is required.'

In general terms, the basic standards agreed were:

Scale 1:5,000

Projection: UTM

Datum: WGS-84

Source of information: Aerial photos scale 1:5,000

Restitution: model by model on urban areas and strips in rural areas.

Topographic details: at least 300 metres inland from coastline.

Hydrographic photo interpretation of the area covered by the plan.

Elevation contour: each 5 metres.

Definition of LWL and HWL plus, line 80 metres inland, measured from HWL.

Information gathered in different layers in DXF format.

Complete Technical Report to support the final cartographic product.

To ensure that private companies would follow the standards in all steps of the work, SHOA issued several technical instructions.

Hydrographic Standards

SHOA prepared a set of different standards that are listed below:

- Technical Instructions for determining the Beach and Backshore area in the Coastal Zone and in Lakes and Rivers
- Technical Instructions for preparing Plans for Aquaculture Concession's application
- Technical Instructions on the use and application of GPS technology in Geodetic, hydrographic and Topographic surveys
- Technical Instructions for the preparation of Maritime Charts of the Coastal Zone
- Technical Instructions for oceanographic parameters' measurement and analysis
- Technical Instructions for Water level calculations

All these publications were offered to companies that were willing to take part in this type of work. Moreover, a register of companies was opened. Belonging to this register, companies are assured of receiving updates and relevant information issued by SHOA.

Preparation of Maritime Charts for the Coastal Zone

Chile is politically divided into 13 Regions. The first task was conducted in the IVth Region, in the north-central part of the country. The Under Secretary of the Navy called for a public proposal for the preparation of 24 maritime charts. The selection of the company was based on a higher value being given to technical competence than to the financial proposal. All technical issues were handled by SHOA and all administrative matters by the Under Secretary of the Navy. This last Agency was also tasked to contract directly the flying of the photographs for the photogrammetry. The photos were provided directly to the selected company.

Execution

The execution of fieldwork considered the link to the national geodetic network, in order to provide horizontal control to the aerial photos as well as the measurement of tides in three places to provide a better vertical control. GPS operated in differential mode and digital tide gauges were used. Topographic instruments were used to check the position of principal elements identified in the photo interpretation. The fieldwork lasted for 30 days, with two teams of two persons each. Fieldwork was inspected by SHOA.

Processing

The positioning data was processed using Win Prism software and with the calculated co-ordinates, the restitution was performed utilising an aviograph Wild BC-1. The heights of the vertices were adjusted to the MSL.

The Product

The compilation of the restitution was done on a Micro Station using DGN format and latter transformed to AutoCAD DXF. Finally it was transferred to NTX for the Spatial Fusion data management tool of CARIS. This last operation was needed to allow several different government agencies to manage the digital information allocated on a central computing facility.

In this way, hydrographers belonging to SHOA as well as to the private sector, contributed to the production of 24 maritime charts suitable for the management of the Coastal Zone.

Governmental and Private Participation

Governmental Role

The National Commission on the Use of the Coastal Zone was in charge of identifying the priority for the work. The administrative and financial aspects were handled by the Under Secretary of the Navy, while the technical aspects were the responsibility of SHOA. This agency also established the technical terms of reference, provided the technical qualification of competitors, exercised the technical control of the work done and executed a detailed revision of the product provided by the contracted party.

Private Role

The contracted party executed all field work, carried out the processing, edited the maritime charts and provided SHOA with a complete Technical Report and all relevant data and information needed to review the resulting products. All these documents were entered into the Coastal Zone Cartographic Database, under the responsibility of SHOA.

Findings

1. It was necessary to hold more co-ordination meetings between the agencies in charge of the finances, administration and technical control than previously considered necessary, especially during the call for proposals. It had to be born in mind that this is the first time that an activity of this kind has taken

place, so there was no previous experience among governmental officials on how to handle a contract with hydrographic private sector.

2. It was noticed that there was wide interest among the private sector in participating in this project. The change of SHOA's attitude in relation to this opportunity was very well received by the private sector, as previously this type of activity had been conducted only by SHOA. This milestone was considered as a new possibility of business and co-operation.
3. The set of Technical Instructions fulfilled their objectives. Standardisation was obtained with regard to fieldwork, processing and editing of the maritime charts. Nevertheless, it was evident that a set of standards identifying the reviewing process was needed. Not having any agreed protocol to review the products, it was very difficult for both parties, at the last stage of the project, to agree on a formal procedure.
4. This 'pilot' exercise opened new opportunities not only at the national level but also at local levels. Local authorities now can allocate resources to fund initiatives and projects to be developed on their coastal zone, according to their own priorities. It was clear that the new maps obtained as a final product satisfy the expectation of different coastal zone management authorities as well as the productive sector interested in investing in this zone.

Biography

Captain Hugo M. Gorziglia (50), graduated as Navy Officer from the Chilean Navy Academy in 1970 and as Hydrographic Engineer in 1975. He was appointed almost all his career at SHOA. Between 1976 and 1986 he conducted more than 36 hydrographic commissions as Chief of the Surveying Party. In 1987 he was appointed Deputy Director and Technical Advisor and in 1994, Director and Chilean Hydrographer until December 1997, developing and leading SHOA's modernisation. Actually he is the International Advisor for SHOA and also an independent Consultant and Technical Advisor in matters related to hydrography, applied oceanography, cartography, maritime and aquiculture concessions, marine environment, among other activities. He participates actively in several international bodies. Among others, the IHO Strategic Planning Working Group, the FIG/IHO International Advisory Board on Standards of Competence for Hydrographic Surveyors and the IHO Manual on Hydrography Working Group, that he chairs.