Chile Litoral

DIÁLOGO CIENTÍFICO SOBRE LOS ECOSISTEMAS COSTEROS

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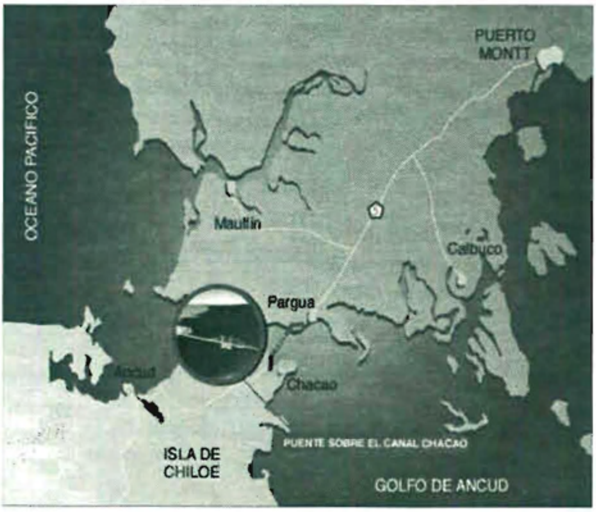
approach is comprehensive and comparative as we identify the regional economic system as the unit of analysis in which we probe socioeconomic, political, and ecological issues in comparative perspective across developed and developing countries in the Americas.

We intend to apply this regional economy method of analysis to the case of Chile in which we are studying three regional economies/ecosystems: North, Central and South. Our unit of analysis is defined by the ecological and regional economic parameters in a geographical area rather than by administrative/political boundaries.

The economic activities we selected to analyze in the regional ecosystems under study include (1) the Chacao Channel Bridge, (2) the Port of Valparaíso (here we will study the importance of ports for international trade and for national and regional economic development), and (3) freshwater, watershed and energy management in the selected regional economies.

5. *Infrastructure: Chacao Channel Bridge*



Fuente: http:// www.concesioneschile.cl/wel_ingles/n_ptbicentenario.htm

Chile will soon be undergoing construction of a 2.5 kilometer-long (29 meters wide) bridge –to cost $300 million, financed by private investors who will collect tolls– that will connect Chiloé with the mainland by 2006 and will allow passengers to cross the Chacao

Channel in five minutes. The bridge will be built at Punta de Gallardo, 50km southwest of Puerto Montt.

The purpose of the bridge is to improve trade between the island and the mainland. Chiloé's salmon and timber products have become important exports in the national economy (the Island of Chiloé provides about half of Chile's annual $800 million in exports of farmed salmon and trout, projected to quadruple by 2010, to 800,000 tons a year). Proponents of the bridge believe it will speed the delivery of Chiloé's goods to the mainland and cut transportation costs. They also believe the bridge will improve Chiloé's tourist industry and provide easy access to hospitals on the mainland.

Chacao Channel: COWI - Danish consulting engineering firm

Danish consulting engineering firm COWI has been awarded a joint venture contract to explore the feasibility of building the bridge. An unusual aspect to the project is a tiny shoal mid-channel that was an island until an earthquake in 1960. The shoal is ideally located to hold a tower mid-span. Replacing today's car ferries with a dual carriageway fixed link, the bridge will enhance future development in the sparsely populated southern regions of Chile.

The bridge will be among the largest in the world and is located in an area with severe conditions. These facts make the project a great engineering challenge. At the proposed crossing the channel is 2.5 km wide and up to 100 metres deep, except for a tiny shoal, Roca Remolinos, in the middle of the strait. This situation requires a cable supported bridge solution with towers standing on the shoal and near the shores. The most likely solution is a continuous suspension bridge with two main spans of about 1,100 and 1,300 metres respectively, joining at a central A-framed pylon on Roca Remolinos. This would be the world's first suspension bridge with continuous cables over two main spans. Also a cable-stayed bridge with a pylon on the Roca Remolinos is possible. Should the tiny submerged island, however, prove unfeasible as a tower foundation, a technical alternative would then be a 2,000 - 2,200 metres single-span suspension bridge. The area has extreme seismic activity. Roca Remolinos was originally a small island, but became submerged as the landscape sank several metres during the world's biggest recorded earthquake, the Valdivia earthquake of May 22, 1960, which surpassed 8.5 degrees on the Richter scale. Even though suspension bridges are fairly resistant to earthquakes, the seismic activity of the region will be one of the major project challenges. Another great challenge, which will complicate floating construction works, is the strong current in the channel.

Chacao Channel: An Extreme Application of MIKE 21

Marine investigations are being carried out for a bridge over Chacao Channel between the mainland and Chiloé Island, Chile. The channel is 2.7 km wide at the bridge site with water depths up to 150 m. Spring tides of up to 6 m range generate currents of 5 m/s accompanied by extreme turbulence. The preliminary design is for a double span suspension bridge with the central pylon on an "underwater mountain", Roca Remolinos, in the middle of the channel, rising from 150 m up to just 5 m below low tide level.

The site location is shown in Figure 1, and a photo of the site with superimposed bridge in Figure 2 (Visit Website to see MIKE 21 in more detail and be able to look at photos and figures).

To illustrate the ferocity of the tidal currents, Figure 3 is a photo of the drilling barge used for the geotechnical investigations. It is moored over Roca Remolinos, and the wake is caused by the 5 m/s tidal currents.

40 km offshore is the epicentre of the 1960 Chilean earthquake that created a tsunami which destroyed not just the Chilean coast, but also damaged coastal installations in Hawaii and Japan. The tsunami formed up into a 15 m high bore on the Pacific Ocean beaches north and south of the Chacao Channel entrance.

The marine investigations for the bridge included modelling to determine the 1 in 100 year design parameters of tidal levels and currents, waves and tsunami impact. Given the extreme hydraulic conditions at the site, this was a challenging task for MIKE 21. A pollution dispersion study was also carried out. The model includes the following sections:

- Tide Modelling
- Tsunami Modelling
- Wave Modelling, and
- Pollution Dispersion Modelling

Selection of worst case accidents

The worst case accidents that could result in the spill of pollutants to the Chacao Channel waters are collisions of ships with the central bridge pylon on Roca Remolinos and the north pylon near the northern shore. Groundings could also occur in the area.

Based on a study of maritime traffic through Chacao Channel, it was decided to assume that the worst case accident would involve a tanker of the size 20,000-30,000 tonne. Such tankers are divided into compartments with each containing about 2,000 tonne of petroleum product. Despite a few spectacular examples of the total destruction of a tanker following an accident, the great majority of accidents involve only the loss of oil from one compartment. Further, ships rarely break in half instantly, but are damaged resulting in a slow leakage of the oil. It is therefore assumed that 2,000 tonnes will be spilled, and it will be leaked to the environment over a period of 6 hours.

Heavy fuel oil was chosen as one of the products to be studied, since it will persist longest in the environment. The lighter, more volatile products will evaporate more quickly. It is noted that ship groundings frequently result in the release of the ship's own fuel oil, so the choice of fuel oil is most appropriate. It was also chosen to study a second product that dissolves in water and will therefore mix right throughout the water column. No specific chemical was chosen since the study was not an environmental impact assessment. The simulations were repeated with winds of 10 m/s from north and from south.

The objective of the simulations was to show the areas that could be impacted by a spill, but no assessment of the resulting damage to the environment was made.

Oil spill results

An example of the results of the oil spill simulations is illustrated in Figure 37 and in animation Figure 38. The thickness of oil on the surface is given in mm.

The general conclusion from all the simulations is that all the coastlines along Chacao Channel are at severe risk of being contaminated by oil dependent on the wind direction at the time of the accident. The bays at Pargua, Chacao and Caulin will experience longer periods with extensive oil coverage.

Sea birds and aquatic fauna, particularly sea lions and penguins will be heavily impacted.

Because of the limited area covered by the model, much of the oil passes out of the model boundaries and is lost to the simulations. In reality, some of the oil will re-enter the model area when the tide changes and the oil contamination in Chacao Channel will persist for a longer time than indicated by the simulations. It also means that areas to the west (Bahia Ancud and Golfo Coronados) and to the east (Golfo de Ancud) will also be impacted.

LOCATION FOR CHACAO CHANNEL

Fuente: http://www.dhisoftware.com/uc2001/Abstracts_Proceedigs/Papers01/007/007.doc

The technical/engineering questions along with environmental concerns are not the only issues to be solved for the construction of the bridge. There are also deep cultural and socio-economic questions that need to be addressed.

Chacao Channel: Cultural and socio-economic issues

Many of the 130,000 islanders, however, adamantly oppose any link with the coast, even though they don't see much chance of stopping the bridge. These rugged individualists, almost all of Spanish descent, have long boasted of their self-sufficiency. For lack of nails, many of the island's 150 historic wooden churches were built with pegs and intricately slotted shingles. In the 1950s, residents crossed the channel on sailboats. There is no newspaper on the island, no airport, no university, and a single two-lane highway. Economically pinched, islanders are endlessly inventive: At a recent food fair, more than 100 dishes from locally grown potatoes were served. And then there's local mythology-a cavalcade of trolls, sirens, and witches. "The island has a magic", says sculptor Luis Ortega, 48, who fled smog-choked, crowded Santiago three years ago to settle in Chiloé. "If they build a bridge, the island will fill up, and the magic will be gone".

Chilotes, as Chileans call the island people, are divided over the bridge. For some it will disrupt their way of life. Chiloé Island has maintained a restricted connection to the mainland since the Spanish Conquest, broken only in recent decades by the ferry service and the construction of major roads. This limited contact has determined the conservation and development of a peculiar and deeply rooted Hispanic-Latin American tradition.

In addition, some sectors of the Chiloé archipelago are sill inhabited by indigenous people (Huilliches), descendants of the pre-Hispanic inhabitants of the region, and keepers of a rich legacy of knowledge of their natural environment. Critics of the bridge argue that the expensive infrastructure as a gift from government to big business. On the other side, there are Chilotes who welcome the enterprise as an opportunity for employment creation, especially those in the salmon industry that is quickly growing. The island provides about half of Chile's annual $800 million in exports of farmed salmon and trout, projected to quadruple by 2010, to 800,000 tons a year.

Chacao Channel: Ecological Impacts

Scientific collaboration to address these and other questions is increasing. For example in the case of land use in Chiloé, the Urban Long-Term Ecological Research (LTER) program is seeking to interact with the Institute of Ecological Research, Chiloé, founded by a consortium of Chilean scientists and educator on the Island of Chiloé in the rain forest region of southern Chile. IER-Chiloé conducts basic ecological research in the endangered rain forests of the region, to develop ecologically sustainable land use practices and restoration techniques based on ecological research in cooperation with local landowners and forest products companies, and to improve the use of ecological knowledge in the local schools. The rapidly changing land use pattern on the large Island of Chiloé and the variety of ecological conditions, ranging from the City of Castro, through small hamlets and pristine and managed forested lands, suggest that the kind of distributed, comparative long-term approach we plan for Baltimore will be very useful to link with the activities at IER-Chiloé. We have agreed with Dr Juan J. Armesto to pursue collaboration between the proposed Baltimore Urban LTER and IER-Chiloé.

One goal of research activities in the Biological Station Senda Darwin, based in the northern coast of the island, is to understand how land use practices influence and transform the landscape, and alter communities and ecosystems. It is evaluating the effects of forest fragmentation and land cover changes on 1) the structure and composition of the forest biota, 2) the interactions between plants and birds for seed dispersal and pollination, and 3) the recovery of degraded forests. Native forests, in Chiloé National Park, provide an additional opportunity to compare the functioning of ecosystems that remain largely untouched by people, with those of areas under increasing degrees of anthropogenic influence.

Biodiversity becomes endangered as the multiple uses of coastal zones and estuaries intensify through land use practices and other developmental activities (see section B.6 below on Ports and Trade and Services for the effects of free trade on biodiversity). Migratory birds and wildlife habitat are some examples of endangered species as the multiple uses of the estuary augment.

Migratory Birds

Migratory birds are legally protected in the United States by the Migratory Bird Treaty Act. As discussed above, both Chile and the United States are Parties to the Ramsar Convention, which protects wetlands, often a prime habitat for migratory birds.

Chile is an important country for wintering shorebirds as well as other migratory species. Large concentrations of shorebirds such as Red Knots, Hudsonian Godwits, Sanderlings, White-rumped Sandpipers, and Whimbrels winter in Chile. Human development of these coastal and estuarine ecosystems could have a significant impact on their populations. Development can interfere with tidal flows and decrease the invertebrate food supply for the birds. These shorebirds are found in the coastal and estuarine habitats primarily around Tierra del Fuego and Chiloé Island. Heavy concentrations of Sanderlings are found all along the Pacific coast with peak numbers around Valparaíso. Many of the other wintering species are wetland/oceanic birds, however, several are forest and shrub dwellers.

Other migratory species include: Osprey, Peregrine Falcon, Franklin's Gull, Elegant Tern, Black Skimmer, Yellow-billed Cuckoo, Common Nighthawk, Traill's Flycatcher and the Barn Swallow. Peregrines prey on shorebirds and their population could also be affected.

Wildlife Habitat

Trade liberalization, through the expansion of markets, can stimulate economic activity in the form of expanded production in existing sectors or the development of new sectors. Such expanded productive activity can affect wildlife habitat, including habitat for endangered species or migratory birds. Among the major export sectors for Chile, the expansion of farmland may displace forest and other habitats, and may degrade riverine habitat through pesticide runoff. Logging can degrade or destroy forest habitat, and mining can degrade or destroy wildlife habitats through effects such as water pollution. Aquaculture projects in wetland areas could degrade or displace habitat for migratory birds.

To the extent that a FTA lowers tariffs or otherwise reduces barriers in such sectors, it could stimulate economic activity that displaces or degrades habitat, thereby having negative effects on wildlife. However, such effects are not expected to be pronounced for several reasons. U.S. tariffs on products in the fishing, forest, and mining sectors already tend to be low, so the FTA is not expected to significantly alter existing trends in Chilean exports to the United States. Chilean tariffs are also relatively low in the fishing and forest product sectors, and the Chilean market is so small compared to the overall size of the U.S. economy that incremental increases in market access for U.S. exporters are not expected to result in measurable changes in U.S. economic sectors. However, site-specific impacts cannot be entirely ruled out. If a small incremental increase in markets through trade liberalization stimulates the expansion or establishment of even a single facility, impacts could be significant if that facility were situated in a habitat that is sensitive for a rare or endangered species (http://www.businessweek.com/1999/99_46/c3655226.htm) (http://baltimore.umbc.edu/lter/proposal/section_6.htm) (http://www.ptialaska.net/~crayola/sscience.html) (http://www.planeta.com/planeta/95/1195chiloe.html).

The analysis of the building of the Chacao Bridge can shed important insights into our analysis of ecosystem resiliency. In this case we will be able to study the natural, human, and institutional dimensions of resilience. Questions to explore include: What will the impact of the bridge be on economic development? cultural makeup of Chilotes? resilience of the estuary? and the governing structures of local, state and national authorities?

6. Ports in National Economy: Trade and Services: Central Valparaíso

Ports in the national economy:

Given Chile's open economy as a result of over two decades of free trade practices, the importance of ports for continued economic development is highly increasing. In addition, the effects of free trade practices in regional ecosystems are also becoming increasingly urgent.

As Chile's economy has grown steadily, its ports have become inadequate after the average 9.9 percent foreign trade growth of the last 10 years (1985-1995). Trade agreements signed with Canada and many Latin American countries have greatly impacted Chile's foreign trade, 95 percent of which moves by sea. Cargo should continue growing at an average of 10 percent yearly, increasing the need to enlarge and improve port facilities and related service systems, as well as building new ports.

Costs at Chilean ports are high due to slow and inefficient cargo handling. Poor infrastructure and operating systems are the key problems. They may be left out of international circuits if they do not upgrade facilities and systems to reduce unloading time. Ships wait days for servicing, increasing costs. The average container transfer rate is 14 per hour, which could increase to 35 per hour with new technology and management systems.

Chile has 37 ports, plus other minor facilities, that belong to companies such as mining facilities, steel plants, cellulose plants, chemical product plants, etc. Of the 37 ports, 10 are owned by the government through Empresa Portuaria de Chile (Emporchi, Chilean Port Authority).

About 90 percent of the 17.7 million tons moved by Emporchi ports goes through only five of them: Arica, Iquique, Valparaíso, San Antonio and San Vicente/Talcahuano. By far, the most important ports in Chile are Valparaíso and San Antonio. Non-Emporchi ports move 33.7 million tons.

The government approved a new law transforming Emporchi into 10 autonomous state-owned companies, one for each state-owned port. It authorizes them to grant concessions to private firms to invest in port infrastructure, cargo transfer systems, and other services. Estimated minimum private investment for state-owned ports in the next 5 years (1996-2000) is projected at US$ 500 million, plus US$ 600 million for private ports such as Lirquen, Mejillones, and Lota. Each port could become a stand-alone business, attracting private investment and promoting competition.

As of 1995, the five main Emporchi ports were turned into private companies. Master plans were prepared for granting concessions for mooring facilities, especially in ports that require urgent upgrading: San Antonio, Valparaíso and San Vicente/Talcahuano. These transfer over 80 percent of cargo transferred by Emporchi ports.

Imports mostly supply the port equipment market. The U.S. is the largest supplier, averaging 50 percent of the port equipment market. Market access for port equipment is barrier-free. Used capital goods can be imported and are exempt from the tax imposed on the importation of used equipment and products, which is 50 percent of the regular 11 percent import duty.

In addition to the state-owned ports, there are 27 privately owned ports, of which 11 are for private use, and 16 are for public use. Following are international trade total cargo figures for 1996 (in metric tons):

- Privately-owned ports for public use: 12,734,558
- Privately-owned ports for private use: 20,852,859
- State-owned ports 17,732,614
  (http://www.tradeport.org/ts/countries/chile/sectors.html)

Trade and services:

Free trade continues to be expected and beneficial to the Chilean economy. As the Fisheries Committee of the International Foundation for the Conservation of Natural Resources reported in 2001, Chile appears destined for better economic times in 2002. To date (December 2001), Chilean exports to the United States top US$4000 million ($4 billion) annually. Chile's aquaculture industry is expected to see a real rise in abalone exports. And, despite a drop in salmon prices, that country's fish exports were strong particularly for products destined for human consumption.

Free trade negotiations between the U.S. and Chile are expected to resume soon. President Bush was granted trade promotion authority (TPA) (previously known as fast track) to resume negotiations for a free trade agreement with Chile and other Latin American countries.

American farmers and fishermen are reported to be leery of a Free Trade Pact between the U.S. and Chile. They claim Chile maintains lower production costs due to allegations of their ignoring labor and environmental standards. Nevertheless indicators suggest the two nations will ink a deal early in the first quarter of 2002. The U.S. House of Representatives approved a Trade Promotion Authority that puts such negotiations on a fast track for Chile last week.

The good news for new product development in Chile comes from the growing interest in its cultivation of two species of abalone: the red or California abalone (H. rufescens) and the green or Japanese abalone (H. discus hannai). First introduced to Chile in the 1980s, demand for the mollusk from Asia, mainly Japan, suggests Chile's exports will rise from 25 tons in 1999 to 200 tons in 2002 (http://fisheries.ifcnr.com/article.cfm?NewsID=253).

Wildlife and endangered species is in the agenda of free trade discussions between the U.S. and Chile. Free trade stimulates multiple uses (e.g., economic activities) in coastal areas, estuaries and watersheds. If not properly managed –through *Ordenamiento Territorial* [OT] for example– these activities can cause habitat loss and other ecosystemic damages (for more on OT refer to section A on Science and Governance as well as to section II.A.3 on Land Management Practices).

Both the United States and Chile contain a wide range of habitats which sustain a diversity of species and communities of wildlife. Endangered species and wildlife, including migratory species, may be subject to effects from changes in trade between the two countries, such as an increase in harvesting of wildlife for export, or the loss or degradation of habitat due to economic activities stimulated by trade.

A number of migratory species, particularly birds, travel between the United States and Chile. Any effects on these species would be both domestic – because the species spend part of their lives within U.S. territory where they could be affected by trade-related activity – and transboundary– because trade-related activity in one country may affect the status of a species that spends part of its life in the other. Migratory species are also a matter of global concern, as evidenced by the Ramsar Convention on Wetlands of International Importance Especially as Waterfowl Habitat, to which the United States, Chile, and 127 other countries are Parties. Many species of birds found in the United States migrate to Chile. The protection of these birds is mandated in the United States under the Migratory Bird Treaty Act.

Multilateral recognition of the importance of species conservation and the need for international cooperation has led to a multilateral agreement through the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), to which both the United States and Chile are Parties. In addition, Congress has mandated the protection, through trade restrictions and other measures, of species identified as threatened or endangered under the Endangered Species Act of 1973 (ESA), including species with ranges outside the United States. Several species found in Chile are on the ESA list.

Economic Data

The overall volume of international trade of CITES-listed species between Chile and the United States has not been substantial in recent years. U.S. exports to Chile consisted primarily of scientific specimens and a few alligator products. Re-exports consisted primarily of sturgeon caviar, a few live reptiles, amphibians and invertebrates. Legal exportation of native mammals from Chile has not been a cause for concern in recent years, because only captive-bred individuals are being exported.

International trade of non-CITES species between Chile and the United States has been more significant. Over the 1985-1993 period, Chile exported over 83.5 million moth larvae (*Chilecomadia moorei* and *C. valdiviana*), used as bait, primarily to North America and Europe. Spider exports from Chile rose dramatically from 1,819 individuals in 1985 to a high of 81,184 individuals in1992. Recent trade data suggest that that portion of spider exports going to the United States may have been substantial. Data on U.S. imports of spiders from Chile for 1998-1999 show that the United States imported 38,220 spiders in 1998, and 33,000 spiders in 1999. Trends in Chilean exports of vertebrates for 1985-1993 reflected the establishment of new hunting regulations in 1993, which imposed a total ban on exports of native species. Legal exports of both native reptiles and amphibians rose to very high levels in 1992, but came to an abrupt end on March 9, 1993 when the regulations took effect.

CONCLUSION

Changes in economic activity resulting from the FTA are expected to be limited in both the United States and in Chile in natural resource sectors such as mining and forestry, where economic changes could pose potential threats to wildlife habitats. While facility expansion or production increases in sensitive areas can produce significant effects on plants and wildlife, including endangered species and migratory birds, the overall effects on wildlife are not expected to be significant based on the anticipated change in economic activity from the FTA (http://www.ustr.gov/environment/draftchileer.pdf).

7.- Freshwater Management in Coastal Regions (e.g., watersheds and jurisdictions)

Since the early 1990s, DIRECTEMAR (*Dirección de Territorio Marítimo y de Marina Mercante*) has been actively controlling industrial discharge in coastal areas. All companies using the coastal zone must conduct a study to determine the surrounding area's carrying capacity and comply with the study's result. Most affected by this program are the chemical, petrochemical, fishmeal processing, and salmon aquaculture industries. The mining industry is also actively pursuing options to stem its effluents. Located in areas where water is scarce, this industry is exploring ways to re-circulate its wastewater.

Due to the increasing changes that rivers, lakes and seas have suffered by so much discharge of domestic water waste, such as industrial liquids wastes, CONAMA began the planning of an emission standard whose main environmental protection objective is to save the environmental quality of water resources. To carry out this main objective, the standard regulates the maximum contamination that industries can discharge into sewage systems. The standard would enter into effect in all the national areas within 30 days, after being published on July 20, 1998 in the *Diario Official*. The Council of Ministers approved the definitive standard on January 23, 1998 and the General Comptroller of the Republic entered it into law on July 6, 1998. The plan for the standard that regulates the contamination associated with liquid industrial waste discharges (riles) is directly related to the Government's Environmental Policy, which assures the quality, conservation, and reasonable use of water resources.

The *"Informe País: Estado del Medio Ambiente 1999"* established that the inadequate disposal of industrial, domestic, and mining wastes has caused the deterioration of water resources. In Chile, the greatest area of demographic increase is in the basins of *the Elqui, Aconcagua, Maipo, Mapocho, Rapel, Maule, Bío-Bío, Valdivia,* and others representing the greatest degree of contamination. In Santiago, the main riverbeds are the *Zanjón de la Aguada* and the *Mapocho* River that receive directly more than 60% and 35% respectively of the total waste water. The majority of world lakes in populated regions have or have had serious eutrophic problems, which is to say that the water has deteriorated to the point that it is unfit for aquatic activity.

Nevertheless, appropriate management measurements have been applied such as to stop the entrance of waste water to lakes avoiding excessive incoming nutrients and the accumulation of heavy metals, which is the result of liquid industrial waste discharges. The great majority of lakes in the South of Chile are low in nutrients, which is to say they are transparent and clean. This is a rich natural resource and in effect of great economic value.

The report affirms that new regulations to preserve biodiversity and restore healthy ecological condition of water resources would be implemented by 2001. This measure allows rivers and lakes to preserve or reach good water quality, under this circumstance, only in rivers/ lakes with good water quality are human activities such as irrigation, aquaculture, and sports fisheries allowed; these human activities are not allowed in rivers that show certain levels of contamination (*El Mercurio* September 5, 2000).

Sea water is also directly affected by domestic and industrial water wastes and the wastes that come from agricultural and forestry activities (multiple source discharge) that flow directly to the sea without proper treatment, by way of the main coastal cities, or in a direct way through the 27 water holes that receive the same kind of wastes. The areas most affected by domestic wastes are Valparaíso Bay, through the *Maipo* River, with the wastes from the city of Santiago, and Concepción Bay. The ability of the ocean to absorb waste is dependent on the currents, stratification, and other oceanographic variables. These variables have different consistencies according to whether they are deep sea or along the coastal borders. Within the coastal borders are zones called Littoral Zones, where the currents are most prevalent (also called littoral drift). The physical dynamic and the bio-conditions here are different from the deep sea. Therefore, the areas called coastal protection zones are areas highly sensitive and vulnerable to a variety of environmental impacts. They are characterized mainly by having low contamination dispersion, high bio-diversity, and are used in a multitude of ways. Their purpose is to maintain a balanced sea ecosystem, conserve their natural resources and the surrounding beauty, and protect the human health (http://www.cwr.uwa.edu.au/cwr/research/projects/rinihue.html).

8. Energy Management: Concepción Case

Chile's energy sector is largely privatized, particularly the electricity industry. Chilean energy demand has been growing rapidly (around 7% annually) since 1986. A significant portion of this growth has come from increased power demand by the mining sector, the country's single largest industry, and by large urban areas such as Santiago, which alone contains over 30% of Chile's population. The increased demand combined with scant fossil fuel resources make Chile a net importer of energy; primary energy production in 1996 reached 0.35 quadrillion Btu (quads), while consumption reached an estimated 0.79 quads. In addition to the energy trade imbalance, the completion of gas pipelines from Argentina will increase imports of natural gas dramatically.

In 1998, Chilean oil production is an estimated 23,000 barrels per day (b/d), of which 10,000 b/d is crude oil. Oil consumption for the same year is estimated at 220,000 b/d, making Chile a large net oil importer. Chilean crude oil reserves in 1997 were estimated at between 100 million and 300 million barrels. Chile's oil demand has doubled since the late 1980s, while crude oil production has declined by two-thirds, leading Chile to increase its imports of oil dramatically. Argentina supplies about 50% of Chile's oil imports, while West Africa, primarily Nigeria, supplies about 25%, and Ecuador another 10%.

Chilean natural gas reserves were estimated in January 1998 to be approximately 3.5 trillion cubic feet (tcf). Production and consumption in 1996 were estimated at 41 and 64 billion cubic feet (bcf), respectively.

Chilean natural gas demand, especially for power generation, is expected to grow rapidly in coming years and could largely replace coal in the nation's energy mix. Chile produces only small volumes of gas, but has plans for increasing imports from neighboring countries (see Section I on Northern Region) through projects such as the 320 million cubic feet per day (mmcf/d) GasAndes natural gas pipeline, now in operation over a year.

Chilean coal is of poor quality and costly to extract, but the coal industry has been kept going by massive subsidies as it is a vital source of employment in Arauco, a highly depressed area. However, with national unemployment down to a low level, the government began to tackle this problem from 1992, when it cut by half the roughly 6,000 personnel of the technically bankrupt state coal company ENACAR. The personnel cuts were accomplished by a generous early retirement scheme. The result was a fall in output from 2.58 million short tons (mmst) in 1991 to 1.58 mmst in 1993; productivity over the same period was significantly increased. Local production costs remain way above international prices, and coal output is likely to decline further in the coming years. Most of the coal produced in Chile is used in thermoelectric power plants in the North and Central regions of the country.

Hydroelectric plants provide an average of about 70% of Chile's electricity. Only an estimated 13% of hydroelectric potential is now utilized, but large viable sites are far from Santiago (40% of demand), requiring large transmission line investments. In late September 1998, Chile switched to summer schedules three weeks early. This step was taken in order to save energy in light of a long drought in Chile's central grid region, which serves the vast majority of Chile's population. The drought has cut hydroelectric output significantly, and in particular has affected utilities such as ENDESA which rely heavily on hydroelectricity. ENDESA has found it necessary to operate older, inefficient, and unreliable fossil fuel power plants to supplement hydroelectric production during low-water conditions.

In the Santiago-Concepción region, several rivers are capable of generating hydropower through run-off river plants. This technology is environmentally friendlier, since it does not require major alterations of river basins, and is being investigated.

The recent history of Chile's electric utility sector is complex and difficult to summarize: some private companies became state-owned, while public companies privatized some of their subsidiaries and affiliates or spun off new companies to operate specific power plants. Newly privatized Chilean utilities also became investors in Argentinean and Peruvian utility properties.

ENDESA was created in 1943 as a subsidiary of Corporación de Fomento de la Producción (CORFO), which remained its majority shareholder until 1988. At that time, ENDESA divested itself of its northern sector (including EDELNOR), the Colbun and Machicura power plants (these became Colbun), and all the distribution areas in central and south Chile along with two small power plants. GENER (formerly Chilgener), a private company, owns 1,367 MWe of thermoelectric generating capacity in Chile, including the new Nueva Renca gas-fired plant, built by General Electric. GENER also holds stakes in 4,577MWe of existing generating capacity (plus 1,504 MWe under construction) outside Chile (in Argentina, Colombia, and Peru). GENER and General Electric have plans to set up a new power operations and maintenance company which will operate in Chile, Argentina, and eventually expand into Peru, Brazil, Ecuador and Uruguay as well.

Chile's power demand is expected to more than double by 2006. As of October 1997, CNE had plans to add around 5,000 MWe of capacity by 2006, including around 3,900 MWe of combined cycle facilities with the rest mainly hydroelectric. With the completion of natural gas pipelines from Argentina, several high-efficiency, combined-cycle natural gas turbines have already been planned. The plants would add 3,526 MWe of generating capacity to mostly northern and central Chile. In addition, a small thermoelectric plant fueled by natural gas is being planned for Punta Arenas.

Additionally, 16 hydroelectric facilities are in planning or construction phases in Chile, with the potential to add almost 3 GWe to Chile's electricity portfolio. Combined with the fossil fuel plants, Chile can expect to add over 6.5 GWe of generating capacity over the next six to eight years, exceeding CNE's goal and effectively doubling current electricity production to meet the burgeoning power demands.

In May 1998, ENDESA invited offers for two, 300 MWe turbines at its $460 million Ralco hydroelectric plant, scheduled to begin operations in 2002 and to supply central Chile, including Santiago. The site for the Ralco dam is on the Bío-Bío River, opposed by Indian rights activists, environmentalists, alternative energy supporters, and ecotourism promoters. In mid-August 1998, ENDESA said it would temporarily halt construction on three lots rented from the local indigenous Mapuche people. ENDESA's decision followed a call by the regional government agency CONADI, which deals with indigenous affairs, to suspend work in the area.

In May 1998, a consortium formed by Enersis, along with its Spanish partner ENDESA, reportedly was awarded a 20-year concession to supply 1,000 MWe of hydroelectricity from the Argentine-Paraguayan Yacyreta dam to Brazil. The venture will require construction of a new power line and other work over two years with total investment of $300 million (http://www.fe.doe.gov/international/chilover.html).

C. National Policy and Regional Feedback in Coastal Management

National policy in coastal management seeks to ensure the conservation of coastal resources and the regulation of multiple uses and activities that take place in coastal areas. National policy seeks to regulate the conflict that arises from multiples uses of coastal resources. The main regulatory instrument that is being implement to regulate potential conflicts is the *Ordenamiento Territorial* (OT) (see Section II.A.3. on Land Management). The OT also seeks to preserve and conserve natural coastal resources.

9.- Science and Regional/National Management Plans in Coastal Zone

How will CONAMA integrate the work of the scientific community into the decision-making process to face the challenges posed by the degradation of coastal zones? What is the role of the Ecosystem Sciences in contributing to the Chilean economic strategy of development in the coastal areas in general and to coastal management policies in particular? Is there a dialogue among scientists and policymakers to create adequate coastal management policies as well as the institutional base that will sustain these policies?

In June 14-16, 2000 there took place the *Encuentro Chile-Ciencia 2000* on Science, Technology and Society at the *Centro de Convenciones Diego Portales*, Santiago.

The most important educational challenges that the *Environmental Sciences* face in Chile have to do with shortages at two levels –Human resources, and/ Physical infrastructure–. Given the multiplication of ecological issues in the last decade in Chile as a result of economic development and industrialization, increased urbanization, and infrastructure development (energy and roads), there is an urgent need to augment the number of ecologists. Ecological education must be emphasized from the very beginning and not only at college and graduate levels; also there must be an integral approach to education in which not only are the disciplines integrated into research teams, but also other professionals (e.g. lawyers, economists) from both public and private sectors are educated and sensitized to ecological issues.

There is a need to foment the formation/education of toxicologists and other ecology-relevant disciplines, given their shortage in Chile. The roles of the state and private sector in enacting these measures are crucial; the amount of resources must be significantly increased to support the long-term studies/projects (at least five years) of multi-disciplinary research teams.

Regarding physical infrastructure, the Chilean government and private sector are required to invest in the creation and maintenance of ecological laboratories and protected areas for scientists to carry out long-term studies and experiments on the ecosystems (a good example that might be followed is the implementation of the oceanography network in the north of Chile to study the Nino phenomenon); also new technology must be absorbed by the Chilean scientific community (e.g., the GIS sophisticated computer system). The Ciencia 2000 session on the environmental sciences specifically recommends setting up at least five ecological stations strategically positioned in important representative -aquatic and terrestrial- Chilean ecosystems, and the creation of a *Fondo de Desarrollo*, supported by the government and private sector, to financially make viable these ecological stations and other projects.

In terms of the Chilean *Social Sciences*, the academic/research training issues have to do with producing high level graduates and with the creation of research centers and institutes. First, even though the number of social scientists with graduate degrees (Ph.D.s) has augmented, it is not sufficient to meet Chile's societal needs. The other social sciences (e.g., Political Science, Sociology, Journalism) must follow the example of Economics, which due to international institutional arrangements with prestigious foreign institutions of higher education has increased the number and quality of Chilean economists. These arrangements will help develop the social science disciplines as well as multi-disciplinary methods of scientific inquiry. Upgrading the training and scientific quality of Chile's social scientists no only requires international exchange but also more rigorous academic standards. Also, the training and development of high quality social scientists in Chile requires more material and financial resources; only appropriate levels of resources can create the working conditions in which social scientists dedicate their time exclusively to the exercise of their academic/research careers.

Chile requires an educational policy to strengthen the existing research centers and think tanks; these already have great influence on the development of the university system as well as in society at large.

This policy must envision the creation and development of large libraries to make available a rich source of bibliography/documents for social scientists, facilitating research and writing for publication in professional magazines. These centers and think tanks must elaborate projects, including multi-disciplinary ones that include integrated work with the natural sciences; this will significantly upgrade the level of scientific research and knowledge (e.g., the Academy of Sciences and the Academy of Social Sciences have already done coordinated work with great results).

The development of the *Marine Sciences* in Chile require the following policy initiatives and actions: One is the development, expansion, and consolidation of doctoral programs in the Marine Sciences; specific actions to achieve this policy initiative would include the incorporation of young scientists in the research teams of the research and university centers, continuous upgrading of the infrastructure and facilities for research, expansion of scholarship programs that would attract students to the areas of the Marine Sciences, and collaborative work with foreign institutions that would supply human and infrastructure resources in needed areas. Second, another policy initiative would be to incorporate new marine scientists in the university system as well as research centers and private enterprises; this includes creating incentives for national scientists working abroad to come back to Chile. Third, there is a need to coordinate a better, and more efficient access to boating facilities, especially to the Oceanography Boats "Abate Molina" and "Vidal Gormaz"; this will facilitate large scale research in the Ocean and coastal areas. There is a need of a national policy that will finance and facilitate the connection among the different Stations and Labs in the coastal zone; this will significantly increase the number of oceanographic research studies. A policy initiative is mandatory for the creation of a mechanism that will coordinate and promote academic development and technological and scientific research in the Marine Sciences

The *Earth Sciences* in Chile need to pay special attention to undergraduate and graduate training. The institutional structure of the Earth Sciences in Chile is found mainly in three universities (Geology and Geophysics in the University of Chile, Geological Sciences at the Northern Catholic University in Antofagasta, and Geo-Sciences at the University of Concepción), one governmental agency (the National Service of Geology and Mining-Sernageomin), and the Chilean Geological Society and Colegio de Geólogos.

By 1997 there were 829 graduates from the above-mentioned three universities. At the graduate level, only the University of Chile has (since

1968) a Ph.D. Program in Geology, and by the 1990s it has only produced 6 doctorates (all foreign); it has yet to produce its first Chilean Ph.D. (there are no work-related or scholarship incentives for Chilean students to pursue a Ph.D. in Geology; the public and private sectors including the large mining companies do not provide work incentives in the form of high salaries). In addition to the University of Chile, the Northern Catholic University of Antofagasta offers since 1996 programs in Geology at the M.S. level (it has yet to produce its first graduate; the University of Chile has already graduated 28 students at the M.S. level).

Given the importance of the Earth Sciences, Chile's policymakers need to pay special attention to this specific educational area. For example, important policies for its development could include (1) Promotion among the national society the importance of the Earth Sciences and its relevance to economic, social and scientific development, (2) Incorporation of the study of Earth Sciences in the curriculum of elementary and secondary education, (3) Promotion of the study of Earth Sciences among high school and college graduates by making scholarships available, (4) Promotion of outstanding young Ph.D. graduates in Earth Sciences to University teaching and research positions, (5) Creation of incentives among public and private enterprises (e.g., Codelco, Enap, Conama, Ministries, and mining state and private companies) to hire Ph.D.s in Earth Sciences, (5) Upgrading the infrastructure requirements for top research in the Earth Sciences, (6) Creation of incentives for systematic research on the national Chilean territory, strengthening technical institutions such as the Geological National Service and the Seismological Service.

Some of the conclusions of this survey indicate that the situation of the integration of the sciences in Chile is still problematic. Even though the Ciencia 2000 Meeting in Santiago (June 2000) sought to build bridges between the sciences and much was achieved in this direction, a wide gap remains and the challenge is still formidable.

The participants of Ciencia 2000 made critical recommendations to the Chilean government to enhance the advancement of science. They emphasized a more equal distribution of resources for the advancement of science especially in terms of regions and disciplines; i.e., a better regional and disciplinary distribution of resources with no particular region or discipline being over- or under-represented. Regional organizations and universities should be an important integral part of science policy.

They recommended that the government reach the budgetary goal of 1.2% of GDP resource allocation to scientific and technological development. Postgraduate development of students should be given a priority by implementing incentives and scholarships so that new graduates increasingly participate in private sector companies as well as universities and research centers.

To increase financial resources the government should promote private sector investment in research and development by various mechanisms including tax breaks, subsidies, and public investment.

The participants of Ciencia 2000 made critical recommendations to the Chilean scientific (and technological) community in order to advance the development of science in Chile. They highly recommended that (a) scientists monitor the quality and accessibility of science instruction at all levels of education (pre-college, undergraduate and graduate) and make sure that the subjects being taught are up to date; and that (b) natural scientists develop close working relations with members of the technological and governmental communities as well as with social scientists and humanists for a more integrated approach.

The recommendations to universities were: (a) to promote inter-disciplinary research that would help integrate new areas of research with the established ones; (b) to prepare teachers in their educating students in the areas of science and technology as well as to promote among students the interest for scientific research and for technological development; and (c) to collaborate with the private sector in the formation of scientists and with other university institutions from different regions to enhance inter-university projects and scientific research capacity across regional areas.

The private sector was recommended to introduce the most develop technologies in their productive (and service) activities; and to increment their research and development areas. Private companies should promote postgraduate education among its personnel and make an effort to incorporate scientists into their team of production as well as research and development (www.ciencia.cl/ChileCiencia2000).

Following on the precepts of Ciencia 2000, particularly on the emphasis on international cooperation, experts from Chile and the U.S. joined forces in December 2000 to formulate an initiative to facilitate research, education and outreach in marine and terrestrial ecology. The first step was a workshop on "Coastal Management: An Interdisciplinary Approach", held in Puerto Montt.

The primary objective of the Workshop was to provide an opportunity for professors from the University of Connecticut and University of Los Lagos (and other Chilean Universities) to get to know each other and to exchange ideas about their research programs. The ultimate goal was to search for (and hopefully find) a common ground from which to develop joint academic pursuits.

As an important step in developing the new program, the University of Los Lagos and the University of Connecticut signed a cooperative agreement to facilitate the exchange of students and faculty, and to foster the generation and exchange of knowledge. In this historic agreement, the two universities will collaborate in education activities, research, and technology transfer, intended to foster their mutual interests in the pursuit of scientific knowledge and management insights intended to foster the wise use and conservation of aquatic, terrestrial, and coastal environments (http://www.nurc.uconn.edu/ctula/Overview.htm).

Another important precept in Ciencia 2000 is more equal (regionally speaking) scientific development in Chile, or in the words of senior scientist Ramon Latorre "decentralization of knowledge". The scientific work of the *Universidad Austral de Chile* (UACH) in Southern Chile has greatly contributed to this decentralization of knowledge.

The move of the *Centro de Estudios Cientificos* (CECS) from Santiago to the city of Valdivia in 2000 has greatly contributed to further decentralization. However, much remains to be done since more than 80% of national funds for research are still invested in Santiago, which heavily concentrates research networks. CECS was funded in 1984 by Claudio Teiteilboim –National Sciences Award winner–. Teiteilboim, Latorre and four other senior scientists are now leading a research team of more than thirty scientists working on various projects in Valdivia.

CECS and UACH are closely collaborating in scientific research. CECS concentrates on Physics and Molecular Biology, particularly in fields such as transgenic animals and climate change. CECS and UACH have recently created a joint doctoral program in Molecular Biology.

Also, based in Valdivia is the *Nucleo Bosque Nativo de la Iniciativa Cientifica Milenio* that studies the temperate forests in the region. The regional economy of Valdivia is included by WWF – the Conservation Organization and the World Bank as the twenty-five most threatened ecosystems in the world.

According to Jorge Toro, senior scientist at the *Instituto de Biologia Marina Doctor Jurgen Winter,* regional development of research centers is beneficial not only to the national development (equal development) of science but also to the development of regional economic centers throughout the country.

A third important component throughout the recommendations by Ciencia 2000 to the academic, and public and private sector communities is the development and use of newer technology. Remote sensing for artisanal fisheries in Chile is a good example of the benefits gained by adopting and investing in new technology.

Swordfish is just one of many valuable species that are important sources of revenue for many artisanal fishers along the coast of Chile. Many of these fish are affected by climatic conditions, and are found seasonally in areas where the sea surface temperature varies by a few degrees along persistent (5-10 day) thermal fronts. To locate the fish, fishers use thermometers and check the water colour for signs of phytoplankton on which the fish feed. Fishers often spend two or three days prospecting the sea, using up precious fuel and time to find the elusive fish. Prospecting accounts for up to 40% of the operating costs on artisanal fishing boats.

Researchers at the Catholic University of Valparaíso and the Institute for the Promotion of Fishing (IFOP) have developed a method to produce timely maps of sea conditions to assist artisanal fishers. The Sea Surface Temperature (SST) maps are based on images from the US NOAA-H remote-sensing satellite, from which sea surface temperatures and the likeliest fishing grounds can be determined. The Chilean Centre for Space Research (CEE) has a NOAA receiving station and acquires daily images. The project, dubbed SATAL, uses the data to prepare maps of probable fish locations. Satellite images received by 3 p.m. can generally be consulted the same evening in the communities located close to Valparaíso.

Use of the maps has helped increase the catch of swordfish, tuna, anchoveta, jack mackerel, and reineta, and has extended the fishing season for these species. While the maps help increase revenue and significantly reduce prospecting expenses, they are costly to produce. Mechanisms for making the service self-sustaining are, therefore, essential. While this goal has not yet been achieved, SATAL has recently acquired its own tracking station to produce the maps.

Fishers are trained on how to use the satellite images and in navigation. A guide has also been developed as a handy reference. Back issues of a monthly newsletter, *SATAL Bulletin*, provide diverse information of interest to fishers, including articles on equipment, legislation concerning offshore fishing, statistics on catches, the satellite maps, and instructions on their use.

During a second project phase, the researchers developed an information package on the technology for wider distribution. They also investigated and developed applications of the technology for small pelagic species, producing SST maps that are now used by fishers of such species.

Using SST maps has increased the total fishing area covered by Chilean fishers. In 1986, the fishing area for swordfish and tuna off the shores of Chile covered a range of 32-34° longitude. By using SST maps, this range was extended from 27-40° in 1989. Fishers are now able to cover an even broader area, trawling further westward. This larger fishing zone resulted in a dramatic increase in swordfish caught, from 764 tonnes in 1986 to 7255 tonnes in 1991.

Before the use of remote sensing technology, the Chilean fishery served local markets only. Now, the fishery has been transformed into a much more competitive, export-oriented industry, aided by a steady increase in the export price for swordfish. For example, in 1986 some 695 tonnes of swordfish were exported at a price of US $5,468 per tonne. In 1991, exports shot up to 5999 tonnes selling at US $6,551 per tonne, owing in part to the increase in fish caught because of the use of remote sensing. In 1995 total exports leveled off at 2567 tonnes, although at an increased price of US $8,288 per tonne.

Going back to the usage of new technology, the following three examples show the work that is being done in this area with relation to geological mapping and sampling, resource management, and geodesy stations.

Digital reconnaissance geological mapping and sampling

Reconnaissance geological mapping and sampling were conducted in the Atacama Desert of northern Chile in the summer of 1999. During this expedition, a new digital mapping system consisting of a pen computer with Geomapper software, a differential GPS, and a laser range finder were utilized. The harsh environment dictated that this system be highly portable, weather resistant, rugged, and stable for the collection of geological data and sample locations. Of personal concern were the ergonomics and weight of the system since it would be worn for eight hours at a time while hiking over rough, mountainous terrain. The GPS and laser were conveniently carried in a backpack along with all batteries, while the GPS antenna was set atop the backpack frame. The computer was slung over one shoulder while moving and connected to the GPS, which allowed for continuous mapping while hiking. When necessary, the laser range finder could be connected and used in areas where steep slopes and cliffs made a hiking approach impossible. This enabled the mapping of areas that would have otherwise been inaccessible out to a distance of approximately 300 meters, yielding valuable data. This distance was essentially the limit of the confident visual identification of geological features and the maximum working distance of the laser.

Using digital topographic and geological base maps stored in the computer greatly aided in the determination of mapping sites and allowed for the plotting of sample locations directly on composite maps. These base maps were georeferenced prior to mapping by locating readily accessible, discernable positions using a Trimble AG-132 sub-meter GPS with real-time differential corrections provided by Omnistar.

A large quantity of data was collected over a short period of time, which allowed a larger area to be mapped than previously expected. After each day of mapping, data was saved to a backup ZIP disk and the systems batteries were recharged. The following day, mapping would commence at the precise point where the previous days' work had concluded.

By careful mapping, specific strata could be correlated over many kilometers and samples could be taken from numerous locations to represent each lithology without concern of stratagraphic errors. This system facilitated the collection of large quantities of spatially accurate data that were crucial in understanding the geological significance of Jurassic-age formations (http://www.kgs.ukans.edu/Conferences/IAMG/Sessions/F/Papers/arcuri1.pdf).

Mapping and monitoring of vegetation in Chile as a tool for adequate resource management

The lack of adequate mapping and quantification of vegetation resources in Chile has been a serious limitation for the design of adequate policies regarding the management of forests and other vegetation resources. In September 1994, a national mapping project was implemented through an agreement between CONAF (Chilean Forest Service), CONAMA (Chilean Environmental Agency), and a consortium formed by three Universities (Universidad Austral de Chile, Pontificia Universidad Católica de Chile and Universidad Católica de Temuco).

The project included the preparation of 641 vegetation maps, mainly at a 1:50,00 scale and secondarily at a 1:250,000 scale, that cover the entire country, with an emphasis on native forests. The maps are produced from aerial photographs and Landsat MSS images, including field work for describing 30% of the stands classified as native forests and 10% of the stands within the other vegetation covers. The project is implemented as Arc-Info based Geographic Information System (GIS), which also contains overlays with the boundaries of national parks and reserves, hydrographic, roads, elevation, slopes and aspect classes. The main results obtained were the area of each land use by category, especially the native forest resources (13,4 million of hectares) that represent the 18% of national area.

This project is the basis for a monitoring project of the vegetation cover that has been contracted by CONAF and CONAMA to the Austral University of Chile. The GIS-based vegetation mapping and monitoring projects that have been described will provide information that is crucial for improving planning and decision-making. This information is not only from the government, but also from a wide range of users including private companies, landowners, researchers, and conservationist groups (http://www.metsa.fi/eng/tat/jointweek/pdf/posters/mapping%20and%20monitoring.pdf).

Observatorio Geodesico Integrado Transportable (TIGO)

Systems of terrestrial and celestial references require geodesic information. The terrestrial system is the whole world and the celestial the whole universe. They provide a stable frame of reference for all networks: Continental, National, Regional and Local that determine any position in the surface of the Earth or in space. There are in the world eight fundamental stations of Geodesy: six in the northern hemisphere (Germany, Italy, China, USA, and Japan) and two in the Southern hemisphere (South Africa and Australia). Chile (Concepción) will have the ninth station and will represent South America. The establishment of the ninth station will be done by the *Instituto Geográfico Militar* (IGM) and the universities of *Concepción, Bío Bío* and *Católica de la Santísima Concepción* in cooperation with the Institute of Cartography and Geodesy from Germany (http://www.igm.cl/Espanol/Proyectos/art_inv_TIGO_4.htm).

10. Natural History Education and Coastal Management

The scientists in Tokyo (see above introductory section to II.A: Science and Governance) highlighted the need for the development of education especially in the area of Sciences. They were briefed by Jorge Allende, Director of the Institute of Biomedical Sciences at the University of Chile, about the Chilean experience in this area; for example the work of the Chilean Academy of Sciences with the Association of Science teachers as well as the courses the Institute of Biomedical Sciences offers high school teachers and students on genetic engineering techniques and molecular biology.

U.S. and French scientists highlighted the need for scientists to work closely together with high school teachers, bringing them up to date information on the new advances in scientific inquiry, and designing with them simple experiments on basic scientific knowledge. Teachers would later impart all this new knowledge to their students. At the *Ciencia 2000* meeting in Santiago Mariana Aylwin, Chilean Minister of Education, asked the same kind of support from the Chilean scientific community.

11. Marine Protected Areas and a Comprehensive Coastal Strategy

Marine protected areas are designed to preserve ecological biodiversity as well as to advance scientific research and knowledge of ecosystems.

Fishing laws and regulations take into account the following aspects to declare an are a Marine Protected Area (MPA):

a) Define clearly the ecological area.
b) Establish clear objectives in the declaration of the MPA.
c) Establish potential conflicts with other fishing activities.
d) Establish potential conflicts with other activities in the ecological area.
e) Establish level of commitment from regional authorities.
f) Determine potential financial sources for training programs (control, research).
g) Establish scientific institutional interest to develop research activities in the MPA.

To meet the objectives of the MPA, the *Servicio Nacional de Pesca* must oversee that the following stages are met:

First stage: Determine base lines.
Second stage: permanent monitoring of the MPA.
Third stage: Proposal for a research program, and control of the MPA.

Fourth stage: Implementation of the proposed program.
Fifth stage: technical supervision of the implemented program.
Sixth stage: Implementation of a control program.

The *Servicio Nacional de Pesca* has established three MPAs: Reserva Genetica de Putemun; Reserva Genetica de Pullinque; and Reserva Marina La Rinconada (http://www.sernapesca.cl/dap/amp.htm).

Chile has 32 National Parks, 13 Natural Monuments, and 47 National Reserves, which cover more than 30 million acres. Yet many state lands in Chile are only "paper parks": the protections are not enforced, making acquisitions such as those coordinated by AFI (Ancient Forests International) so necessary. AFI was a key force in kickstarting the movement to acquire and permanently protect critical, threatened forest areas in Chile. When AFI first became involved, Chile had at the most a handful of private parks; now there are more than 140, translating into hundreds of thousands of protected acres (http://www.ancientforests.org/chile.htm).

Chile has been attempting to establish a Management Area (MA) system that melds the use of marine protected areas with marine tenure. The process has brought to the fore the competing interests of various user groups: artisanal fishermen, marine science professionals, government managers, tourist developers, and the Navy. Fishermen and the ecologists and biologists' work is essential for establishing and maintaining a MA. The MA system's creation and implementation raise the key question of whether a marine tenure system can work under the conditions imposed by the Chilean government. There is a need to recognize and reconcile contradictions in a government management model that strives simultaneously to be a conservation zone and a financially profitable comanagement zone.

IACERE will draw on the important work of Professor of Ecology Juan Carlos Castilla. Professor Castilla from the Pontificia Catholic University has pioneered work on marine parks and reserves and the role they play in the sustainable use of natural resources. He focused on benthic marine invertebrates, small-scale fisheries, and single and multi-species management plans. He noted new management practices for small-scale benthic resources in Chile and cited some of their key elements. They include: institutionalization of knowledge and appropriate legislation; incorporation of fisheries as the main actors; and territorial use rights in fisheries (TURFs). Since fishery legislation was enacted, Castilla emphasized that Chile has integrated conservation units, such as marine parks and reserves, with TURFs through a spatially connected model for multi-species and ecosystem management. He highlighted that the initial experiment with the small spatial scale approach for TURFs is currently operating at a national scale with 160 units. According to Castilla, this scaling up process presents new challenges, such as the implementation of direct stock assessment, larval transport, and connectivity and ecosystem co-management approaches.

In his paper "Roles of experimental marine ecology in coastal management and conservation" he reviews the main findings of rocky shore and subtidal nearshore experimental marine ecology (EME) in cold and temperate marine ecosystems during the past four decades. The paper analyzes the role of EME in coastal management and conservation, and reviews the historical development of strategies for managing single or multispecies fisheries. The published results show over-exploitation and depletion of more than 60% of the fish stocks and a lack of connection between the management of fisheries and results derived from experimental marine ecology.

This is mainly due to: (a) the different temporal and spatial scale at which most marine ecologists and fishery managers operate; (b) the lack of long-term fishery monitoring and adaptive techniques for management; and (c) limitations in the design of experiments on fisheries.

Castilla discusses the large-scale oceanic perturbations, due to combinations of excessive resource exploitation and environmental variability coupled with present trends in management approaches. Modern approaches and tools for management of fisheries, such as Adaptive Management (AM), Territorial User Rights in Fisheries (TURFs), Individual Transferrable Quotas and Non-Transferrable Quotas (ITQs, INTQs) are discussed in the context of small-scale fisheries and EME.

He also discusses published views on limits of applied ecological research with regards to management of fisheries –highlighting the linkages between EME, marine conservation and the establishment of Marine Protected Areas (MPAs) and experimental exclusions of humans– and the results derived from MPAs, such as: (a) species or community trophic cascades, and (b) the role of key-stone species and species interaction strengths.

The paper concludes that the role of EME in conservation has been greater than has been the case in management of fisheries. The potential to link EME, conservation and the management of fisheries is exemplified through the proposed establishment in Chile of a connected network of Scientific Reserves, MPAs and TURFs sites. The final conclusion is that to cross-fertilize EME, conservation and management, there are three main challenges: (1) to end the traditional view of approaching the management of fisheries and marine conservation as contradictory/antagonizing issues; (2) to improve communications between experimental marine ecology and the management of fisheries through the implementation of experimentation and adaptive management; (3) to improve linkages between marine conservation, the management of fisheries and social sciences (http://www.iisd.ca/linkages/sd/nor/sdvol31no3e.html) *Journal of Experimental Marine Biology and Ecology* 250 (2000): 3-21.

A proposal to create Chile's first marine reserve along the western coast of Chiloé was made public in November 1996 by the National Forest Corporation, CONAF. An area covering 438 square kilometers stretching along 37 kilometers of the southern island province of Chiloé is under consideration for what would be country's first protected sea area. CONAF regional director Francisco Mendoza said Chile, with its 4,000 kilometers of coast, is one of just two Pacific coastal nations that lack a protected marine zone. Mendoza also pointed out that Chile is a signatory of the Protocol for the Conservation of Protected Sea Areas of the Southeastern Pacific signed in Colombia in 1989. Populations of sea otter and abalone, both endangered species, as well as colonies of sea lions, cormorants and penguins are sheltered in the region, which is also rich in mollusks and shellfish. Unlike the eastern shore of the great island of Chiloé, a rocky coast shaped by strong winds characterizes the western side. Sparsely inhabited, CONAF counts it as the only area of the Chilean central coast that is virtually untouched by man. A small Huilliche community persists, however, and its subsistence fishing would have to be taken into consideration, since a nature reserve normally implies an immediate halt to all economic activities. CONAF has plans on the drawing board for protected marine areas in other locations, including Playa Chipana (Region I), La Portada (Region II), Pan de Azucar (Region III), and Isla Cachagua (Region V) (http://www.seaweb.org/background/abstracts/marinepro/2001/01marinepro.2.html).

Wildlife Protection Laws and Trade Effects

Legislation as a governance issue is critical for the development of marine protected areas and other management plans. It is especially important for the protection of endangered species (see section on trade II.B.6 above).

Both Chile and the United States have legislation to protect endangered species. In the United States, the ESA has two classes of protection, endangered and threatened, for wildlife and plants. The ESA protects both domestic U.S. species and foreign species that are on the Federal List of Endangered and Threatened Wildlife and Plants. Several native Chilean species are listed as endangered under the U.S. ESA, including the alerce (*Fitzroya cupressoides*), the Andean mountain cat (*Felis jacobita*), the huemul deer (*Hippocamelus antisensis* and *H. bisulcus*), otters (*Lontra felina* and *L. provocax*), vicuña (*Vicugna vicugna*), and Andean condor (*Vultur gryphus*). However, ESA protections for species found outside U.S. jurisdiction are relatively limited, including prohibitions on sale or commercial movement in interstate commerce within the United States, and import into or exports from the United States.

In Chile, the Hunting Law of 1993 protects most of Chile's vertebrate fauna from hunting. The Chilean Red Data Book categorizes over 250 taxa into one of five IUCN categories of threat: endangered, vulnerable, rare, indeterminate threat, or inadequately known. Despite protection, many Chilean vertebrate species remain in danger of extinction. Huemul populations, for example, are reported to have declined dramatically during the last 50 years, becoming increasingly fragmented within protected areas in Regions VIII and XI.

Both Chile and the United States are Parties to CITES, a treaty that regulates international trade of wildlife. In the United States, CITES is implemented though the ESA, as amended. The U.S. Fish and Wildlife Service's Division of Management Authority (DMA) has been given CITES Management Authority responsibilities, while the Service's Division of Scientific Authority (DSA) has been given CITES Scientific Authority responsibilities. Wildlife imports and exports are controlled largely by the Service's Division of Law Enforcement for animals, and the Animal and Plant Health Inspection Service for plants. Wildlife can only be imported and exported through designated ports.

In Chile, CITES Management Authority responsibilities are divided among three Agencies: The *Servicio Agricola y Ganadero* (SAG) is responsible for terrestrial fauna and non-timber flora, the *Servicio Nacional de Pesca* (SERNAP) is responsible for marine species, and the *Corporacion Nacional Forestal* (CONAF) is responsible for forest products. CITES Scientific Authority responsibilities for Chile are also divided among three agencies: the Comisión Nacional de Investigación Cientifica y Tecnológica (CONICYT) for terrestrial fauna and non-timber flora, SNP for marine species, and CONAF for forest products.

Wildlife imports and exports are controlled largely by SAG and the Chilean Customs Service.

Chile's implementation of CITES is generally considered to be good, despite the limited resources it has available. Chile issues permits in accordance with CITES requirements, consistently submits the required CITES annual reports, and has not been the subject of any trade suspensions. Enforcement along its long border can be difficult, especially because Chile has heavy truck traffic from neighboring countries that are transporting goods to Chilean ports for export to third countries.

In coastal Chilean waters between 48 and 56 degrees South latitude, dolphins and sea lions have been killed to provide bait for the king crab fishery. Given the strong legal protections in place in each country, it is unlikely that a FTA would cause a significant increase in illegal trade of wildlife or endangered species. Both Chile and the United States have good records on compliance with international laws governing wildlife trade and the two countries have also worked cooperatively on many of these issues over the years. It is also unlikely, given the already low tariffs on most products that legal wildlife trade would increase significantly. CITES regulations require the exporting country to ensure that export is not detrimental to the survival of the species.

An example of a species in which trade could increase if tariffs were reduced is the vicuña. The vicuña (Vicugna vicugna) is a mammal native to South America that produces highly valued wool and is currently listed as endangered in the United States under the ESA. The FWS has proposed to downlist the vicuña in Chile and some other countries from endangered to threatened under the ESA. The proposed downlisting package would allow importation into the United States of legal vicuña fiber and fiber products (primarily luxury garments) from certain vicuña populations listed as threatened under the ESA and CITES. This rule would allow the sale of vicuña wool to the United States, but only from specific sustainably harvested populations. When finalized, the ESA downlisting and special rule would align U.S. policy and the ESA listing more closely with CITES. If there is a reduction in tariffs as a result of a FTA, the market for sustainably managed Chilean vicuña fiber in the United States could expand. With CITES measures remaining in place, expanded exports could increase the incentives in Chile for sustainable management and conservation of vicuña (http://www.ustr.gov/environment/draftchileer.pdf).

12. Social and Cultural Institutional Change

Few areas of production in Chile demonstrate more clearly the disparity between the government's free market policies and the notion of sustainable management of the environment than the fishing and fish farming industry. Nowadays the fishing sector is paradoxically the only area of the economy whose resources are public property and easily accessible to the public. In other words the public have the right not only to demand greater transparency in the implementation of government fishing policies but also stricter monitoring of the marine ecosystems and resources.

On Jan.27, 2000 the government's fourth attempt to allocate individual transferable fishing quotas (ITQ) to private fishing companies was rejected in the Senate. Pressure from workers in Chile's fishing industry, environmentalists, and members of the public had a major influence on the decision. The ITQ bill was introduced in 1998 by President Eduardo Frei as an attempt to solve the problem of rapidly depleting fish stocks and was designed to assign seasonal catch quotas to different companies to ensure each of the major companies got a fair share.

However, small companies complained the bill would lead to a monopoly of a resource that was considered free for the taking for all Chileans. An urgency tag was applied to the bill three times meaning it had to be voted on within thirty days or the urgency would have to be renewed. The bill emerged for a fourth time in the Senate in August 1999 and was proposed by Senators Hossain Sapag (DC), Edgardo Boeninger (DC) and Jose Viera-Gallo (PS).

In mid-January 2000 the National Fisheries Society, Sonapesca, proposed that the Government adopt the bill as an attempt to resolve problems in the sector for the coming year but it was rejected on January 27. For artisanal fishermen, a two-year battle has been won. The artisanal fishworkers, crew from the industrial fleet, environmentalists and small fishery enterprises, opposed the project both in Parliament and in demonstrations (Valparaíso, Antofagasta, Concepción, Puerto Montt, Chiloé).

Analysts consider it improbable that the bill will be passed in the short term. The new President Ricardo Lagos promised during his election campaign to support artisan fishermen. His last address to the people before the second round of the elections in December was given to fishermen in Valparaíso. However the ITQ initiative has been discredited and has little chance of being discussed, let alone approved. During his election campaign, the President elect received the full backing of the artisanal fishing sector, and their powerful organization CONAPACH which includes 95% of the unions and more than 50,000 members. Several months before the campaign Lagos called for the formation of a Council for Social Dialogue to unite commerce, government and unions. This was well received by most of the sectors except big fishing businesses. The representatives of the big companies, Felipe Lamarca, President of the Society for the Promotion of Manufacturing Industry (SOFOFA), and Chairman of the largest Chilean fishmeal corporation.

Felipe Lamarca Manager of Angelini did not turn up for the first meeting between the President elect and the Confederation for Production and Commerce. Neither was Lamarca present at the first meeting of the Council for Social Dialogue.

Osvaldo Cubillos, General Secretary of the National Confederation of Chilean Artisanal Fishermen (Conapach) pointed out that individual transferable quotas would do irreparable damage, not only to the artisanal fishing sector but for the community in general. He said that the ITQs would mean giving away 2,000 million dollars worth of resources in the first 5 years of the application of the bill.

Juan Carlos Cardenas, Director of environmental organization Centro Ecoceanos and Luis Almonacid, member of the National Fisheries Council and Chairman of the organization of Captains and Engineers of the industrial fleet, both said the failure of the bill represents a strategic defeat of the attempts of the large consortia and transnational fishing companies for privatization, as well as a clear victory for the artisan fishermen, workers and environmentalists. This opens up new opportunities to promote greater democracy in Chile's fishing industry, and allow a more environmentally sustainable policy to be introduced (http://www.chiper.cl/reports/index.asp?r=97) (http://www.geocities.com/ecoceanos/NOTICIAS/nopudieron.html).

III. CONCLUSIONS: TOOLS OF SCIENCE, GOVERNANCE AND ECONOMICS FOR CHILE'S COASTAL ECOSYSTEM

With the expected resumption of free trade negotiations between the U.S. and Chile, once President Bush was granted trade promotion authority (TPA) (previously known as fast track), Chile's coastal ecosystem gains more importance and relevance. The FLACSO-IACERE international conference will take place in a timely fashion, addressing coastal zone issues especially within the globalization context that is gaining increasing preminence as free trade negotiations are expected to resume. The conference will address in detail the issues of labor and environment within the framework of free trade.

And an important area of our research focus is governance. How will policy be implemented in regional economies and ecosystems whose boundaries are not properly defined in terms of administrative and political parameters? Regional economies and ecosystems exist and interact among themselves and in the face of increasing globalization and international regionalization in an independent way from administrative boundaries. Therefore, the evolution of the political system must address this issue and come to terms with how ecosystems and regional economies are defined. *Ordenamiento Territorial* (OT) and de-centralization policies represent a step forward toward bridging the discrepancy between how administrative boundaries are designed and how regional economies and ecosystems function. It is our goal to assess how OT, de-centralization and other political/judicial reforms are trying to address this problem for better, sounder ecosystem and resource management policies.

We will have a specific policy discussion on coastal management. For this particular workshop we are drawing on current research in Chile on marine protected areas. All the forementioned issues will be discussed in a comparative context for which we will draw upon our multi-disciplinary and multi-national expertise.

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This discussion document is partly based on a digest that summarizes selected materials of a number of web site sources that are listed below. The purpose of the document is to highlight key themes that will be discussed in greater detail at the International Conference by FLACSO-Chile/IACERE on November 19-20, 2002.

For more information on IACERE and FLACSO-Chile please visit their websites at:

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