(Theme: Governance)

Integral Strategy for the Recovery of Water Resources of Talcahuano, Chile #288

A. ABSTRACT

Description

- The Municipality of Talcahuano, due to its geographic location, natural conditions and closeness to energy supply centres, such as coal from Lota and Coronel, had from the fifties onwards an important growth in terms of industry and fishing, a greater military presence, and an increased port capacity; all this led to an accelerated urban growth. The co-existence of active urban and industrial areas in an uneven territory, with abundant water bodies and a surface area of only 142.8 km2, have made the city specially sensitive to natural resource degradation and environmental deterioration, a situation that was made critical in the last decade and which gave rise to the municipal strategy started in 1993 and the subject matter of the current Case Study. This situation was being aggravated by the chronic scarcity of resources in the Municipality and the lack of infrastructure and control mechanisms faced with environmental deterioration.
- The Municipality, as the institution in charge of administering this serious environmental deterioration that affected the quality of life of its inhabitants, its economic activity and its sustainability as a municipality, assumes at the start of the nineties the firm purpose of solving this serious problem, designing and developing plans, projects and programs aiming to revert the deterioration. It is thus how the Municipality, in co-ordination with other public, private and community organisations, manifest their outmost commitment and concern for decreasing contamination, specially those affecting water resources, and to appropriately zone the city in order to harmonise the different activities and make them sustainable in time.

Lessons Learned & Replicability

- Thus the case is a good example of the application of an integral approach in the management of water resources (the "IWRM approach"), within the possibilities of a local level government having modest resources, in terms of a) its concern regarding the equitable and sustainable use of the resource, by different social and productive sectors, b) with a long range vision, c) with accountability, making the agents of contamination responsible for their mitigation and d) with a notable and permanent capacity for the participation of all interested parties and agents in the use and management decisions of the resource.
- The most important lesson the case provides, of great value in the replication of the experience, is that it demonstrated the appropriateness of the Municipal level of government in successfully addressing the recovery of water resources and environmental management, even under apparently insurmountable circumstances of inequality in facing powerful contaminating agents, as was the case in Talcahuano. The experienced analysed indicates that Municipalities may achieve this by exercising efficient and informed conduction and which employs a strategy capable of combining interests and negotiating efficient associations with the community, private companies and national and regional government.
- Given that all municipalities in Latin America and in developing countries are faced to a greater or lesser extent with the scarcity of resources and only relative response capability to the growing demands for local services capable of preventing natural resource deterioration and able to preserve the environment, the experience of the Talcahuano Strategy is relevant, and, for the same reasons, widely replicable. For these reasons, it is very important to disseminate this case in Latin America, as the capacity demonstrated by the Talcahuano Municipality in obtaining the co-operation of national and regional governments, that of the private sector, and the ability to manage funds and resources additional to those of the squalid municipal budget proved fundamental, as all local governments in the continent manifest an incapacity to answer to the demands of their own communities with their on local budgets.

Importance of the Case for Integrated Water Resource Management (IWRM)

Its main importance is that it is an example at a local scale (municipal level) *of integrated management of water resources*, namely:

a. ***Integral Approach to the Resource,*** is important for answering the consumption and usage needs of all sectors of society, both productively speaking (industries, residential, institutional, small-scale fishermen, visitors) as well as

in the social context (different economical strata, health and sanitation demands, etc) and environmental (preservation of the resource, protection of biodiversity, risk protection, etc).

b. ***Sustainable Management*** of the water resource, aware of the need to ensure continuity for the benefit of future generations.
c. ***Acknowledgement that water is a valuable resource*** and that this value must be reflected in the way that it is used.
d. ***Participative approach*** for water management, involving interested partners ("stakeholders") to ensure fairness as well as efficiency in water use.

Instruments Used

A1.2 Water resource usage policies;
A3.1 Investment policies;
A3.3 Role of the private sector;
C1.4 Development of indicators for water resource management;
C4.5 Dissemination and Educational Campaigns;
C5.3 Consensus building;
C6.4 Land Use Control;
C7.2 Fines for polluting

Key Words

Integration in the management of resources (water, air, soil) – *bottom-upwards* approach to local management – *Modest* resources – *Long range* vision – Public-private *agreement* / negotiation – *Accountability* of contaminating agents - *Participation.*

B. MAIN TEXT

B.1. Problems that led to the creation of an Integral Strategy for Talcahuano Water Resources

Talcahuano is one of the nine municipalities within the Province of Concepción[1], capital of the Bío-Bío Region, located some 500 km to the south of Santiago, Chile. The Municipality was founded in 1764, evolving from its original role as a military station to that of a commercial and then a fishing port, to become around the middle of the 20th century, an important industrial and residential complex of the metropolitan area of Concepción. It comprises nowadays a port complex consisting of five terminals[2]; an industrial area consisting of close to 800 companies, including the Huachipato Steelworks, large petrochemical, fishing and industrial plants and a naval complex, housing the most important operational base, shipyard and naval dockyard of the Chilean Navy. The territory of Talcahuano is a peninsula over the Pacific, limiting to the south with the Bío-Bío River and to the northeast with the Andalién River. It contains two port roads, San Vicente and Talcahuano, as well as numerous lagoons, canals, marshes and wetlands.
Bays are in general systems prone to contamination and to natural changes due to the dynamics of their currents (this being a function of the amount of time their waters remain within the bay area) and because they attract multiple uses: port, transport, fishing, recreation, industry, residential, tourism, etc. In the case of Talcahuano, the coexistence of active urban and industrial areas within a surface area broken with abundant bodies of water and of only 142.8 km2, have made the city specially sensible to the degradation of their natural resources and deterioration of their surroundings, leading to critical levels in the last decades, giving rise to the municipal strategy initiated in 1993 and subject of the current Case Study. As pointed out by Municipal sources, what was at stake was "the deterioration in the quality of life and the contamination of natural resources as well as image of the city and even that of the products manufactured within the municipality". These negative factors were determinant and decisive in the design of a plan that was to commit and integrate all players; be they the problem generators, impact recipients or solution administrators.

Two stages were distinguished in the process of environmental degradation of Talcahuano:

◦ *1950 to 1970: Development of a Steel and Petrochemical Industrial Centre*.

The environmental problems of Talcahuano started in 1950 with the operational start of the Huachipato Steelworks, located in the area in order to make use of its port and railroad infrastructure, its coal and water resources, and to ensure the reactivation of the area after the devastating 1939 earthquake. In the following two decades the area consolidated itself as an important industrial centre at national level, with an accelerated demographic growth rate ranging from 17% between 1952 and 1960 and 20% from 1960 to 1970. The speed of the process and poverty of the Municipality could not make the infrastructure and urban services match increased demand, and the municipality was settled by blue collar workers and their families, while white collar workers chose the neighbouring municipality of Concepción. Meanwhile, industrial income was diverted towards Santiago, which strengthened its concentrating role. During this phase the environmental impact of industrial and urban development was compounded by deficiencies in cleaning and health services arising from the accumulation of solid waste, uncontrolled discharges of liquid residue to bays and river beds and the emission of noxious gases into the air. Palliative measures had scarce effects, in some cases making things worse, as was the case with the installation of a cement works, the intention was to make use of the slagheap from the steel works, yet additional noxious gases and particulate material was produced.

- *1970 to 1993: Consolidation of the Industrial Centre and Growth of the Fishing Export Sector*.

Although the opening up of the Chilean economy to international markets in 1975 meant the shut down of the countries import substitution industries, the large metal and chemical industries of Talcahuano remained active, even

(1)In Chile the term Comuna refers to the territory governed by a Municipality. Commonly both terms are used indistinctly. Talcahuano, with a population of 281.647 inhabitants as at 1999 (according to INE statistics) is one of the 8 municipalities (comuna) which comprise the Greater Concepción or Metropolitan Area, a conurbation with 834.028 inhabitants in 1999 (according to Sectra, Greater Concepción Transport Study, of Source and Target Destination Survey). The municipalities being Tomé, Penco, Talcahuano, Concepción, San Pedro, Chiguayante, Hualqui, Coronel, Lota. Administratively speaking, Talcahuano is one of the 9 municipalities that make up the Province of Concepción which, together with the Provinces of Ñuble, Bío-Bío and Arauco make up Region VIII of the country, also called the Bío-Bío region

(2) Includes: a) Empresa Portuaria San Vicente - Talcahuano (State company, successor to Empresa Portuaria de Chile, with the terminal operated by private companies); b) Port of the Compañía de Aceros del Pacífico, Molo 500 - Talcahuano and Oxiquim Compañía Chilena de Petroleos (private parties having public use); and c) San Vicente Port Terminal (private).

attracting new business. From the eighties onwards this trend was strengthened with the increase in the number of industries located in the fishing and derivatives sector, reaching a total of 22 active plants for fishmeal, canning and frozen foods, meaning direct employment for over 3000 people. When Chile became the first producer of fishmeal in the world, 60% of this was generated in Talcahuano. The nineties saw a fall in growth, both due to external and to local factors. Among the local causes was the insufficient port infrastructure and the inability of companies to give the existing ones a rational use, taking into account the fact they had to share them with small-scale fishermen. Additionally, the proliferation of workshops, sawmills, gas generators and supporting industries contributed to making the process more inefficient, as well as contributing towards environmental deterioration. These reached critical point as of 1990, when the first efforts for recovery were carried out by the Municipality of Talcahuano. These efforts were given a further sense of urgency as a consequence of the fire in the San Vicente Bay in March 6th, 1993, widely seen as aggravated by the high levels of contamination by fuels the waters had.

- *Deterioration of the Water Resources in Existence in 1933 and Associated Environmental Problems.*

Studies carried out in 1993 by the Municipality of Talcahuano, the National Environmental Commission (Conama), and other units of the regional and national government, together with Universities and other local entities allowed gaining a greater understanding regarding the deterioration of water resources and other associated environmental problems before the design and application of the recovery strategy.

- *Contamination of Water Resources*

The bodies of water of Talcahuano identified by the above mentioned studies include: the Talcahuano Bay with a surface area of 167.4 Km^2, a volume of approximately 3,09 x 10^9 m^3 and an average depth of 18.5 m; the San Vicente Bay, having 17.5 Km^2 and a volume of 260.5 x 10^6 m^3; the El Morro Canal, which mixes sea, river and rain waters, 2.88 Km in length and a volume of 450.000 m^3, the Bío-Bío and Andalién rivers, and the Lagoons Price, Macera and Verde. Regarding the source of contamination, the following were identified:

- Sea waters: San Vicente and Talcahuano Bays: from the cleaning and maintenance of ships and launches; industrial and urban liquid residue eliminated via rainwater channels and the sewage system, leading to outlets which emit directly at sea.
- Continental waters: Bío-Bío River; outlets connected directly to the river, sewage system and rainwater channels. Andalién River; sewage system and rain water channels used for discharge of liquid residue. Price, Verde and Macera Lagoons; rainwater channels used for the discharge of liquid residue.

Regarding contamination impact, four main impacts were identified: 1. Water contamination, posing human health risks and death to fishes and mollusc; in 1987, 80% of bivalves in the Talcahuano Bay area died, depriving inhabitants from an important food source. 2. Emission of foul smelling gases, arising from the decomposition of organic residue from the fishing industry, with a potentially harmful effect on human health. 3. Sedimentation. 4. Visual contamination.

The estimates made by the Municipality of Talcahuano regarding the contamination of the bodies of water most affected were the following:

- ***San Vicente Bay*.** 26 outlets spilled 267,621 m3 / day of liquid residue, both industrial and domestic in source, organic and inorganic in nature. 51% came from the steelworks, 35% from the fisheries, 7% from petrochemicals, chemical and metal working industries and 7% from urban areas. Added to this was an indeterminate amount of hydrocarbon and oil residues from the ships operating in the bay. The effects of the wind and currents prevented the dispersion further out to sea of the organic discharges, accumulating in the bay floor area next to the port, in an area equivalent to 18% of the total surface area. Due to their particular characteristics and their discharge further out to sea, the chemical parameters for hydrocarbons, phenols and metals had a greater dispersion rate in the bay, without reaching high concentrations in water column measurements; there were also seasonal variations in response to the physical-organic characteristics of the bay, although the levels found in marine animals indicated important bio-accumulation rates.
- ***Bío-Bío River*.** The river received a daily discharge of 230,000 m3 per day from the Petrox Refinery, plus 7,000 m3 per day from four urban outlets, one of which contained residues from various industries, such as gas, bottling and electrochemical.
- ***Talcahuano Bay***. In capture periods, the fish processing plants discharged into the bay 79,738 m3 per day of residue, added to which are the 2,000 m3 per day of sewage waters from the Naval Base and Asmar Shipyard, plus indeterminate amounts contributed by shipping activity. A greater impact was generated by the discharge of two

urban drainage plants, one into the Talcahuano port, located right next to the centre of town, and the other adjacent to the south, where fishmeal also discharges.

- *Associated Environmental Problems.*

The contamination of water, soil and air resources are closely linked, as they are generally due to the same agents, be they companies or citizens. They have combined effects, as is the case of water contamination which emits noxious gases into the atmosphere, and associated sources, as is the case with run-off from rubbish dumps which contaminate waterways that run into the sea or air from emanations and particles that are then deposited into the sea. Their solution lies in related regulation and similar funding sources, due to this fact, the studies undertaken by the municipality were integral in nature, identifying different environmental problems associated to water contamination. Among the most important were the following:

- ***Management of Solid Residue and Rainwater Evacuation***. There weren't any studies at the start of the strategy that fully measured their source and impact, although the symptoms were evident: in 1992 residential and commercial activity generated a total of 4.500 tonnes per month, accumulated in the Talcahuano Rubbish Dump without discerning their contaminant nature. The same situation held true for industrial wastes, whose volume was unknown, nor of the waste that had accumulated in their own grounds. Many other unauthorised rubbish dumps existed in undeveloped land or in public highways, testament to the lack of environmental awareness and education of the population. Regarding the evacuation of rain water, its deficient nature constituted one of the most serious problems for the Municipality of Talcahuano, giving rise to an important portion of water contamination and which drastically limited the capacity for geographical expansion and the rational build-up of density in the city.
- ***Atmospheric contamination, Noise and Other Urban Problems***. The full picture of the atmospheric contaminants of the municipality was lacking, only having partial information regarding its contamination with sulphuric acid, amines, carbon monoxide, photochemical oxidants, hydrocarbons and suspended particulate matter of an unknown composition. Foul smelling emanations from bay waters had been detected, close to urban and fish processing drainage, who also used contaminated water for their cooling processes. In total, some 40 industrial plants (fishing, chemical, petrochemical, steel, metal, food and others), as well as commercial and service ones, contaminated the air through 106 chimneys or though direct gaseous or particulate emanation from their operations, specially fishmeal, and from the storage of raw materials and fuels and the drying of resinous and plastic products. Due to the geographic conditions and wind direction, most of these emanations affected residential areas, these being in close proximity with industrial locations. Also, industries did not have the appropriate technology for living in close proximity with residential areas. The authorities, on their part, lacked any emission standards, added to the insufficient human and technological resources the environmental health services had at their disposal for control. Most of the industries had not gone through an integral environmental management scheme for reducing air, water, and soil contamination. Regarding noise contamination, without there being rigorous measurements, there were areas detected that were exposed to high levels of bothersome and persistent noise emanating from industrial works located adjacent to residential areas, as well as public transit and freight circulating through residential areas. Linked to the noise problems there were also serious deficiencies in the transport system, arising from the operations required by the most important port, industrial and naval complex of the country and using an inappropriate road and rail infrastructure, thus generating serious congestion in key city points. Finally, there was urban deterioration due to the congestion caused by freight and public transport, seen both in the road system as in the train lines crossing the city, and the extension of the urban periphery for accommodating a population which from 153 thousand inhabitants in 1972 grew to 207 thousand in 1982 and 249 thousand in 1992, mostly low income and installed precariously in unhealthy places prone to flooding and located in steep slopes, inaccessible and susceptible to landslides, lacking water and sewage services. This situation was mirrored by the deterioration in the centre of Talcahuano and the lack of any real motivation and incentives for making its renovation profitable, attenuating the need to expand the City periphery.
- ***Natural and Man made risks.*** It must also be born in mind that the Municipality of Talcahuano has always been exposed to several types of natural risks, the main ones being flooding, landslides, risk of tsunami and hurricane force winds. This is related to local characteristics such as soil permeability, slopes, the presence of old river beds, depressions, escarpments, the closeness of large rivers, an open maritime front, the existence of geological faults and fractures, among others. Added to this is the exposure posed by man-made risks, the main ones being related to the fact that populated areas are adjacent to productive areas (where one may find storage tanks containing fuels, oil pipelines, high tension wires and the transport of dangerous substances) and to the insecurity and accidents caused by deficiencies in the road and rail structure.

- ***Degradation of Natural Ecosystems***. The municipality has an interesting variety of natural systems, consisting of hilly areas with native forest, coastal cliffs, rocky and sandy beaches, marshlands and wetlands. With urban and industrial growth, these have been inadequately intervened and degraded: water contamination and intensive fishing were depleting bentonic resources; the wetlands of Rocuant and Lenga (protected as a Sanctuary of Nature) have also been intervened, due to the accumulation of organic residue within them and thus being filled up. These wetlands are way stations for migratory birds, concentrating an important level of biodiversity within them, having the potential for controlled recreational use. Lastly, the hills of the municipality have been losing their original vegetation cover due to erosion or replacement with exotic vegetation.

B.2. Actions Undertaken

• *Actions, Decisions, Plans and Instruments*

According to the Environmental Directorate of the Municipality, recovery work in the area of Talcahuano started out towards the end of 1990, undergoing a major boost as a result of the alarm generated by the fire in the San Vicente Bay in March of that same year and planned in 1995. The deterioration in the quality of life of its inhabitants, the contamination of water, air and soil and the image of it being one of the most contaminated municipalities in Chile harboured in the municipal authorities the commitment to start on a recovery strategy, starting out with those problems which, being the most serious, allowed for a speedy solution. This manifestation was given credibility by the community and businesses, allowing for the design of participative strategy under community leadership, having a shared view of development; "Talcahuano, balanced city, opportunity for all", to be started in 1995 with the execution of the three instruments for which there was funds for: The Strategic Plan, the Development Plan and the Municipal Regulator Plan. The key element achieved through participation was that each resource user be held accountable for the sustainable management of the resource; applicable to national and regional government, business, the community and the Municipal Government itself. The municipality also took on the responsibility of seeking a balance between the different interest at play, such as economic development, the protection of natural resources and the quality of life of people living in the municipality. Under these criteria, the Municipality undertook to initiate the following actions.

a. Territorial and environmental regulation of the municipality, with community participation, through a new Regulation Plan, financed by the Municipality and with national government contributions.
b. Plans for Improving the Quality of Water, Air and Soil resources, with industrial finance.
c. Plan for Integral Sanitation of all municipal sectors, funded by the Municipality.
d. Integral clean-up plan for all municipal areas, funded by the Municipality.
e. Urban Solid Residue Integral Management Plan, funded by the Municipality.
f. Training and Awareness raising program, funded by the Municipality.
g. Permanent Supervision plan and Regulation Application, in accordance to impact severity, technically demonstrated through monitoring, funded by the Municipality and Public Services.

• *Aims, Organisation, Leadership: The Municipal Environmental Commission of Talcahuano*

The targets set for the recovery of water resources were the following:
1994-2000 : recovery of the San Vicente Bay, Talcahuano Bay and El Morro Canal, requiring the decrease of liquid industrial residue emissions to the standards agreed with industrial fisheries. 1991 - 2000: eliminate foul smelling gaseous emissions, both from waters of the Bay area as from waters from industrial and residential areas. 1996 – without end date: training of environmental monitors and providing environmental training to professionals from health centres and teachers
The targets for related environmental actions were the following:
1991 - 1996 : eliminate emissions from fishing industries having direct drying. 1995 - 2000 : reduce emissions of sulphurous anhydride, starting from the areas where regulations are surpassed. 1995 - 2001 : reduce particulate material emissions from the main point and diffuse sources. 1996 - 1999 : eliminate the 42 small-scale clandestine landfills in the municipality. 1996 - 2000 : to clear the municipality of rats. 2000 - 2003 : regulate and control the canine population of the municipality. 1996 - 2002 : integral management of urban solid residue with selective recollection.
Up until the end of 1989, the Municipality did not significantly intervene in environmental control. In 1990, within the guidelines of the democratic government inaugurated that year, the Mayor appointed the serving Environment Director and made use of the powers the Organic Municipal Law confers on the Mayor for co-ordinating the different municipal services, making up the *Environment Commission*, with the participation of Municipal staff, Municipal

Institutions (such as the Maritime Government, the Health Service, the Police Prefecture and the Municipal Union of Neighbourhood Boards) and Regional (such as the Fisheries Regional Direction, Sanitation Company and the Regional Environmental Commission – Corema). Within this commission the invitation was made to participate in the governing boards of sectorial social organisations in accordance to their interest. The Presidency of the Commission was left in the hands of the Mayor and the function of Executive Secretary was given to the Environment Director of the Municipality. The participation of each of the different levels that make up the city in the resolution of environmental problems was determined by the principle that states, "Environmental contamination is everyone's problem" and the principle of "exerting democracy". Therefore, for each environmental problem those that generated the problem, those that received the impact and those that administered the treatment and solution (control and supervision) were invited.

The leadership undertaken by the Mayor and the Environmental Direction of the Municipality was fundamental in the development of the recovery process, as the Municipality is the public institutions that has the most coverage in the local area, helps out in the organisation of the different social groups, its the one that receives most of the complaints and administratively speaking, it has the legal authority to co-ordinate all the city public services. These conditions were the most relevant for achieving participation, harnessing concerns and search for solutions. The permanent collaboration and technical capacity of the Environment Direction provoked, motivated and provided impetus to the other public services in maintaining an active stance regarding their environmental responsibility.

- *Methods and Information Used*

The planning and management methodology of the Integral Strategy for the Recovery of Talcahuano Water Resources consisted in a sequence of numerous steps[3]:

- Identification of the problems experienced by the community.
- Recompilation of information and studies regarding environmental contamination (universities and other sources), plus information gathered from inspection visits to the sources of contamination.
- Analysis and determination of the contribution each activities has in the most relevant impacts.
- Co-ordination of the public services having environmental attributes
- Meetings where the problems were exposed and analysed with the public services and community leaders. Tripartite meetings carried out in order to analyse problems and search for solutions to the impacts: Public service, community and businesses met to determine causes, those affected and those responsible for problem solving, highlighting the positive advantages, in terms of image, saving made and improvements in quality of life for workers and community dwellers.
- Meetings to asses strategy progress.
- Seminars with specialists invited to strengthen technical capacities and the ability to interact with businesses. Winning the respect of business due to the technical capacity of municipal staff and not from the power that they may have, demonstrating the reason why for each problem, and pointing towards solutions.
- Sessions aiming to develop an inclination towards community service and an ethical, transparent and no-nonsense stance in each action implemented.
- Structural changes and strengthening of public services, aiming for greater co-operation and efficiency.
- Strengthening of the technological capacity of the Municipal Environmental Direction and other Public Services through the purchase of measurement instruments and equipment for carrying out permanent monitoring, or through joint work with the Universities.
- Looking into and verifying each complaint made and looking for integral solutions to the most recurrent complaints.

B.3. Results of the Municipal Strategy: Qualitative and Quantitative Reach of the Goals Quantitative and Qualitative Scope of Objectives

(3)The Talcahuano Environment Director summarises recovery programme working methods using the following steps and instruments: a) Technical breakdown of the contamination and the contribution each industry makes towards contamination, b) Agreements with each industry; c) For large industries with multiple impacts, tripartite commissions were formed which included the affected community, the industry and the municipality involved, d) short to mid term recovery or mitigation programs. In cases of non agreement, the Urban and Building Law was used, which allow for industry transfer and/or closure, e) In the case of small-scale impacts or damages, immediate reparations were applied, otherwise fines were imposed. (Letter from Eng. J.G. Rivera to J. Valenzuela), October 2002.

The results of the actions undertaken by the Municipality of Talcahuano are ordered according to the terms defined in Annex 3 of the Terms of Reference of the Case Study (Structure of the GWT Toolbox), in the part relating to Management Instruments, having been grouped together in Studies/Plans and Instruments ([4]). In accordance to the integral management approach of the Talcahuano Municipality for the Recovery of Water Resources, also included are the results of the other concurrent environmental management actions regarding solid residue, atmospheric decontamination and others**.**

- *First Results: Implementation of Baseline Studies and Plans*

A first step in the strategy used by the Municipality was to carry out or use existing studies in order to define an appropriate environmental policy, such studies included; geomorphologic and demographic studies, the environmental situation and territorial risks, water supply for residential and industrial uses, sewage water disposal, rain water disposal and road and transport structure. Due to lack of resources, the municipality made use of the planning instrument that by law Governments must carry out, including them in their own designs, namely; the Regulator Plan, the Development and Investments Plan and the Strategic Plan. The *Strategic Development Plan* was designed under an integral sustainability approach, which included the protection of the environment and local resources, developed in conjunction with Regional Government and its own Development Strategy for the Bío-Bío Region. Thus allowing for the integration of the community, businesses and institutions under a shared vision of the economic and social future in the mid to long term of the municipality, under the slogan "Talcahuano, port city integrated with the sea and its natural and historical values, in harmony with its varied and contrasting activities, destined to be the main port of the South Pacific". The *Municipal Development Plan* became a guiding instrument for those in charge of administration, investors and other players interested in local development. It set down zoning guidelines and as such it was useful for, in conjunction with the Strategic Plan, in guiding the *Municipal Regulator Plan.* The latter one set the guiding lines for land use in order to lay down criteria for the location of productive activity and residential areas. Given the prior diagnosis that environmental deterioration was in part due to the indiscriminate location of incompatible activities([5]), the Regulator Plan was assigned a fundamental role in the long term environmental recovery strategy, although it did begin with mitigation measures, as indicated further below.

- *Results obtained from Plans, Projects and Actions Aiming to Recover Water Resources*

The Municipality carried out co-ordination strategy, the various Municipal Directions were called on for the implementation of an effective environmental action, within which is found the recovery of water resources. These resources and the main sources of contamination are: a) Sea waters: Talcahuano Bay, having a surface area of 167.4 Km^2, an approximate volume of 3.09 x 10^9 m^3 and an average depth of 18.5 m; San Vicente Bay, 17.5 Km^2, volume 260.5 x 10^6 m^3; the El Morro Canal, containing sea, river and rain water, having 2.88 Km in length and a volume of 450.000 m^3. The contamination of seawaters comes mainly from the cleaning activities performed on ships and launches, liquid industrial residues eliminated into rain water channels, the sewage system and the outlets that discharge directly into the sea. b) Rivers: the Bío-Bío and the Andalién rivers: Contamination from outlets that emit

([4])Results presentation scheme according to Annex 3 of the Case Study Terms of Reference (Structure of the GWT ToolBox)

	MANAGEMENT AREAS OF THE TALCAHUANO MUNICIPALITY: Water resources and associated environment problems	RESULTS ACCORDING TO TYPES OF MANAGEMENT INSTRUMENTS							
		STUDIES AND PLANS		INSTRUMENTS					
				Demand Management			Regulations	Instruments	Information.
		C.1. Studies	C.2. Plans	C.3. Better Demand	C.4. Education	C.5. Conflict Solving	C.6. Regulation	C.7. Economic Instruments	C.8. Information
1.	Water Resources								
2.1.	Solid Residue								
2.2.	Air and Noise								
2.3.	Others								

([5])This diagnosis has been confirmed by environmental conflicts researchers in Chile, see Francisco Sabatini and others, Conflictos Ambientales entre la Globalización y la Sociedad Civil (Environmental Conflicts between Globalisation and Civil Society), Publicaciones Cipma, Santiago, 1997. The main problem is no longer that of deficient production or management techniques, as they have undergone significant improvements in the last few years so as to fall in line with the international standards set for each case, but rather in conflicts arising from the location of these productive activities. An important responsibility is attributable to the deficiencies or non-existing official regulations regarding zoning, regulation plans, etc. (observation forwarded by Guillermo Geisse, President of Cipma).

directly into the sewage network and rain water channels. c) Lagoons: Price, Macera, Verde: Contamination from outlets that emit directly into rain water channels. The main impact the contamination of these waters has is the death of fish and molluscs and the emission of foul smelling gases (these being the result of the decompositions of organic matter content - specially from the fishing industry), high sedimentation rate and visual contamination. The results were as follows:

° ***Control of Residues from the Fishing Industry***: The project "Sample and analysis of liquid industrial residue carried out on the Talcahuano area fishing industry in order to determine the contaminant load emitted. (1991-1992), conducted by the Municipality ([6]), and which set the first parameters for controlling water contamination by the fishing industry. It was carried out as a contribution to the General Marine Territory Direction, legally responsible for the seawater resource. It was applied after an agreement signed on February 11th, 1994 with the Associations of Fishing Industrialists. It stated that all fishing industries and fishmeal processors of the municipality should submit themselves to monitoring and qualifications in accordance to the following liquid industrial residue emissions standards.

Temperature: < / = 30 C°; pH: > / = 6 y < / = 9	Oils and grease (Kg/TP)	*DQO (KgO2/TP)	Suspended solids (Kg/TP)
Maximum points	1,4	9,1	3,6
Monthly average	0,9	6,0	1,5

The sanction given out to the industries failing to comply with that stipulated and agreed upon in the Agreement with Fishing Industrialists, consisted in that after each round of monitoring (three monitoring events to be carried out randomly every four months) a list was to be drawn up ranking the industries according to their level of water contamination, to be published in newspapers having the largest circulation in the region ("**public sanction**"). The effectiveness of this measure is demonstrated in the following table, indicating the decrease in the amounts of contamination emitted, as measured by the DQO parameter (KgO_2/h), average per Fishing Industry emitted to the San Vicente and Talcahuano bays

Bay	DQO (KgO_2/h)		
	Diagnosis per year 1991 - 1992	Average yearly monitoring 1995 - 2000	
		Reduction	(%)
San Vicente	985,5	424,7	56,9 %
Talcahuano	618,9	227,0	63,3

° ***Liquid Industrial Residue*.** The Agreement of 1994 with the Association of Fishing Industrialists was recently strengthened by the Agreement with the Maritime Government of Talcahuano, of March 1999. After monitoring carried out by the Environment Direction of Talcahuano Municipality and by the Maritime Government, the latter institution decided to eliminate from a sector of the Talcahuano Bay, called La Poza, any liquid industrial residue resulting from the unloading of fish.

° ***Clandestine Discharge in Rain Water Channels.*** The project called "Clandestine Discharge of Residual Waters into the Rain Water Channel System: Assessment and Solutions" led to increasing the network sewage waters in residential areas which used rainwater channelling for discharging sewage.

° ***Industrial Treatment Plants*.** Starting from 1992 it was required that treatment plants be installed in industries that untreated eliminated residual waters into the rainwater channelling system or into the sewage system. This was carried out in 1992 for a canning plant and a fishmeal and canning plant, in 1995 for a frozen sea produce plant, a steelworks in 1997 and a soap plant in 1999.

° ***Clean up of Lenga Canal***. In 1995 the company Oxy-Chile was required to clean up the channel due to the mercury content present in its sediments. This meant the cleaning of a stretch of 2.5 km of canal and to dispose of it in the first landfill site in Chile to have all its environmental controls operational.

- *Results of Associated Environmental Actions.*

([6])The project was carried out by Juan Guillermo Rivera, Environment Director of the Talcahuano Municipality.
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As previously indicated, acknowledging the close link existing between the contamination of water soil and air resources, the Municipality in parallel to the recovery of water resources, initiated other environmental management measures, namely:

- *Solid Waste Management:* These were (a). Management and disposal plan for solid industrial residues, including an agreement with large companies for the creation of a dangerous substances and residues treatment resource. (b). Agreement by industry to clean and maintain rainwater channels within or adjacent to their sites. (c). Control of residue emission of transport companies through permanent inspection and notification. (d). Elimination of 42 small-scale clandestine rubbish dumps, through clean-up and fence building by the Municipality, educational campaign and fines to re-offenders. (e). Integral management plan of urban solid residue, with selective separation of residue (glass, tyres, batteries and aluminium cans) started in 1996 by the Municipality through the Gardens and Hygiene Directorate, including community education, installations of containers, regular withdrawal of residue, payment for delivery (batteries) and sending off to recycling plants. The plan reduced in 900 tonnes the volume of urban residue in 2000 with respect to 1999.
- ***Acoustic and Atmospheric Decontamination*** (a). Plan and commitment to implement indirect drying techniques so as to decrease gaseous emission, particulate material and smells by the fishing industry, 7 large companies signed on between 1991 and 1996. (b). Plan and commitment by the fishing companies with the Talcahuano Health Service to suppress the burning of non-condensing gases and the processing of material undergoing decomposition, all companies signed in on 1997. (c). Project by the Municipality, Petrox company and the Swedish agency BITS for the suppression of sulphurous anhydride emissions and nitrogen dioxide, including a study and detailed monitoring between 1993 and 1995 of the emissions exceeding the regulations set by the Mining Ministry. Emission mitigation plan with fuel change, treatment plants for large-scale sources (with a 60% reduction target for the year 2002) and increasing chimney height in small companies. (d). Mitigation plan in the emission of particulate emission, requiring the installation of filters and the closure of high risk plants. (e) Plan for the elimination of foul smelling gaseous emissions from the El Morro canal, started by the Environment Direction of the Municipality in January of 2000, controlling the emissions of the fishing industry, reducing to practically zero the sulphuric acid dissolved in water as of June of that year ([7]). (f). Decontamination plan in association with the regional office of Conama, starting with the preparation of a noise map, then a noise monitoring and control plan started in 1997 by the municipal health service.
- ***Other Environmental Actions*****.** (a)**.** Integral and by sector environmental clean-up plan and campaign, 1997. (b). Municipal rat control program, 1996 - 2000. (c). Mosquito control program 1993 - 2001. (d). Registration of canine population, 1999-2001. (e). Dangerous substance management and transport plan and campaign, 1997. (f). Environmental education and consultant work for municipal social organisations**. (**g). Tree planting program, with 1300 trees distributed annually to neighbourhood organisations, in conjunctions with the School of Forestry Engineers of the Universidad de Concepción.

- *Main Problems Encountered, their solutions or if still a problem.*

The main problems faced by the water resources recovery strategy of the Talcahuano Municipality were a combination of three factors:

a. The intrinsic environmental fragility of the territory, due to its small size, its intensive use by conflicting land uses (industry v residential, environmental protection zones, tourism, etc.) and by the highly contaminant nature and intensive use of the water resource for several critical productive processes (steel, petrochemical, metal, fishing etc).

b. Powerful economic and institutional interests that support contaminating activities. In the case of steel and petrochemical industries, the strong national government support its companies enjoyed in the beginning, and then, after the economic opening, the strong institutional support given to private companies, then extended to foreign investments aimed at the fishing industry. The fact that the industries of the area were a significant pillar in the success of the economic model strengthened even more the vested interests and the tendency to ignore its negative effects on the environment. A special case was that of the shipyard, port works and other navy installations, to which national security interests were added.

c. The lack of resources and capacity of the Municipal Government in applying controlling measures against the deterioration of water and other resources.

([7]) See Annex 2.

The related effect of these three factors was that more than 40 years went by without adequate measures being taken to lessen the contamination of water resources, nor in lessening the longevity of these effects.
Factor **a** is geographic in nature and therefore a constant threat, up until today, although in the mid to long term its effects are being mitigated through a more rational organisation of land use within the territory, through the Regulator Plan and similar measures, and also due to the effect of the various contamination controlling measures adopted, part of the current Case Study.
Problem **b** is structural in nature and its severity is accentuated in times of economic boom, making them specially hard to address. However, the Municipality has had significant success in controlling these vested interests though the use of a strategy of harmonisation and skilful negotiation with the private sector, supported by a campaign of ample community participation for its application.
Finally, problem **c** has been mitigated through associating private funds with those of national and regional government for the applications of environmental recovery measures, or the efficient and imaginative use of other resources (as is the case of the studies employed for the Regulator plan, as previously mentioned). Regarding the intrinsic weakness of municipal political power when dealing with national or regional interests, in this case it seemed to have acted in favour of the strategy. In effect, prior to the municipal action started in 1990, the strength of official national support to the industry and the powerful private interest at play was what neutralised the weak efforts at intervention by the national or regional institutions involved, as was the case with Conama and the Maritime Territory Directorate, whose orders where "top down" in nature. However, the municipality, supported "bottom upwards" could, with a harmonising and negotiating strategy, put forward solution alternatives that were then supported by these institutions. For example, once the Integral Municipal Strategy was started in 1990, and due to successes involved, the regional Conama created the Talcahuano Environmental Recovery Plan (PRAT), started in 1995 and whose first phase ended in 1996, part of whose resources were administered by the Municipality. After this, Conama has kept some of these activities. ([8])
Something to consider when assessing these results is the fact that, according to some of the industrialists interviewed, the application of industrial contamination control measures, at least in the case of the fisheries, has been made easier by the decrease in activities experienced towards the end of the nineties, as the pressure to oppose any control that may decrease profits, cause delays or pose barriers in the short term is much lessened in times of economic downturn.

- *Impact on Regulations, Institutions, Agreements with Private Parties, Regional or National Politics*

The results obtained by the Municipal strategy, specifically in the creation of instruments and the control of water contamination, and on environmental deterioration in general, have been positive. The territory affected by the municipal strategy is important both within the Bío-Bío region and within the country as a whole, regarding population, industry, institutions, the environment and tourism. The wider impact of the strategy has also been significant at the regional and national level, namely:

° Regarding institutional strengthening, it created the first Municipal Environment commission of the country, a permanent institution to date, 12 years after being created, being an example to other similar institutions in other municipalities of the country (such as in Valparaíso, Coronel and Valdivia).

([8])The following is the information contributed with respect to the relationship between the PRAT programme and the Municipal Strategy, kindly contributed for this Case Study by the Environment Director of Talcahuano Municipality:
1) The funding of the PRAT program referred to in CONAMA documents are shared with industry and the Municipality.
2) The Municipality started the Municipal Recovery Plan in 1991. The PRAT program started in 1995 and lasted up until December 1996, together with the first industry pledges. Then it continued only with those whose solution was pending.
3) The Municipality surpassed the PRAT programme in several aspects, amongst which: a) the integral management of urban solid residue, not considered in Prat, b) the monitoring of particulate material in the air, where the Municipality determined not only its existence but also its composition and effects in the health of the population, c) citizen's participation, lasting to the present day, where environmental awareness building meetings were carried out in Parent and Guardian Meetings in the different schools and churches of the area, d) the formation of tripartite commissions between the community, industry and the Municipality.
4) The recovery of El Morro Canal, which was hoped to be a part of the projects ascribed to the Public Works Ministry, yet was recovered through a Municipal project towards the end of 2002, while the public works project was started out only in January 2002.
In general it can be said that the success and the progress made by the municipal recovery initiative endorsed the PRAT project, while it lasted.
Source:
Letter from Eng. JG River, Environment Director of the Talcahuano Municipality to Jaime Valenzuela (October 2002).

- Regarding its influence in national and regional politics, it drew the co-operation of the guiding institution regarding environmental management in the country, the National Environment Commission, Conama, who together with the Municipal Strategy organised the Talcahuano Environment Recovery Plan (PRAT), which has allowed the channelling of important national, private and international funds into similar solutions around the country.
- Regarding regulations, it developed the first water contamination control parameter modelling for the fishing industry of the country, and the first agreement model with private companies for implementing these controls (1994).

- *Strategy Sustainability and Continuity: Strengths and Weaknesses*
- It was previously mentioned (see section "Problems Found") it has been deemed an important strength that the Strategy be lodged at Municipal level and from here it has been able to obtain citizen and company support, leveraging this to obtain regional and national support. This kind of negotiating capacity has been going for 12 years and has been materialised in resources, institutional support and positive results in environmental control, thus ensuring the *future sustainability* of the Strategy.
- Reference was also made to the capacity the strategy had of facing its problems and weaknesses and turning them into strengths (lack of institutional power, scarce resources, low technical capacity), specially the capacity to administer regional and private resources to solve problems having priority on an agenda that was drawn up in conjunction with the community and for the common good.
- Regarding the concept of Strategy winners and losers, due to the fact that we are dealing with a concerted action having ample participation from the community, companies, the different levels of government and the Municipality, during a 12 year period, all society levels have seen benefit from the strategy. The Municipal Environment Commission, which gathers all of these levels together, is emphatic in pointing out that the beneficiaries of municipal environmental recovery are its inhabitants, businesses and workers of the different productive activities, the city, the region and the country, and the environment in general.

- *Resources Used in the Actions Undertaken*

The resources contributed by the different partners of the Integral Strategy for the Recovery of Water Resources for Talcahuano have been the following for the period 1990 to the end of 2002 (in US dollars):

° Talcahuano Municipality	1.000.000
° Fishing companies	25.000.000
° Steel and metal works	10.000.000
° Companies from the Petrochemical complex	100.000.000

In accordance to the information supplied by the Environment Directorate of the Municipality, there are other investments originating from companies committed with the Environmental Recovery Plan for the municipality of Talcahuano (Prat), which have been co-ordinated by the Regional Conama as part of the plan, carried out in conjunction with the Municipal Integral Strategy. During the period 1995 to 1996, the Regional Conama Plan contributed 300.000 US dollars for studies (see footnote number 8).

B.4. Lessons Learnt

1. Suitability of the Municipal Level for Recovering Water Resources and Environmental Management.

The most important lesson the case analysed demonstrates, of great value for replicating the experience, is the fact that the municipal level is well suited for successfully undertaking water resource recovery and environmental management, even in apparently unfavourable circumstances, such as was case in Talcahuano, where the Municipality faced powerful agents of contamination. The experience analysed indicates that municipalities can achieve this through efficient, informed conduction using a strategy capable of achieving agreements of interests and to negotiate an efficient association between the community, private companies and the national and regional government. The factors that mostly influenced the achievement of these results were the following:

- Political and technical leadership from the Mayor and his Directors related to the problem of tackling environmental deterioration, meaning that the political authority must take charge of the problem and be responsible for its solution. The directors must give strong technical support to buttress the Mayor's decisions, decisions reached at through informed diagnosis, appropriate monitoring of problems and development of realistic solutions.
- Clear identification of the direct and indirect causes of water resource contamination and deterioration and the different factors involved, meaning the identification of variables to consider for problem solving and ensuring their sustainability in time, such as: improvements in education, infrastructure, technology, labour training, motivations of the players involved, application of sanctions and incentives etc. An important part of this lesson is the integral approach in the management of water resources, demonstrating that problems aren't point sources nor arising from isolated circumstances, but rather part of a system of deficient management on behalf of the contaminating agent.
- Realistic and participative diagnostic methodology, whose results was a full report that identified the 14 environmental problems that affected the municipality, indicating the causes of the problem according to their related spheres (water, air, etc.). The mere systematisation of this information activated in public institutions having controlling duties a series of co-ordinations and actions aimed at solving these problems. This participative approach regarding diagnosis reached out to the proposal stage, as both those affected and those causing the problem being present in the sector working committee lead to more realistic solutions that were applicable in the short to middle term.
- Definition of the different players or agents intervening in the problem. Amongst the players involved the following distinction is made: a) problem generators, b) impact receivers; and c) those responsible for administering problem management.
- Co-ordinated and negotiated action management by the different players involved, ranging from solution diagnosis and formulation to the setting in motion and evaluations of results.
- The will to respond and the commitment of the contaminating agents, industrialist in particular, to respect the commonly set requirements
- The efforts to ensure efficient action on behalf of the public services participating in the solution to environmental problems, in order to ensure credibility by the different parties involved: technically formulated diagnosis; reasoned and non-authoritarian interaction with the parties aiming to reach an appropriate agreement regarding its solution; fast implementation response; determination in the application of sanctions upon agreement non-compliance; and integrity in the solutions (considering the different aspects and interest involved).

Another relevant aspect in Municipal management is the 12 year continuity in the Strategy, largely due to the Environment Director remaining at his post for that length of time, having a high technical proficiency and contributing initiative and leadership to the process.

2. Turning Threats into Opportunities.

An important lesson emerging from the Case analysed is that disasters can be turned into opportunities. In fact, both the industrial and economic development of the area as well as the start of an initiative seeking to address the environmental problem arising out of this development had as its genesis some kind of disaster: the first arising from the location of the Talcahuano steel works, carried out in order to mitigate the effects of the earthquake of 1939; and the second out of the public support and awareness the issue acquired after the fire of 1993 in the bay area, which was made worse by fuel contamination. The necessary condition required for turning these events into opportunities is that there be a future vision that may allow to anticipate both negative as well as the positive results that change will bring. In the case of the installation of the steel works, unfortunately there were was no clear vision regarding the environmental fragility of the Talcahuano Municipal territory, only the advantages for operating the industry and the resultant economic progress, so there was none of the preventative measures take which may have avoided the resultant ecological disaster. In contrast, for the fire of 1993, a long range environmental and territorial zoning strategy was designed (Regulator Plan) which involved all of society and with institutional support in order to ensure its sustainability, accompanied with ecological mitigation measures of immediate applicability.

On a lesser scale, the lesser activity faced by the fishing industry towards the second half of the nineties allowed for a less problematic and fuller enforcement of environmental controls by the Municipality towards industry, allowing for a kind of "slow start-up" regarding system verification, which, becoming part of regulations, can be applied without hesitation in times of economic boom to any industrial activity.

3. Case Relevance in Other Contexts and Replication

Given that all municipalities in Latin America and in developing countries are faced to a greater or lesser extent with the scarcity of resources and only relative response capability to the growing demands for local services capable of preventing natural resource deterioration and able to preserve the environment, the experience of the Talcahuano Strategy is relevant, and, for the same reasons, widely replicable. For these reasons, it is very important to disseminate this case in Latin America, as the capacity demonstrated by the Talcahuano Municipality in obtaining the co-operation of national and regional governments, that of the private sector, and the ability to manage funds and resources additional to those of the squalid municipal budget proved fundamental, as all local governments in the continent manifest an incapacity to answer to the demands of their own communities with their on local budgets.

As previously indicated there are already replications of the strategy at the national level, namely: for buttressing local institutions for environmental management, as the initiative of a Municipal Environment Commission, which gathers all relevant stakeholders is already being adopted by other Municipalities. Also, its influence in national politics is already supported by the fact that the Talcahuano municipal initiative has been adopted by the national environment institution, Conama, this fact has motivated the channelling of national, private and international funds to similar solutions throughout the country, and finally, also replicable is the control parameter that modelled water contamination for contaminant industries, which was designed by the Talcahuano Municipality

4. Importance of the Case for Integrated Water Resource Management (IWRM)

Its main importance is that it is an example at a local scale (municipal level) *of integrated management of water resources*, namely:

e. ***Integral Approach to the Resource,*** is important for answering the consumption and usage needs of all sectors of society, both productively speaking (industries, residential, institutional, small-scale fishermen, visitors) as well as in the social context (different economical strata, health and sanitation demands, etc) and environmental (preservation of the resource, protection of biodiversity, risk protection, etc). Also highlighted is the integral approach in the strategy of water resource recovery, in co-ordination with management of solid waste and atmospheric and acoustic decontamination, urban deterioration and other problems for joint solution in order to ensure sustainability in the preservation of the water resource.

f. ***Sustainable Management*** of the water resource, aware of the need to ensure continuity for the benefit of future generations. Of importance here is the fact that actions be officially lead and implemented through the Talcahuano Municipality, as its governmental character ensures the continuity of the measures adopted, as opposed to only community based actions, transient in nature, or if led by national government, divorced from local reality and having a sectorial and non integral approach. In effect, the Case refers to a policy adopted officially and kept for over 12 years with gradual but significant achievement in time, not merely being one more “pilot or demonstration project”.

g. ***Acknowledgement that water is a valuable resource*** and that this value must be reflected in the way that it is used. Regarding the use of the resource, the key element here is that each sector user of resources be made accountable for the sustainable management of that resource, thus: for city problems, those that must answer are the Ministries and the Municipality, with help from the community and businesses: problems generated by the community must be dealt with by the community with the help of the Municipality, Public utilities and businesses, and those problems generated by businesses must be dealt with by businesses, with the help of the Municipality, Public Services and the Community.

h. ***Participative approach*** for water management, involving interested partners ("stakeholders") to ensure fairness as well as efficiency in water use. This is a key aspect in the strategy of Talcahuano Municipality, as their lack of resources, a condition that affects to a greater or lesser extent all of Latin American Municipalities, forces them to establish alliances with private interests, the community and regional and national government in order to ensure the success and continuity of the measures adopted, apart from reflecting the interests of all beneficiaries, in a genuine democratic manner, as exemplified in numerous occasions in the Case presented. As indicated by the Municipality, “The recovery of environmental quality, with the participation of all the players, generators, controlling agents, authorities, community, business and government, builds over time a strong and sustained base which produces in everyone a change of attitude towards a more responsible behaviour, ensuring a route towards clean production, decreases risks, protection of production lines, offering greater security to those who work and

live in residential areas close by, obtaining the goal of a better quality of life for the municipality and sustainable development for our city".

Additional Sources of Information

- *People and Organisations*

° Juan Guillermo Rivera Contreras, Chemical Civil Engineer, Environment Director, I. Municipalidad de Talcahuano
Anibal Pinto 276, Talcahuano, telephone 5410 83, 546060 ext. 408 / Fax 541083, E-mail jgrivera@entelchile.net

° Comisión Nacional del Medio Ambiente. www-conama.cl/regiones/8

- *Information Sources for the Case and Relevant Web Sites*

° J. Guillermo Rivera, *Recuperación Ambiental de la Comuna de Talcahuano; Diagnóstico y Gestión Ambiental Municipal*, United Nations Centre for Regional Development, Latin America and the Caribbean Office, Bogotá, December 2001

° ----- y otros, *Muestreo y Análisis de Residuos Industriales Líquidos a las Industrias pesqueras de la Comuna de Talcahuano, para Determinar la Carga de Contaminantes a Evacuar*, Municipalidad de Talcahuano, 1992

° Centro Eula, Universidad de Concepción, *Estudio de la Situación Ambiental y de Riesgo de la Comuna de Talcahuano,* Municipalidad de Talcahuano, 1991

° I. Municipalidad de Talcahuano, Estudios para el Plan Regulador: Prof. Pedro Ilabaca, Universidad Católica de Concepción, *Estudio Geomorfológico y Demográfico de la Comuna de Talcahuano*; Ing. Alberto Duyvestein *Factibilidad de Agua Potable de la Comuna de Talcahuano*, ; Ing. Alberto Duyvestein *Factibilidad de Alcantarillado de Aguas Servidas de la Comuna de Talcahuano;* Inci Ingeniería Asociados, *Estudio del Sistema de Evacuación de Aguas Lluvias de la Comuna de Talcahuano*; Universidad del Bío-Bío, *Expediente Urbano para la Reformulación del Plan Regulador Comunal de Talcahuano*.

° I. Municipalidad de Talcahuano: www.talcahuano.cl

° Environmental Sciences Centre EULA-Chile, Universidad de Concepción, Casilla 160-C Fono: (41) 204002, 204080, 204000
Fax: (41) 242546, www.eula.cl

° Universidad del Bío-Bío: www.ubiobio.cl

° Empresa de Servicios Sanitarios de Bío-Bío: www.esbio.cl

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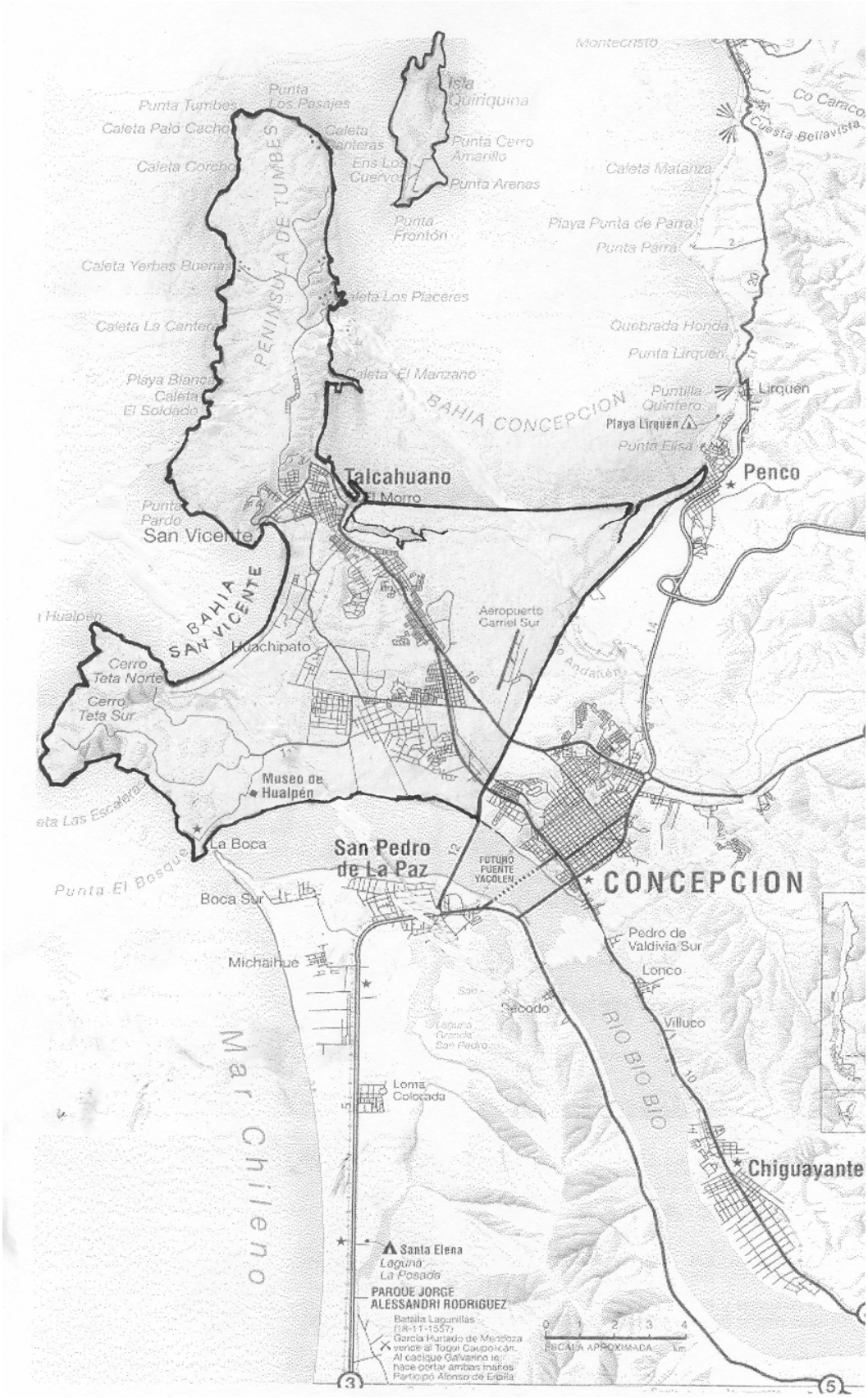
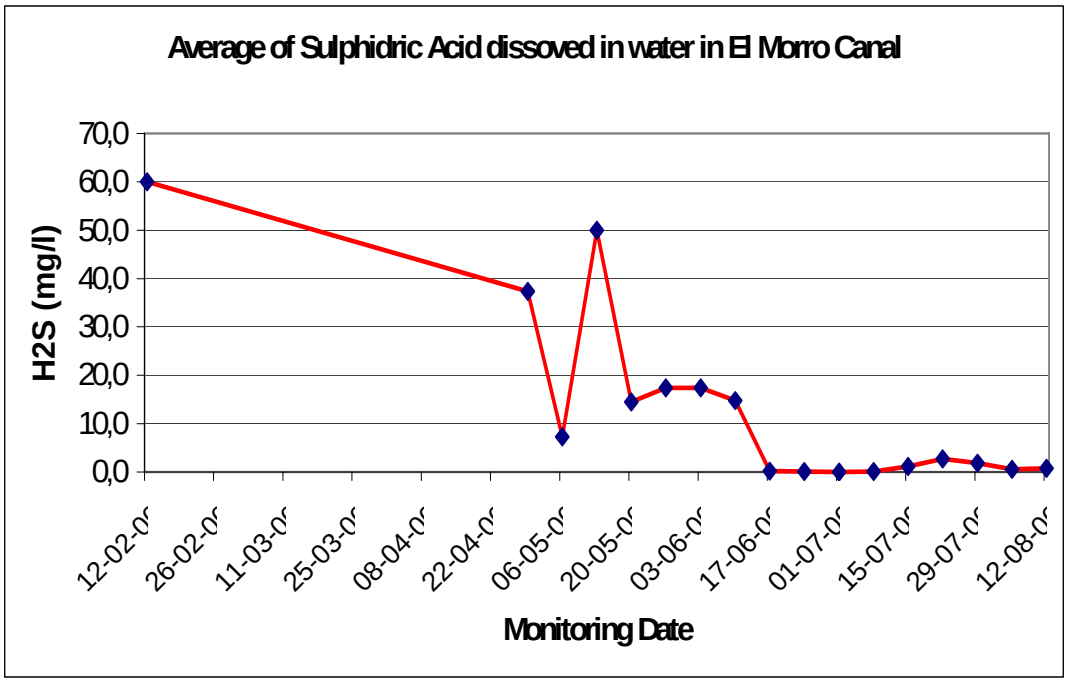
ANNEXES

1. Map of the Talcahuano Municipality and neighbouring areas
2. I. Municipalidad de Talcahuano, Results from El Moro Canal Recovery Plan, February - August, 2000


Montecristo
Isla Quiriquina
Punta Los Pasajes
Punta Tumbes
Caleta Palo Cacho
Caleta Canteras
Caleta Corcho
Punta Cerro Amarillo
Punta Arenas
Co Caracol
Cuesta Bellavista
Caleta Matanza
Punta Frontón
Playa Punta de Parra
Punta Parra
PENINSULA DE TUMBES
Caleta Yerbas Buenas
Caleta Los Placeres
Caleta La Cantera
Quebrada Honda
Punta Lirquén
Playa Blanca
Caleta El Soldado
Caleta El Manzano
BAHIA CONCEPCION
Puntilla Quintero
Lirquén
Playa Lirquén
Punta Elisa
Talcahuano
El Morro
Penco
Punta Pardo
San Vicente
BAHIA SAN VICENTE
Aeropuerto Carriel Sur
Huachipato
Cerro Teta Norte
Cerro Teta Sur
Museo de Hualpén
La Boca
San Pedro de La Paz
FUTURO PUENTE YACOLEN
CONCEPCION
Punta El Bosque
Boca Sur
Pedro de Valdivia Sur
Lonco
Michaihue
Villuco
Mar Chileno
RIO BIO BIO
Lomas Coloradas
Chiguayante
Santa Elena
Laguna La Posada
PARQUE JORGE ALESSANDRI RODRIGUEZ
Batalla Lagunillas (18-11-1537): García Hurtado de Mendoza vence al Toqui Caupolicán. Al cacique Galvarino le hace cortar ambas manos. Participó Alonso de Ercilla
ESCALA APROXIMADA
Km

I. Municipalidad de Talcahuano, Results from El Moro Canal Recovery Plan, February - August, 2000

GRAPH



Source: Guillermo Rivera, *Recuperación Ambiental de la Comuna de Talcahuano; Diagnóstico y Gestión Ambiental Municipal,* United Nations Centre for Regional Development, Latin America and the Caribbean Office, Bogotá, December 2001