Terram Publications
Public Policy Statement Nº1

# The Value of Chilean Biodiversity

## Economic, Environmental and Legal Considerations

Currently there is evidence of the deterioration of essential components of biodiversity, which can be seen by soil erosion, deforestation, the strain on renewable resources and the contamination of both primary water sources and important biological habitats.

The disregard for nature motivated this attempt to show that biodiversity has an economic value, which is not being taken into consideration in decision-making. Various groups will find this to be a valuable report. Included are: those who are dedicated to the study of the environment, and those who will use it in making future decisions in Chile.

> *"It is our contention that biodiversity has an undeniable value that can be economically measured. We hope that this study will promote more investigation and bring about harmony between value and methodology."*

**Introduction**

Biodiversity refers to the variety of and variations among all living organisms. It is not the sum total of the organisms but instead it represents the diversity within and among them.

The Convention on Biological Diversity (CBD) recognizes the ecological, genetic, social, economic, scientific, educational, cultural, recreational and aesthetic values of biodiversity and promotes the sustainable use of its components and the equitable distribution of the benefits.

Though many countries of the world recognize CBD, biodiversity is being threatened so seriously that two million species of plants and animals could become extinct by the end of the 21st century.

Chilean biodiversity is also being threatened on several fronts. By the end of 1999, 50 species of animals were endangered and another 92 were "vulnerable" to extinction. Although studies have shown evidence of the destruction, there has been no official acknowledgement made regarding the potential loss created by this depletion. Moreover, value is placed on products obtained by direct exploitation and not on that which suffers from the exploitation. Unfortunately, decisions are being made that promote exploitation rather than the preservation of biodiversity.

**State of Protection of Chilean Vertebrates**

| | *Mammals* | *Birds* | *Reptiles* | *Amphibians* | *Fish* |
|---|---|---|---|---|---|
| Endangered | 15 | 10 | 1 | 6 | 18 |
| Vulnerable | 15 | 32 | 13 | 9 | 23 |
| Rare | 12 | 12 | 18 | 10 | 1 |
| Threatened | 2 | 0 | 0 | 0 | 0 |
| Inadequate studies | 7 | 18 | 13 | 6 | 2 |
| Conserv. Problem | 51 | 72 | 45 | 31 | 44 |
| Extinct | 1 | 1 | 0 | 0 | 0 |
| Out of danger | 6 | 0 | 0 | 0 | 0 |

Source: State of the Chilean Environment - Produced by the University of Chile

The purpose of this study is to propose a methodology that can give an approximate value of biodiversity. This value will show that Chilean biodiversity is not only important because of its magnitude and degree of endemism but also for the potential value of its services.

An English summary of the report:
El Valor de la Biodiversidad en Chile
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## DESCRIBING CHILEAN BIODIVERSITY

This study will divide biodiversity into three types: genetic, species and ecosystem. Genetic diversity represents variation among living organisms while species are referred to as the population of genes, which moves around according to the conditions of nature. It is important to recognize the variety among the species and the extent of its endemism. Lastly, ecosystems are groups of vegetables, animals and microorganisms that interact as a functional unit.

## CHILEAN GENETIC DIVERSITY

Although Chile has signed the International Undertaking on Plant Genetic Resources, there is not a globally organized attempt to collect and preserve genetic resources. Notwithstanding, private sources reveal that the Chilean flora has 5,215 species of plants, including native and introduced, 45% of which is endemic. Variety and endemism have promoted attempts to analyse the structure of certain species so as to know their potentiality for future manipulation. Most national studies are being carried out on potatoes, eucalyptus globules, lucuma, papaya, boldo and lavender. The forestry and fruit tree species represent the primary groups of study at a national level while vegetables, cereals, plants and others are almost left out. In fact fruit tree and forestry species are the focus of university laboratories, while in the commercial laboratories the focus is on fruit and plants.

> "Much of the Chilean fauna's genetic diversity has been used for medical purposes. Approximately 561 plant species, 10% of the Chilean flora, have medical properties."

More than 30 species of fruit existing in Chile are endemic. However, only two of these are listed as genetic resources: the "lucuma" and the "tumbo". Also of importance are the wild strawberry, the hazelnut and the murtilla.

## GENETICALLY MODIFIED ORGANISMS

Projects working with genetically modified plants have as their goal to improve the marketability of the products. Within Chile, one hundred and four food items have been detected with genetically modified characteristics. Additionally, some of the foods that are being exported are raised with modified seed.

Chile has been allowing genetic modification since 1992 when experimentation was first carried out on tomatoes and rape (used for fodder). Since then the modified foods, the hectares being used for transgenetic agriculture and the number of animals being modified have greatly increased.

> "Though it is true that Chile doesn't have a large number of different species, its potential is due to the genetic diversity among its species and the presence of numerous endemic species."

## SPECIES DIVERSITY

The species in Chile can be classified as: a) Plants and Fungi, b) Invertebrates, c) Vertebrates. Chile has about 12,000 different species of plants and fungi but unknown fungi could double that number. Invertebrates outnumber all other organisms in Chile. In fact 24,000 species of insects have been identified in Chile.

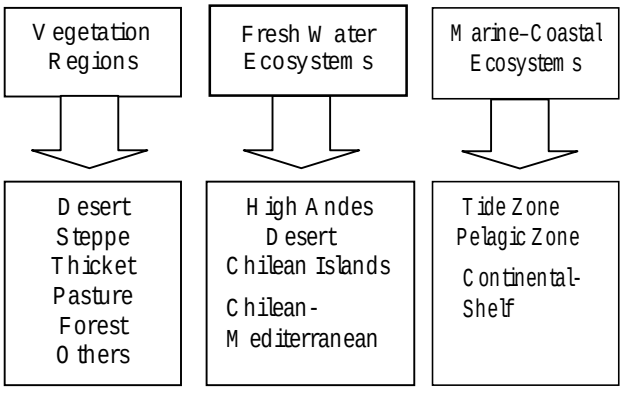
The total number of identified vertebrates in Chile reaches 1,767 wild species, 40 introduced species and 137 endemic species.

## ECOSYSTEM DIVERSITY

The Chilean surface can be classified within three ecosystems. These are: a) Vegetation, b) Fresh Water, c) Marine and Coastal Plains. According to a study by the University of Chile, the eco-regions present a high level of endemism. Chile also has seven fresh water regions of endemic importance: Mediterranean Chile of the North and South, Juan Fernandez Island, Valdivia, Chiloe Island and the Archipelago of Chonos and Magallanes. The Chilean coastline extends for 4,080 kilometres and includes many different biological and oceanic environments. Finally, the Continental Shelf, which is, located in Chilean waters measures 27,472 square kilometres.

In short, Chilean biodiversity is not characterized by the large quantity of species but instead by the high level of endemism when compared with other countries having similar climates. The high level of endemism is due to Chile's geographical isolation, variety of climates, limited continental area and evolution of its fauna. For example, 46% of the plants in Chile are endemic, with dicotiledones as the organisms with the largest group of species and the greatest level of endemism (83.5% in the islands of Chile). Although fish represent the largest group of vertebrates, they only represent 5.3% of the existing species in the world. Amphibians make up the group of vertebrates with the highest level of endemism (76.7%). Though invertebrates constitute the largest number of organisms in Chile as well as in the world, there is no information available regarding the level of endemism among them.

Furthermore, even Chilean ecosystems have endemic characteristics; 25% of the vegetation eco-regions and 70% of the fresh water regions are endemic.




**PROTECTION OF CHILEAN BIODIVERSITY**

After identifying the characteristics of Chilean biodiversity, it is necessary to look into the state of its conservation. This will allow us to determine if Chilean biodiversity is in danger and, if so, to recognize the factors which are causing its demise.

The principal cause for genetic erosion in plants is increased productivity, especially in agriculture, which has led to the abandonment of traditional species and an excessive use of pesticides. In northern Chile, the *Bromus mango*, *Oxalis tuberosa* and *Chenopodium* have disappeared from the local diet because of the lack of planting. *Lycopersicon chilense* and *eruvianum* are in danger of extinction because of an intensive campaign to control weeds. Additionally potatoes such as *S. lycopersicoides*, *S. rickii* and *S. Magalia* have suffered genetic erosion because of the use of genetically altered potatoes. In the northern Chilean High Plains, 58% of the potatoes are genetically altered and are showing signs of crossbreeding with various commercial species.

Different methods are being used to insure biodiversity by collecting and warehousing pollen, seeds, etc. The problem with these collection banks is that many species are later eliminated due to lack of desirable genetic qualities. The banks become part of the selection rather than the collection process. This is done because limited budgets don´t permit large quantities of species.

Biosecurity is lacking in the programs to develop genet-ically modified plants. Since 1994, 99% of all genetically modified plantings have done without any biosecurity quarantine.

For example, the lifting of the biosecurity quarantine from genetically altered corn, Soya and rape (used for fodder), means that there is neither a minimum distance nor any special measures required to avoid pollen contamination with other species. In the case of corn, there could be contamination in twenty-three prehistoric corn species, seven of which are threatened with extinction. Genetically altered rape (used for fodder) could contaminate 4 species of wild grass and transform them into super-weeds. Genetically altered tomatoes could cause irreversible damage to the native tomato (*Lycopersicon chilense*) and the same is true for the 165 varieties of native potatoes in Chiloe.

Among the tree and bush population in Chile, 11 species are classified as endangered, 26 as vulnerable and 32 as rare. All of those classified as endangered are endemic while more than two thirds of the vulnerable and rare species are endemic. Additionally there are two groups of land and Continental Shelf vertebrates that are classified as extinct while another 50 are considered endangered,

92 vulnerable and 53 rare. On a national scale 35% of vertebrates are currently being threatened in some form.

Looking at Chilean ecosystems from the perspective of eco-regions, we arrive at the following conclusions: a) Eleven of the 12 land eco-regions have problems with degeneration. Of these, three are classified as endangered. Two of them are endemic eco-regions, b) Eight eco-regions are considered to be vulnerable and one of these is endemic – the Atacama Desert, c) Only two of the ten fresh water eco-regions do not have problems with degeneration.
d) Four eco-regions are considered to be endangered. They represent 9% of the 43 eco-regions in Latin America and the Caribbean considered to be endangered. e) The two eco-regions that are considered to be vulnerable represent 4% of the "vulnerable" eco-regions of Latin America and the Caribbean.

In short, in spite of the fact that the majority of the Chilean species have not been classified for special protection, information reveals that an important part of Chilean biodiversity and ecosystems are in danger of disappearing.

**LEGISLATION REGARDING BIODIVERSITY**

Chile has signed the major, international environmental treaties, which recognize the human impact on nature and the need to develop national policies for the preservation of biodiversity. Chile has taken action, through certain national documents, to express its concern for biodiversity.

> The Chilean Constitution establishes that citizens have the right to live in an environment free from pollution.

The Constitution considers environmental protection to be a vital ingredient of social function and therefore declares that specific pro-environment restrictions can be applied. There are many norms but none of them are specifically applied to biodiversity.

Secondly, laws exist which regulate the development of certain activities and projects. Approval for these projects or activities is based on the quantity and quality of adverse effects that they cause on renewable natural resources, including soil, water and air; location in relation to people, protected areas, anticipated aesthetic changes and the impact on tourism. Though there is criteria requiring environmental impact assessment studies for individual natural resources, there is none for biodiversity, which is the interrelationship between these elements.

> Chilean laws serve the purpose of regulating commercial activities that impact the environment rather than striving to protect natural resources.

Laws (D.S. 4363 and DL 701) regulate forestry. These laws regulate the activities of the industry more than the protection of the native forest. Furthermore these laws refer to the "forests" as the places of forestry activities and they are not described in relation to ecosystems.

Laws permit the President of Chile to set aside lands for parks but there is a contradiction since the same laws allow certain economic incentives to forest industry development that increases commercial exploitation. Unfortunately, these laws have led to tree plantations which have caused the destruction of native forests.

Because of the systematic destruction of the native forests, *Decretos Supremos* Nº490 and Nº43 were passed for the protection of two specific native species: the araucaria and the alerce. These trees can only be cut for scientific investigation, preparation of the land for public works, national defense and proper forestry management. These two species are protected from extinction but this shows the delicate nature of the native forests when the only protection is a total ban on cutting. In fact, a national native forest law which protects the forest does not exist.

Laws (4061 and 18,892) regulate activities, which affect fauna. Law 4061 prohibits the capturing of any wild components of the fauna, which are classified as endangered, protected, rare or relatively unknown. It also prohibits the commercialisation of these wild fauna or their by-products. It is important to note that to protect these species we must go beyond having the law and begin to take legal action against people involved in this illegal activity.

In Chile, there is a National System of Protected Areas (SNASPE) that watches over areas

of ecological interest through a network of national parks, sanctuaries and reserves. Although it was put into effect in 1984, the legal framework of this system has yet to be approved.

As is true with other laws, Law 18,392 controls the activities of the fishing industry and is not concerned about the protection of its natural resources.

Chilean laws are inadequate because they do not include all of the variety of biodiversity and deal with commercial activities, not preservation of biodiversity. Chile does not have a national policy regarding the protection of biodiversity. We are faced with the reality that the protection of our biological wealth is in the hands of governmental organizations, which are using obsolete tools that are not adequte for proper management. A clear policy and uniform laws would be of tremendous value for our national development.

**ECONOMIC VALUE OF BIODIVERSITY**

Biodiversity generates a flow of goods and services that benefit all living beings. From this perspective, the deterioration of biodiversity has become an underlying concern, which demands an efficient method of regulating its use and preservation.

The economic value of biodiversity is important because by incorporating the value of its uses more accurately, decisions can be made in relation to its preservation and exploitation. Nonetheless, reaching an accurate value of biodiversity is not an easy task because of its magnitude and economic characteristics.

From an economic standpoint, many environmental goods and services can be considered as public goods, with free access, in the presence of externalities. This characteristic does not allow the market to be a good guide for determining the correct social price per unit to be charged for the use of biodiversity. For this reason it is necessary to use alternative methodologies of economic valuation. In this sense, Mr. Day[1] concluded that the market underestimates the economic valuation of environmental goods and services because the market only considers the direct uses of biodiversity. The true economic valuation of biodiversity must include its direct, indirect and optional uses.

Natural resources have different uses and services, each of which has an associated value. The market is incapable of comprehending these multi-uses and so methods of alternative valuation of natural resources are vital for achieving a representative valuation. We will present the Total Economic Value (TEV) of biodiversity. This standardization will allow us to give a subsequent economic value to Chilean biodiversity.

Due to the expanse of biodiversity, the practice of giving it a value that is not based on the market faces many challenges. The reason for the difficulty is that it attempts to assign economic value to goods and services that the majority of the people don´t realize they are using.

According to Mr. Krutilla[2], economists have come up with the concept of Total Economic Value (TEV) and thus have made major advances in classifying the individual values of each function of the environment. The concept is based on "use" and "non-use" values for the goods and services of the environment.

The "use" value is derived from the actual uses of the natural resources. It is divided into three categories:
a) direct use, b) indirect use, and c) option value. The principal characteristic of this valuation is that, given the direct relationship with the natural resources, any change in

Categories of economic values attributed to environmental assets

| "Use" values | | Total economic value | "Non-use" values | |
|---|---|---|---|---|
| Direct use | Indirect use | Option values | Bequest values | Existence values |
| Outputs directly consumed | Functional benefits | Future direct and indirect values | Use and Non-use value of environmental legacy | Value from knowledge of continued existence |
| Food, Biomass Recreation, Health | Flood control, Storm protection, Nutrient cycles | Biodiversity, Conserved habitats | Habitats, Prevention of irreversible change | Habitats, Species, Genetic, Ecosystem |

Source: Pearce D. y Moran D., 1994. The Economic Value of Biodiversity - The World Conservation Union UICN. London

these regarding their quality or quantity directly affects the well being of people.

The "direct use" value refers to the use of a resource in a specific location. The resources can either be consumed or non-consumed. In the first case, the resource is consumed by the activity that is being carried out, such as the case of the harvesting of fruit or fish while the second case would be a visit to a tourist location.

The value of "indirect" use considers that people do not have direct contact with the resource in its natural state but still receive benefits from it. This is true with the ecological and ecosystem functions such as flood, climate and storm control, recycling of nutrients and soil formation. On the other hand, the "option value" corresponds to what people are willing to pay now for its future use.

"Non-use" or intrinsic value refers to the inherent value completely apart from any type of direct or optional use. "Non-use" value includes "legacy" and "existence" values. Legacy value measures the personal benefit of knowing that others will be able to enjoy certain resources in the future while existence value is the valuation given to something just because it exists even though humans might never see or touch it. For example, it would be the satisfaction produced by knowing that a species exists in its natural habitat.

Direct, non-consumed use must be calculated through indirect methods such as the "Travel Cost" method or the "Contingent Valuation" method but the methods for calculating the indirect valuation of environmental goods and services have many possibilities which range from "Avoidance Costs" to "Restoration Costs". Additionally the "non-use" value can be calculated by using hypothetical market situations which measure individual preferences leading to an estimate of what people would be willing to pay for the species and habitat. Given the existing difficulty in fixing absolute values for indirect and non-use of biodiversity, it should be noted that the estimates for the TEV in this study represent only a small part of the true value.

> "As can be seen, the different uses of environmental goods and services have generated the need for a methodology of economic valuation, which is not rigid."

Costanza[3] et al. divided the world ecosystems into 17 macro categories and arrived at a yearly value of US$ 33,000 billion. Pimentel[4] et al. used a different method to arrive at his total value which was US$ 2,928 billion, a figure greatly inferior to that calculated by Costanza. In this study both the methods of Costanza and Pimentel will be used.

Using the Costanza method, Chilean biodiversity in 1999 is estimated at US$ 183,021 million. Of this value 46%, US$ 84,524.9 million (1999), represents the marine ecosystems and 54%, US$ 98,496.6 million (1999), the land ecosystems. Using the Pimentel method the total figure resulted in US$ 690 million.

The difference between these calculations can be explained by looking at the methodology of each investigator. Costanza formulated his calculations upon

TEV of the Chilean biodiversity according to Costanza and his Investigators

| Biomass | Superficies (Millions of ha.) | Total US$ Value 1999/ha/year | Total Value | |
|---|---|---|---|---|
| | | | US$ Million 1999/year | % |
| Ocean: | 371.7 | 227.4 | 84,524.9 | 46.18 |
| Land: | | | | |
| - Forest | 13.3 | 217.8 | 2,902.7 | 1.59 |
| - Pasture | 20.5 | 169.8 | 3,482.3 | 1.90 |
| - Wetland | 4.5 | 18,691.0 | 82,142.6 | 44.88 |
| - Lakes/Rivers | 1.2 | 8,113.6 | 9.830.3 | 5.37 |
| - Cultivation | 3.8 | 36.5 | 138.7 | 0.08 |
| Total-Ocean | 371.7 | 227.4 | 84,524.9 | 45.71 |
| Total-Land | 43.3 | 2,315.9 | 98,496.6 | 53.82 |
| Total-Chile | 41.5 | 445.5 | 183,021.5 | 100.00 |

Source: Fundación Terram.

the value of each one of the 17 macro ecosystems, which he identified in the world. Pimentel separated the different environmental goods and services into 14 separate categories and formulated a value for each one of these.

Having given an economic value to Chilean biodiversity, the next step is to analyse the results. First, we will analyse the importance of having an accepted economic value for biodiversity. After that, we will look at the differences in calculating Chilean biodiversity.

Recognizing the anthropocentric point of view of the study, we must face the fact that there is a circular relationship between quality and quantity of the services of biodiversity and man's actions. Man uses biodiversity to satisfy his needs and improve his quality of life but his use has caused a diminishing of the goods and services. In the short term this process affects man's well being but in the long term it will affect his existence. Why has man been so destructive to nature and not dedicated to the protection of the environment? It is true that there is a lack of understanding concerning the value of biodiversity, but the greater problem is the way that natural resources are treated in the marketplace and thus in the policy field.

When the value of nature is disregarded, economic exploitation takes preference over protection. In a world guided by economic forces where protection and exploitation decisions are faced, giving a value to biodiversity should not considered to be a bizarre idea.

## DIFFERENCE IN THE TOTAL ECONOMIC VALUE

As was previously seen, there exists a sizeable difference between the Total Economic Values (TEV) of the two methodologies used here: Costanza and Pimentel. This difference is explained by the divergent methodologies used.

Pimentel and his investigators calculated the value of biodiversity as a flow of goods and services at a given time. Pimentel used current prices to calculate the economic value of the services offered by the ecosystem.

It is recommended that the use of alternative methodologies for calculating economic value should include the willingness of people to pay for environmental goods and services. Pimentel thinks that this is an acceptable approach but he did not record the true measure of its impact upon the value of biodiversity.

### Services offered by the Chilean biodiversity According to Pimenteland his Investigators

| Services | Value US$ Million |
|---|---|
| Capture of carbon dioxide | 312.6 |
| Solid waste treatment | 128.3 |
| Soil formation | 47.4 |
| Ecotourismo | 41.0 |
| Biological pest control | 34.5 |
| Biotecnology | 32.0 |
| Nitrogen fixation | 25.5 |
| Increase in production | 17.3 |
| Biological control of cultivation | 15.2 |
| Pollenation | 13.3 |
| Natural resistance of plants | 10.2 |
| Forest resistance | 5.7 |
| Bioprospection | 4.9 |
| Permanent harvests | 2.4 |
| Total | 690.4 |

Source: Terram Foundation

tional level. The prices internalize the "willingness to pay" of countries with higher salaries than Chile, thus raising the mean. On the other hand, Pimentel's figures are very conservative.

Neither Pimentel nor Costanza considered biodiversity to be a natural capital but instead to be a flow of goods and services that emanate from this natural capital. Costanza´s TEV is greater than that given by Pimentel because his price level was higher and because he considered more services.

It would be incorrect to take a mid-point value of these results since they approach the problem in different ways. One can look at the differences in value in terms of current use of biodiversity services (Pimentel) and of potential uses (Costanza).

## CONCLUSION

What conclusions can be drawn from this study? Chile does not have a wide biological diversity but its wealth is found in the endemism of the components. Chilean biodiversity is important because it contains genetic wealth, which is unique in the world.

The state of natural preservation of Chilean biodiversity shows that because of the weak judicial framework, there has been overexploitation of its resources and contamination of its habitats. Current laws tend to regulate economic activities and not set into action that which will protect the environment.

Biodiversity is a natural asset, which sustains, among others, human life and economic activity, and so it is necessary to know how to protect it. In the decision-making process it is important to take into account the total value of biodiversity because it is the only way to defend its protection when the competing decisions are made based on economic fields.

The methods for calculating the true value of biodiversity are scarce, face serious limitations due to the lack of understanding of the interaction of the components of ecosystems, lack statistical investigations into the value of the environmental services and the value that people are willing to pay.

Because of these weaknesses in the system, it is easy to understand why the two estimates, presented here, of the Total Economic Value (TEV) of Chilean biodiversity are considerably different from each other. This is not the result of mathematical errors but the methodologies used.

In any event, the estimate made of the economic value of Chilean biodiversity is important because even more than the results obtained, it allows for reflection upon the importance of its individual components. Hence it is possible to know that Chilean biodiversity has an advantage over other temperate climates, including tropical ones, because of its high levels of endemism.

## RECOMMENDATIONS

What solutions do we propose for the preservation of Chilean biodiversity?

- Create a national organization whose sole purpose is protecting Chilean biodiversity.
- Follow-up on all international agreements regarding the protection of Chilean biodiversity.
- Design economic instruments for the protection of the environment. E.g. create a special tax.
- Encourage studies that allow for an accurate value to be placed upon Chilean biodiversity.
- Look for new international markets for Chilean biodiversity services. From the profits, create a fund that would be used for its protection.
- Biodiversity should be a national legacy for future generations, so it must be our commitment to use it responsibly and recognize the value of the individual components.

The government should look out for the social interests of the people but in this case of national riches, public policy is absent. It is our hope that this effort might contribute to the correction of that error.

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[1] Dr. Day, quoted by Flores in La Valoración Económica de los Recursos Naturales Renovables.
[2] Mr. Krutilla, quoted by Hanley in Environmental Economics, In Theory and Practice.
[3] Mr. Costanza et al., 1998. The Value of the World´s Ecosystem Services and Natural Capital. - Nature Magazine, May 15.
[4] Mr. Pimentel et al., 1997. Economic and Environmental Benefits of Biodiversity. BioScience. Vol. 47 Nº11

### THE TERRAM FOUNDATION

The Terram Foundation is a non-governmental or-ganization born in 1997 through the combined efforts of a group of professionals from different backgrounds, committed to creating an institution which would stimulate a renewal in political, social and economic thinking. Today the institution is directed towards strengthening three areas of action: serious research into economic and environmental problems, legal actions and public communication. The overall objective of the institution is to generate proposals for sustainable development in Chile

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