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## Chilean Antarctic Statute and Environmental Impact Assessment: Regulatory considerations to protect the Antarctic environment and its dependent and associated ecosystems

*Estatuto Chileno Antártico y Evaluación de Impacto Ambiental: Consideraciones regulatorias para proteger el medio ambiente antártico y sus ecosistemas dependientes y asociados*

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**ABSTRACT** The Protocol to the Antarctic Treaty on Environmental Protection compels the Parties to the global protection of the Antarctic environment and dependent and associated ecosystems. Additionally, it includes an annex on Environmental Impact Assessment (EIA) requiring that the environmental impact of activities carried out in Antarctica are considered, before their commencement, in accordance with appropriate national procedures. In this context, our article addresses how EIA has evolved internationally and how the Chilean Antarctic Statute integrates international guidelines on the matter. Likewise, we reflect on the interactions between Antarctic and national EIA, highlighting their differentiating elements. Finally, we propose some elements to consider when regulating Antarctic EIA, particularly in relation to international guidelines and commitments.

**KEYWORDS** Antarctic environment, Environmental Impact Assessment, Madrid Protocol, Chilean Antarctic Statute, International Guidelines for Antarctic EIA.

**RESUMEN** El Protocolo al Tratado Antártico sobre Protección del Medioambiente obliga a las partes a la protección global del medioambiente antártico y de los ecosistemas dependientes y asociados. Adicionalmente, incluye un anexo referido a la Evaluación del Impacto Ambiental (EIA) que exige que el impacto ambiental de las actividades a realizarse en la Antártica sea considerado, antes de su inicio, de acuerdo con procedimientos

nacionales apropiados. En este contexto, nuestro artículo aborda cómo ha evolucionado internacionalmente la EIA y cómo el Estatuto Chileno Antártico integra las directrices internacionales en la materia. Asimismo, reflexionamos sobre las interacciones entre la EIA Antártica y la nacional, destacando sus elementos diferenciadores. Finalmente, proponemos algunos elementos a considerar al momento de reglamentar la EIA Antártica, particularmente en lo relativo a directrices y compromisos internacionales.

**PALABRAS CLAVE** Medioambiente antártico, Evaluación de Impacto Ambiental, Protocolo de Madrid, Estatuto Chileno Antártico, Directrices Internacionales para la EIA Antártica.

## Introduction

The importance of Antarctica as a global climate thermometer and sensitive ecosystem is often highlighted, as it is key to understand how the world works and our impact upon it. Considering it has been mostly untouched over centuries, it is a scientific paradise for investigating world evolution and a real indicator of world climate present and prospective changes.

The Antarctic international regime, and specially its environment protection, has developed on the efforts of several countries over the last seven decades, in which Chile has a leading as one of the twelve signatories of the Antarctic Treaty (1959), and in the adoption of related treaties and implementing protocols.

In this context, the Protocol on Environmental Protection to the Antarctic Treaty, or the Madrid Protocol (1991), plays a fundamental role in the Antarctic protection since it obligates all Parties to protect the Antarctic environment and its dependent and associated ecosystems, designating it as a “*natural reserve, devoted to peace and science*”. In doing so, Protocol provisions are implemented by means of several Annexes, among which one of the most relevant is the one on Antarctic Environmental Impact Assessment (Antarctic EIA), which requires all activities be preceded by EIA.

The EIA is a tool for the analysis and evaluation of activities to ensure an environmentally sound and sustainable development (UNEP, 1987). Its origins are rooted in the US National Environment Protection Act (1969) and has extended over several international instruments and treaties (Bermúdez Soto, 2015: 263), being the Madrid Protocol a relevant one as it covers an entire continent.

As required by the Madrid Protocol, activities to be undertaken in Antarctica are being subject to EIA procedures. Such task was coordinated in Chile by the Environment National Commission until 2010, when the country’s environmental governance was entirely replaced. Currently, the Ministry of the Environment conducts Antarctic EIA since overseeing international treaties on environment it is one of its main legal powers.

In this context, Law 21,255 or the Antarctic Statute (2020), aims at establishing a general framework to comply with Chile international commitments, being one of the most relevant the protection of Antarctic environment and its dependent and associated ecosystems, and the regulation of Antarctic EIA and its procedures.

As mandated by the Antarctic Statute, the Ministry of the Environment must enact regulations to provide for Antarctic EIA governance. In doing so, the Statute creates a special governmental entity which evaluates and certifies if an activity complies with applicable international and national regulations, leaving to further regulations its composition and functioning. In addition, the Statute provides that all activities must be preceded by different types of EIA, depending on whether the impact is less, equal, or greater than a minor or transitory impact; thus, leaving to regulations the task of determining when such criteria is met and the procedures to arrive a final decision.

In this context, our work outlines the international regulation for the protection of Antarctica. Then, we review the international development of EIA as an instrument for environmental protection and how it is incorporated to Chilean legislation. Later, we describe EIA under the Madrid Protocol and its implementation by Chilean Antarctic Statute. Finally, regulatory considerations are proposed to protect the Antarctic environment and its dependent and associated ecosystems, considering advancement in national EIA and international guidelines and commitments.

## **Environmental Protection of Antarctica**

It is common ground to assert that Antarctica is the most important natural laboratory in the world, which is based on the great variety of marine species that live in their waters and contains more than 90% of Earth's ice and 70% of all available fresh water. Likewise, Antarctica plays a fundamental role in humidity, winds, atmospheric pressure, and global temperatures that exert a gravitating influence on the world climate. Such characteristics plus an extremely sensitive ecosystem, highlights its role as a global indicator of fast-growing environmental changes. In fact, the Antarctic not only contains information of climate evolution as far as 800,000 years ago but has allowed confirming climate forecasts made in the 80's and 90's, tough at a higher pace (Klekociuk and Wienecke, 2016).

The concern about Antarctica protection has undoubtedly grown over the years as climate change exerts daring effects on their territory, which are prospected to be even more acute. As the Intergovernmental Panel on Climate Change (IPCC) recently stated, it is likely the Antarctic ice sheet will continue to be lost over the 21st century, since all global warming temperature scenarios indicate Antarctica warms more than tropics (IPCC, 2021: 16).

In this context, a regulatory system for the development of activities and Ant-

arctica protection is in place since mid-twentieth century. Although someone could imagine environmental issues were at the root of the adoption of international treaties and implementing protocols to protect Antarctica, that perception is mistaken. In fact, the Antarctic Treaty and its related agreements (collectively known as the Antarctic Treaty System or ATS) find its origin as a political and geostrategic international instrument that declares Antarctica peaceful purpose and accommodates multiple territorial claims in the Cold War era. Notwithstanding, the ATS has evolved to adopting legal instruments to the sustainable economic use of its natural resources and, lastly, to its environmental protection. As to the latter, the legal system has made space for such concerns and provided an appropriate legal framework, even though the challenges climate change poses ahead remained to be addressed (Ferrada Walker, 2012).

The ATS underpin is the Antarctic Treaty (Washington, 1959) signed by twelve countries including Chile and acceded to by many other nations. Its main provisions relate to the use of Antarctica for peaceful purposes, the facilitation of scientific research and cooperation, rights of inspection over other Parties' activities, the exercise of jurisdiction, and the preservation and conservation of living resources. As Ferrada Walker explains, the latter would entail an “*indiciary rule*” of what would be the ATS progression over time (2012: 138).

The protection of the Antarctic environment, although not the main reason behind the ATS, has been a central issue in the cooperation among Parties to the Antarctic Treaty. In fact, and as the ATS evolved to promote international instruments to guarantee the sustainable use of Antarctica economic resources, several measures<sup>1</sup> and additional treaties were adopted. Such as, the Convention for the Conservation of Antarctic Seals (London, 1972), adopted given the vulnerability of Antarctic seals to commercial exploitation and the consequent need for effective conservation measures. Over a similar reasoning, the Convention on the Conservation of Antarctic Marine Living Resources (Canberra, 1980) regulates harvesting activities, applying an ecosystem conservation approach.

This evolving context framed the adoption of the major advancement on Antarctica environmental protection. The Madrid Protocol establishes a framework for the comprehensive protection of the Antarctic environment and its dependent and associated ecosystems. Such a framework is based on a set of rules that lie on the following principles: (i) the designation of Antarctica as a “*natural reserve, devoted to peace and science*”; (ii) the protection of Antarctica as a fundamental provision to be considered in the planning and conduct of all activities; (iii) the need to evaluate

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1. In 1964, the Antarctic Treaty Consultative Meetings (ATCM) adopted measures for the conservation of Antarctic fauna and flora, which establish general and specific regulations that specially cover protected areas. Available at <https://bit.ly/32GY8GB>.

environmental impacts prior to the implementation of any activity; (iv) the prohibition of mining; (v) the requirement of emergency response for immediate action and contingency plans; and, (vi) the creation of the Committee for Environmental Protection to provide advice and formulate recommendations for the Protocol and Annexes implementation.

The Protocol Annexes are an integral part thereof and contain detailed regulations, considering the flexibility necessary to amend and include new provisions as needed by environment requirements and scientific knowledge advancement. Currently, the Protocol has six Annexes on the following matters:<sup>2</sup>

- Annex I, on Antarctic EIA, which establishes a legal framework for activities in Antarctica, considering the type of impact they are likely to generate. As such, it distinguishes among several types of EIA and regulates their content and procedures.
- Annex II, on conservation of Antarctic fauna and flora, which regulates their harmful interference, the prohibition to introduce non-native species unless exceptional permits are granted, and the designation of Specially Protected Species.
- Annex III, on waste disposal and management, which requires the least interference possible and their removal to their country of origin. Likewise, it requires the removal of waste from abandonment sites, prohibits the introductions of specific type of waste and requires waste management plans.
- Annex IV, on the prevention of marine pollution, which requires contingency plans for marine pollution response and prohibits the discharge of noxious liquid substances into the sea, as well as plastics and any other garbage.
- Annex V, on protected areas, which regulates the designation of Specially Protected and Specially Managed Areas and requires management plans.
- Annex VI, on liability arising from environmental emergencies, that regulates preventive measures to reduce the risk of environmental emergencies and their potential adverse impacts. Likewise, it regulates the liability of governmental and non-governmental operators that fail to take prompt and effective response action in case of environmental emergencies.

Among the Protocol Annexes, the EIA Annex is the most important, considering its provisions are applicable to across-the-board activities. As mentioned, it does not

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2. Annex I to IV were adopted in 1991 together with the Protocol and entered into force at the same time. On the other hand, Annex V was adopted in 1991 and entered into force in 2002, and Annex VI was adopted in 2005 and will enter into force once approved by all parties.

only contain provisions that guide evaluation procedures but also regulations that substantively inform the assessment and its outcome.

In this context, it worth noting that Antarctic EIA has not grown out of nothing but from an extensive development of international and national regulations. To a similar extent, Chilean EIA has followed a comparable path but incorporating some specifics due to the particularities of the Chilean legal system.

Considering the perspective such approach could shed over the implementation of the Protocol provisions on the Antarctic EIA national regulations, the following chapter will review the EIA international and national evolution.

### **Environmental Impact Assessment: international evolution and application in Chile**

The United Nations Environment Programme (UNEP) defines EIA as a tool used to identify environmental, social, and economic impacts of a project prior to decision-making. It aims to predict environmental impacts at an early stage in project planning and design, reduce adverse impacts, shape projects to suit local environments and show impact predictions and options to decision-makers.

EIA was introduced for the first time into legislation in 1969, by the United States National Environmental Policy Act (NEPA) and has gained widespread application throughout the world, by means of international recommendations, Multinational Environmental Agreements (MEAs), and the subsequent incorporation into national legislations.

To understand the importance and extent of the application of EIA as an environmental management instrument, we will review main international instruments and related MEAs, as well as the adoption thereof by Chile legal system.

#### Relevant EIA international instruments and MEAs

##### *World Charter for Nature*

The World Charter for Nature<sup>3</sup> established a series of principles, recognizing that Nature shall be respected, and its essential processes shall not be disrupted. As so, it states that conservation of Nature is an integral part of planning and implementation of social and economic development activities.

Likewise, it declares that its principles shall be appropriately reflected in States law and practice, as in the international level. Moreover, it declares that conservation strategies, ecosystem inventories, and the assessment of proposed policies and

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3. In October of 1982, at the 48th plenary meeting of United Nations General Assembly, Resolution 37/7 was adopted, also known as World Charter for Nature.

activities effects on Nature are an essential element of planning, that should be disclosed to public by appropriate and timely means to permit effective consultation and participation.

Finally, it emphasizes the importance of natural processes, ecosystems, and species status, which shall be monitored to enable early detection of degradation or threat, ensure timely intervention, and facilitate the evaluation of conservation policies and methods.

### *United Nations Convention on the Law of the Sea (UNCLOS)*

UNCLOS (1982) gave a special place to environmental matters, especially to monitoring and environmental assessment. In effect, it provides for the monitoring of pollution risks or effects on the marine environment, mandating States to observe, measure, evaluate and analyze them.<sup>4</sup> In addition, it requires the assessment of planned activities when there are reasonable grounds for believing they may cause substantial pollution of, or significant and harmful changes, to the marine environment.<sup>5</sup>

### *European Union EIA Directive<sup>6</sup>*

The Directive establishes that certain projects (Annex I) require mandatory EIA, while others (Annex II) are subject to national authorities' decision. This Directive has been modified several times over the years, strengthening evaluation procedures and standardizing EU national regulation. Among other elements, the Directive defines types of projects subject to EIA; elements to be identified, described, and assessed; responsible authorities; public participation; and grounds to exempt a specific project from EIA procedures.

### *EIA goals and principles*

A set of EIA goals and principles were adopted by the Governing Council of UNEP<sup>7</sup> affirming that States (including their competent authorities) should not undertake or authorize activities without prior consideration, at an early stage, of their environmental effects. Furthermore, it requires a comprehensive EIA where the extent, nature or location of a proposed activity is likely to significantly affect the environ-

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4. UNCLOS, Article 204.

5. UNCLOS, Article 206.

6. Directive 85/377/CEE of the European Parliament and of the Council, on the assessment of the effects of certain public and private projects on the environment, was adopted in June 1985.

7. In January of 1987, the Governing Council of UNEP adopted Decision 14/25 "Goals and Principles of Environmental Impact Assessment".

ment. Finally, it contains other relevant principles regarding EIA contents, information, public participation, activity supervision, among others.

*Convention on Environmental Impact Assessment  
in a Transboundary Context (Espoo Convention)*

The objective of the Convention (1991) is to take all appropriate and effective measures whether legal, administrative or any other to prevent, reduce and control significant adverse transboundary environmental impacts from proposed activities. By such, it requires Appendix I activities to be subject to environmental impact assessment procedures that allow public participation.

*Rio Declaration on Environment and Development*

In 1992, the United Nations Conference on Environment and Development proclaimed a series of principles towards sustainable development and promoting international agreements to protect the integrity of the global environmental and developmental system.

Notwithstanding its soft-law nature, the Rio Declaration has become a roadmap for environmental regulations both domestically and internationally. In this context, Principle 17 establishes that EIA shall be undertaken for proposed activities that are likely to have a significant adverse impact on the environment and are subject to a decision of a competent national authority.

As this chronological review shows, the importance of evaluating impacts on the environment has exceeded national jurisdictions. In fact, EIA has gone from international guidelines for national jurisdictions to complex MEAs covering sea pollution, transboundary impacts, and even impacts in continents such as Antarctica.

In this context, the Madrid Protocol is part of an array of EIA international instruments that have evolved over time as environment evaluation and scientific knowledge has increased. In doing so, the Madrid Protocol plays a significant role in that is one of the first MEAs covering EIA in a way that frames national EIA for signatory countries, focusing not only on procedures but also on substantial provisions. Such a characteristic is very relevant and distinctive since EIA is generally labeled as a third-generation instrument, which means it relies upon environmental policies and substantive regulations that set obligations and requirements to be operative.

## EIA in Chile

EIA in Chile has been applied for more than two decades and gained a fruitful experience by the implementation of Law 19,300, on General Basis of the Environment,



which can be instrumental in supporting national procedures for Antarctic EIA.<sup>8</sup> As well as international instruments, national EIA is by nature a preventive management tool by which action is taken prior to a project or activity implementation to mitigate, repair or compensate their environmental impacts.

As such, EIA is a procedure by which activities or projects must certify whether their environmental impacts comply with current regulations based on a general (Environmental Impact Statement) or a detailed analysis (Environmental Impact Study).

The Chilean system, as in comparative laws, is structured following different phases of analysis focused on the type of project to be evaluated, identification of relevant impacts, scope of evaluation depending on the impact significance, approval, supervision, and public participation and disclosure.

### *Screening*

Law 19.300 uses a standardized system for determining whether a project or activity needs to undergo evaluation, setting a list of projects or activities that may impact the environment significantly and requiring their assessment prior to implementation. As such, impacts or risks are not considered at this early stage, since the list of projects and activities is limited and restrictive. Such a regulatory decision provides certainty to developers, forbidding the inclusion of new projects or activities unless the law is modified.

### *Scoping*

The scope of the project or activity is determined by identifying their influence area and reviewing base line studies thereof. This will determine which impacts are considered in the assessment procedure.

### *Preparation*

Projects and activities need to be evaluated depending on the significance of environmental impacts by means of an Environmental Impact Statement or Study. The general rule is they will be subject to a procedure under an Environmental Impact Statement unless projects generate significant effects, characteristics, or circumstances, case in which they will be subject to a more comprehensive procedure under an Environmental Impact Study.

The list of significant effects, characteristics, or circumstances include: human health risk due to the quantity and quality of effluents, emissions or waste; significant

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8. Chilean EIA finds its origin in Law 19.300, on General Basis of the Environment, enacted in 1994 and started implementation in 1997 when its first regulations were drafted.

adverse effects on the quantity and quality of renewable natural resources, including soil, water and air; resettlement of human communities or significant alteration of their life systems and traditions; location in or nearby protected areas; significant alteration of landscape or tourist value; alteration of sites belonging to cultural heritage; among others.

The Environmental Impact Statement or Study must identify impacts to rule them out or propose mitigation, reparation, or compensation measures, in case significant impacts are generated. In doing so, mitigation measures aim at avoiding or reducing adverse effects. On the other hand, reparation measures are for restoring environment components or elements to a quality similar to what they had before they were impacted and, if not possible, restoring their basic properties. Finally, compensation measures are intended to produce or generate an alternative positive effect equivalent to an adverse effect, which cannot be mitigated or repaired.

### *Approval*

The Environmental Impact Statement or Study will be reviewed by competent sectorial authorities and the Environmental Assessment Service (technical agency). After the process is concluded, the agency issues a consolidated evaluation report to the Environmental Assessment Commission (political entity) that will approve or reject the project. If approved, an environmental permit is issued.

### *Supervision*

The environmental permit contains the conditions upon which the project is approved and regulations it should comply with; mitigation, reparation or compensation measures, if appropriate; and, monitoring obligations that enable proper supervision, among others. In this context, the permit holder must strictly comply with such contents.

The Superintendency of the Environment oversees compliance with permits provisions by means of monitoring and supervision programs. If a deviation is detected, it initiates sanctioning procedures that may lead to fines, and suspension or revocation of permits.

### *Public participation and disclosure*

Public participation is always required for Environmental Impact Studies, while in Environmental Impact Statements take place only for certain projects or activities and as long it is required in a timely manner by public.

Participation mainly consists of submitting comments to the project or activity

and to obtain a proper answer. If not the case, citizens or organizations that made such observations may challenge the legality of the procedure before Environmental Courts. Regarding disclosure, it must be noted that EIA file is publicly available; thus, citizens may access and review all documents submitted in the process, as well as governmental authorities' requirements and decisions.

### **Environmental Impact Assessment under the Madrid Protocol and its implementation by Chilean Antarctic Statute**

In the context of international EIA evolution, the Madrid Protocol and specially its Annex I is not only a good example of EIA provisions that were prevalent at the time of its enactment but is at the forefront of substantive regulations and requirements to protect the environment. Such provisions must be adequately considered as national legislations need to guarantee compliance with the Protocol, which is precisely what the Antarctic Statute does as it incorporates international obligations and ensures that are complied with by several regulatory means.

#### **The Madrid Protocol and EIA**

The comprehensive protection of the Antarctic environment and its dependent and associated ecosystems is the Protocol main objective which steamed from the underlying designation of Antarctica as a “*natural reserve, devoted to peace and science*”. Being its main objective, provisions ranging from the prohibition of certain activities which are deemed to be against that purpose such as mining, to the requirement that all activities must be planned and implemented following the Protocol environmental principles and always be preceded by their EIA.

In doing so, the Protocol contains substantive and procedural provisions which are intended to inform the development of activities of any sort, which are further detailed in its Annex I.

#### *EIA substantial provisions*

The Protocol article 3 contains an environmental principle which is a fundamental rule to be applied in the planification and implementation of all activities in Antarctica.

That is, all activities must consider (i) the protection of the Antarctic environment and its dependent and associated ecosystems, and (ii) Antarctica intrinsic value, which includes wilderness and aesthetic ones, as well as scientific research values, being especially important those essential to understanding the global environment.

This rule provides a benchmark for the evaluation of impacts in Antarctica which in case of activities means that priority is given to scientific research and to preserve the value of Antarctica to conduct such research. Additionally, means that all activities must limit their adverse impacts.<sup>9</sup>

As the Protocol states all activities must “avoid” such impacts, that is refrain from causing effects that are deemed to be “adverse”, “significant”, “detrimental” “further jeopardize”, “degrade” or pose a “substantial risk”. This demonstrate that activities not only must be evaluated prior to its implementation but planned in way that such effects are limited to the extent possible. In fact, this rule expresses the importance of Antarctica in that the EIA is a procedure to identify impacts and take appropriate measures, as crafted in other EIA regulations, and a substantial provision that limits the scope of activities at an early stage.

In addition, the Protocol not only protects common environment components such as flora, fauna, endangered species, areas of special relevance, and air and water environments, but also elements that are at the core of the Antarctic protection, such as climate and weather patterns. This is of the utmost relevance considering the effects Antarctica has on the world climate and the changes it has experienced and continues experiencing due to climate change influence.

At the core of Antarctic EIA is the quality of information used to identify possible impacts. In effect, the Protocol requires that any decision must be taken based on “*information sufficient to allow prior assessments of, and informed judgments about [possible impacts]*”. To that end, it requires a level of information prior to the implementation of the activity such as its scope (including area, duration and intensity); the existence of cumulative impacts; the possibility of detrimental effects to other activities; whether environmentally safe operations can be undertaken considering technology and procedures; whether there is capacity to monitor key environmental parameters and ecosystem components; and, whether there is response capacity to accidents, particularly those that may cause potential environmental effects.<sup>10</sup> In addition, the Protocol establishes requirements after activities implementation such as “*regular and effective monitoring*” to verify predicted impacts and the early detection of unforeseen effects.<sup>11</sup>

These environmental provisions inform the development of activities in Antarc-

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9. Article 3 section 2 a) and 3 of the Madrid Protocol. Limiting adverse effects imply that activities must avoid such effects on climate or weather patterns; significant adverse effects on air or water quality; significant changes in the atmospheric, terrestrial, glacial or marine environments; detrimental changes in the distribution, abundance or productivity of species or populations of species of fauna and flora; further jeopardy to endangered or threatened species or populations of such species; or, degradation of, or substantial risk to, areas of biological, scientific, historic, aesthetic or wilderness significance.

10. Article 3 section 2 c) of the Madrid Protocol.

11. Article 3 section 2 d) y e) of the Madrid Protocol.

tica since they can only be approved if they are consistent with such regulations and once approved may be modified, suspended, or cancelled altogether if they cause or threaten to cause impacts that are inconsistent with such regulations.

As mentioned before, the Protocol constitutes an enormous advancement in environmental protection in Antarctica since it imposes procedural obligations and substantial provisions that inform the results of EIA and decisions thereof.

### *EIA procedural provisions*

The way the Protocol assures that all substantial provisions are complied with is by establishing the EIA of all activities prior to be performed, or modified, in Antarctica. In doing so, article 8 states that all governmental and non-governmental activities for which is required prior notice to other Parties under the Antarctic Treaty must be environmentally assessed.<sup>12</sup> This in practice means that all activities must be preceded by EIA, unless expressly exempted by Annex I, as in the case of emergencies relating to the safety of human life, ships, aircraft or equipment and facilities of high value, or the protection of the environment;<sup>13</sup> or, by other applicable treaties.

In turn, the Protocol establishes a three-tiered EIA regime and Annex I fills them with content, depending on whether an activity causes a less than a minor or transitory impact, in which case a preliminary EIA is undertaken; a minor or transitory impact, in which case an initial EIA must be made; and, more than a minor or transitory impact, case in which a comprehensive EIA is required.

It is worth noting that neither the Protocol nor the Annex regulates the way impacts may be classified in one category or another, being national legislations in charge of filling that gap. This has been a controversial matter since the Protocol adoption as there are no subsequential guidelines and it is hard to define and operationalize such criteria, thus leaving countries with the challenge to determine their key elements (Hemmings and Kriwoken, 2010: 191).

As Annex I clearly states, the types of EIA differentiate themselves as to scope, content, and procedures to be undertaken for its finalization.

In the case of the preliminary EIA, Annex I requires that if it is determined an activity causes a less than a minor or transitory impact, may be undertaken right

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12. Article VII (5) of Antarctic Treaty states that “Each Contracting Party shall, at the time when the present Treaty enters into force for it, inform the other Contracting Parties, and thereafter shall give them notice in advance, of (a) all expeditions to and within Antarctica, on the part of its ships or nationals, and all expeditions to Antarctica organized in or proceeding from its territory; (b) all stations in Antarctica occupied by its nationals; and (c) any military personnel or equipment intended to be introduced by it into Antarctica subject to the conditions prescribed in paragraph 2 of Article I of the present Treaty”.

13. Article 7 (1) Annex I Madrid Protocol.

away. That is, there is no need of subsequent procedures. The issue again is how to determine such an impact is foreseeable in a specific case, which is left to national regulations.

On the other hand, if an activity causes a minor or transitory impact, an initial EIA is required. In that case, there is a requirement to previously discard the need of a comprehensive EIA, to which end the activity must be described including its purpose, location, duration, and intensity, and consider the analysis of alternatives to the activity and its impacts, including cumulative impacts of existing and planned activities. If verified an activity is likely to have no more than a minor or transitory impact, the activity may be undertaken only if appropriate procedures are in place to verify such impacts, including monitoring.

If the analysis of an initial EIA determines that more than minor or transitory impacts are likely, a comprehensive EIA is necessary. Such EIA must comply with several requirements considering the extent, entity and effects of likely impacts, which includes the activity description; the analysis of alternatives to the activity and its impacts, including the possibility of not proceeding; the description of a baseline and its evolution without the activity; the prediction of likely direct and indirect impacts, considering its nature, extent, duration, and intensity; the consideration of cumulative impacts of existing and proposed activities; identification of mitigation or minimization measures to tackle identified and unforeseen impacts, as well as measures to deal with contingencies; the identification of effects on scientific and research activities and other core values; and, the identification of scientific uncertainties; among others.

In addition to comprehensive EIA content, Annex I provides for international participation provisions. In fact, it requires that a draft of the comprehensive EIA is made public for comments to other Parties to the Protocol, which in turn make it available for comments for a 90-day period. Additionally, such a draft must be submitted for the consideration of the Committee for the Environmental Protection at least 120 days before the next Antarctic Treaty Consultative Meeting, whose opinion must be considered prior any final decision. Finally, a definite comprehensive EIA must address and include all comments received, and the final decision must be circulated to all Parties, which in turn will make it publicly available at least 60 days before the activity is undertaken.

As the description of the different EIA types shows, the three-tiered level of analysis focus the requirements on the likely impacts the activity may generate and it is more detailed in scope, content, public participation and international scrutiny as the impact's intensity, duration, effects, and possible outcomes increases.

Additional provisions apply to across-the-board EIA regarding monitoring of activities, aiming to identify whether impacts are consistent with Protocol provisions and, if required, the need to modify, suspend or cancel any activity. As of compre-

hensive EIA, the requirement is stricter in that environmental indicators must be appropriately monitored to verify predicted and unforeseen impacts. Finally, it imposes obligations to countries to report to other Parties a description of preliminary EIA procedures, list of initial EIAs and decisions adopted, significant information obtained from monitoring obligations, and decisions adopted in comprehensive EIA procedures.

### The implementation of the Madrid Protocol and the Chilean Antarctic Statute

The Protocol is comprehensive of both substantial and procedural matters for the development of activities in Antarctica, but it not enough to make national activities compliant with them. In effect, Parties have the obligation to adopt national measures to ensure compliance with the Protocol, including laws and regulations, administrative actions, and enforcement measures. Such obligation extends to the duty to employ appropriate efforts, so no one engages in activities contrary to the Protocol provisions, as well as obligations to notify such conducts.<sup>14</sup>

In this context, Chile has enacted the Antarctic Statute (2020) which is a framework law intended to comply with international commitments acquired by Chile in the Antarctic in a comprehensive manner. In doing so, the objectives of the Statute are to: (i) strengthen Chile sovereign rights over Antarctica, with geographic, diplomatic, historic, and legal grounds; (ii) establish principles upon which Chile conducts Antarctic policy and exercise its powers; (iii) promote the protection of the Antarctic environment and its dependent and associated ecosystems, as well as its condition of a natural reserve, devoted to peace and scientific research; (iv) regulate Chilean governmental and non-governmental activities in Antarctica, increasing its role as a provider of operative, logistic, technological and scientific services; and, (v) encourage Antarctic activities, promoting social and economic development in the Magallanes and the Chilean Antarctic region.

As the Statute clearly states, one of its main objectives are those related to the protection of Antarctica and its dependent and associated ecosystems, including a very similar wording to Protocol provisions. In fact, the Statute provides for the protection and conservation of the environment as a general principle, waste elimination and treatment, Antarctic EIA, obligations in case of environmental emergencies, environmental damage liability, and environmental crimes.

Regarding the Antarctic EIA, the Statute establishes a specific governance and regulates the content of each type of EIA and relevant procedures.

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14. Article 13 (1) and (2) of the Madrid Protocol.

### *Antarctic EIA governance*

A very distinctive matter of Antarctic EIA is that mixes the assessment of competent environmental and sectorial authorities, as in the national EIA, with the involvement of the Foreign Affairs Ministry, which is grounded on international and diplomatic issues that could arise from the development of activities in Antarctica.

A good example of that, it is the fact that projects and activities prior to be evaluated must be submitted to the Foreign Affairs Ministry, which verifies that non-governmental activities are consistent with the National Antarctic Policy<sup>15</sup> and Chilean foreign policy. It must be noted that governmental activities are not required to undergo this procedure if they are included in the National Antarctic Program,<sup>16</sup> case in which such consistency is taken for granted.

After receiving the Foreign Affairs Ministry validation, if required, the proposer must submit the project or activity to the Antarctic EIA Operative Committee which oversees the evaluation of environmental impacts and certifies they comply with international and national obligations. Once the Committee grants its opinion, it is the Foreign Affairs Ministry that issues the authorization. Additionally, the Ministry may order the modification, suspension or cancelation of a project or activity when it causes or threaten to cause impacts that are inconsistent with Protocol principles.

It is worth noting that the Committee depends on the Ministry of the Environment as it is the national governmental entity that oversees compliance with international treaties on environmental matters.<sup>17</sup> Although the Statute defines the Committee functions to some extent, the composition thereof and functioning rules are to be set by specific regulations enacted by such Ministry.

### *EIA substantial provisions*

Following the Protocol provisions, the Antarctic Statute states that all activities must undertake an EIA preceding its implementation, including governmental and non-governmental activities especially those requiring prior notice to the Antarctic Treaty Secretary, except for fishing and extracting activities which are regulated by the ATS related treaties.

The Antarctic Statute recognizes three types of EIA, depending on whether they cause a less than minor or transitory impact (preliminary EIA), a minor or transitory impact (initial EIA), or more than a minor or transitory impact (comprehensive EIA).

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15. The National Antarctic Policy states Chilean objectives in Antarctica, which is proposed by the Council on Antarctic Policy and approved by the President.

16. The National Antarctic Program is the set of tasks and activities annually planned by governmental agencies in compliance with the Antarctic Strategic Plan.

17. Article 70 (d) Law 19,300.



It is worth noting the Statute follows the Protocol provisions as described above and leaves several matters to the regulations to be enacted by the Ministry of the Environment. For instance, regulations must determine (i) the activities and projects to be submitted to EIA; (ii) EIA minimum contents depending on the type of evaluation; (iii) criteria, parameters, and indicators that allow defining when a less, equal, or greater than a minor or transitory impact is caused; y, (iv) the EIA administrative procedure including phases, periods, coordination of competent authorities, activities modification and clarification mechanisms, and notification of final decision.

Considering the Protocol and Annex I establishes mandatory content for the Antarctic EIA, it is relevant highlighting the novelties the Statute additions since they undoubtedly complement and improve international obligations. Among others, such improvements relate to the following:

i) *Homologation procedure*. The Statute establishes a simplified EIA procedure in case a foreign non-resident executes or participates in a non-governmental activity that is initiated or organized from the rest of the national territory. In such a case, and if the activity holds a permit issued following an equivalent EIA procedure by a third Party to the Protocol, there is no need to follow through the complete Antarctic EIA procedure. Compliance with these requirements must be qualified by the Foreign Affairs Ministry, considering the opinion of the Antarctic EIA Operative Committee, under a procedure set by specific regulations.

ii) *Preliminary EIA procedure*. The Statute states that all types of EIA require a procedure to determine whether the criteria of minor or transitory impacts are met and, thus, the type of applicable EIA. In doing so, the Statute innovates as to preliminary EIA provisions in the Protocol, which states that once a preliminary EIA is determined, the activity may be undertaken right away.

Additionally, it is worth noting the Statute does not define when an impact is “minor” or “transitory”, or more or less than that, but leaves such definition to the regulations to be enacted by the Ministry of the Environment, which must set criteria, parameters and indicators for such determination.

iii) *Comprehensive EIA procedure*. As to comprehensive EIA, the Protocol sets a streamline procedure for the involvement of the Protocol international bodies and Parties, without setting a national procedure for the evaluation of the activities subject to such type of EIA. This is a relevant difference with the Statute which requires a national procedure to evaluate comprehensive EIA before being submitted to international scrutiny in compliance with Protocol provisions.

## **Regulatory considerations to protect the Antarctic Environment and its dependent and associated ecosystems**

As we have discussed throughout this article, EIA is an important tool to protect the environment in general, and Antarctica in particular. The Chilean Antarctic Statute has mandated specific regulation on procedural and substantive Antarctic EIA. This mandate will have to be carried out building on the experienced gained through Chile's national EIA system (*SEIA*, by its acronym in Spanish) and considering international guidelines and commitments.

### **Antarctic and national EIA**

Chilean Antarctic Statute establishes a subsidiary rule regarding environmental issues, stating that Law 19,300 is applicable if there is no Statute provision and no contradiction thereto. Therefore, *SEIA* will be of great contribution to Antarctic EIA, contingent on their fundamental distinctions. To this effect, we reflect in the most important elements that difference both systems.

### *Overarching principles*

The preventive principle inspires *SEIA*, which means that measures must be adopted to address environmental impacts before they occur when there is certain risk thereof. On the other hand, precautionary principle motivates Antarctic EIA, which means that when there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation (Rio Declaration, 1992). In conclusion, *SEIA* acts under certainty of impact or risk, while Antarctic EIA operates even if impacts or risks cannot be fully estimated, which defines the approach to EIA and substantive provisions.

### *Necessity to undergo EIA*

This element is closely related to EIA underlying principles. The general rule in *SEIA* is that activities need no evaluation unless they are listed in a pre-established catalog of projects. Therefore, this is a manifestation of the preventive principle.

On the other hand, the general rule in Antarctic EIA is that all activities must undergo review to determine whether preliminary, initial, or comprehensive EIA is required, demonstrating a precautionary approach given Antarctica's uniqueness and fragility. In addition, there are certain activities that are strictly forbidden in Antarctica such as mining and nuclear activities, among others.

### *Prioritization of activities*

In SEIA there are no preferred activities, but rather an assessment of any type of activity if listed. Perhaps an exemption to this rule would be activities to be executed within protected areas. In those cases, such activities or projects must be consistent with the conservation objectives defined by the administrative declaration act, or by its management plan. In turn, activities conducted in the Antarctica shall give priority to scientific research and to preserve its value for conducting such research. This means impacts on scientific research activities must be considered during evaluation and, thus, may imply that mitigation measures are in place.

### *Impacts: significance, measures, and assessment of alternatives*

In SEIA, impacts with a certain significance are evaluated, so only those activities that are preestablished by law must undergo EIA. If not listed, activities only require sectorial permits. On the contrary, in Antarctic EIA, all impacts are considered, having a lesser impact threshold (minimum or transitory), widening the scope of activities that must be evaluated.

Regarding methods to address impacts, SEIA establishes mitigation, reparation, or compensation measures, which are prioritized following the same order. To address impacts in Antarctica, only mitigation or minimization measures are accepted, which is coherent with the Protocol requirement to avoid or limit adverse impacts on the Antarctic environment.

Finally, in SEIA there is no need to consider impacts of alternatives, but only address activity impacts properly, while in Antarctic EIA, both initial and comprehensive EIA require the analysis of alternatives, including cumulative impacts of existing and planned activities.

The experience of the SEIA can be of great contribution to Antarctic EIA, when considering the differences stated above. In addition to the SEIA, there are other relevant aspects to contemplate when regulating the procedure of EIA, as we will discuss next.

### International guidelines for Antarctic EIA

The Chilean Antarctic Statute requires the Ministry of the Environment to enact regulations regarding Antarctic EIA, containing, among other things, criteria, parameters and indicators that will determine whether an impact is less, equal, or greater than a minor or transitory impact.

However, it is no easy task since there is no agreement in what a minor or transitory impact entails. So, Chilean Antarctic Statute has given this obligation to the Min-

istry of Environment and, to do so, it will be paramount to incorporate experiences learned through the SEIA, the Madrid Protocol requirements, and also consider international guidelines, being the most important the Guidelines for Environmental Impact Assessment in Antarctica (Guidelines).<sup>18</sup>

The Guidelines highlight the importance of correctly identifying the intensity of exposure of an activity to make a reliable prediction of impacts. Furthermore, it lays out some elements that contribute to this identification, such as the temporal variation and cause-effect relationships. The former considers the interactions between an activity and an environmental value or resource over time, while the latter refers to determining the relationships between the activity and environmental values or resources.

Then, impacts need to be identified through the characterization of all changes in environmental values or resources resulting from the activity. After identifying an impact, its significance needs to be assessed.

Under the Guidelines, impacts may be identified by their nature (type of change imposed on the environment due to the activity); spatial extent (area or volume where changes are likely to be detectable); intensity (measure of the amount of change imposed on the environment due to the activity); duration (period during which changes in the environment are likely to occur); reversibility (possibility of the system to return to its initial environmental conditions once an impact is produced); and, lag time (time span between the moment an environmental interaction takes place and the moment impacts occur).

In addition, identification should also consider direct, indirect, cumulative, and unavoidable impacts. On this regard, cumulative impacts are particularly relevant since they can influence the significance of other identified impacts. In doing so, cumulative impacts can be difficult to establish since they involve the need that environmental aspects and impacts of a proposed activity are considered together with those of past, present, and reasonably foreseeable future. Nonetheless, identifying these impacts is critical for significance evaluation.

Significance is a value judgment about the severity and importance of a change in a given environment or environmental value or resource. Therefore, should be made on a case-by-case site specific basis.

To determine the severity of the impacts, and given the subjectivity that this may entail, the Guidelines propose a series of elements to consider, such as how similar impacts have been judged in earlier EIAs at similar sites and/or for similar types of activities; the opinion of several experts; and direct impacts as well as possible indirect and cumulative impacts.

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18. The most recent version of the Guidelines was adopted by the 39th Antarctic Treaty Consultative Meeting (ATCM) XXXIX, in Resolution 1 (2016), in Santiago, Chile.

Once impacts are identified and their significance is evaluated, relevant mitigation measures should be adopted to reduce or avoid impacts. These measures must be taken prior to the execution of the proposed activities, and with sufficient information, ensuring the protection of the Antarctic environment and its dependent and associated ecosystems.

### Other international commitments

The elements discussed above create a proper framework to foster strong regulations for Antarctic EIA. In addition, considering relevant commitments acquired by Chile will strengthen these regulations, creating synergies for environmental policy in the country. We will discuss two which are particularly relevant.

#### *Climate Change Commitments*

Chile has ratified the Paris Agreement, and therefore is bound by its terms and the goal of holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 °C above pre-industrial levels.<sup>19</sup>

Even though greenhouse gas (GHG) emission reduction in Antarctica do not count towards Chile's mitigations goals, undoubtedly mitigating these emissions will result in a benefit for all mankind and it will go towards accomplishing the Treaty's objective.

In this context, data and recommendations by the Scientific Committee on Antarctic Research (SCAR) are very relevant. In 2009, SCAR published the "Antarctic Climate Change and the Environment" report, which provides a comprehensive account of Antarctica environment and how it may change in the future due to GHG emissions increase.

The report considers information of scenarios, models, and projections from the IPCC, clearly reflecting how mitigating climate change and protecting the Antarctic environment are intertwined.

Considering this information in Antarctic EIA is very relevant, particularly when Chile has participated actively in climate change international policy as President of the 25<sup>th</sup> Conference of the Parties (COP) of the United Nations Framework Convention on Climate Change and the submission of the 2020 update of its Nationally Determined Contribution (NDC). Furthermore, in COP 26 held in Glasgow, Scotland, the Chilean government officially submitted the country's Long Term Low Emissions Strategy setting out specific sectoral objectives and goals that will enable the county

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19. Article 2. Paris Agreement. Available at <https://bit.ly/3FzuGAD>.

to become carbon neutral and climate resilient by 2050 at the latest, in line with the latest science.<sup>20</sup>

To achieve this goal, Chile has embarked on the process of creating an ambitious Climate Change Bill incorporating the international recommendations on the matter, including long term goals; climate change regulatory instruments with monitoring, reporting and verification obligations; strengthening the institutional framework, with clear mandates and defined roles; and the involvement of governmental agencies across the board to tackle a multisectoral problem (Currie Ríos and Sandoval Valdés, 2021: 477).

### *Protocol on the protection of the Antarctic Environment between Chile and Argentina*

In 1991, Chile and Argentina agreed on a Treaty on Environment that included two additional protocols. One regarding their hydrological shared resources and the other about the protection of the Antarctic environment. The latter highlighted the importance of Antarctica and its ecosystems, as well as its preservation for future generations.

To this end, the Parties agreed to establish environmental monitoring programs to verify foreseen effects and detect possible unanticipated effects on the environment and Antarctic living resources of activities carried out in the Antarctic Treaty area, including waste disposal; pollution by hydrocarbons or other dangerous and toxic substances; construction and operation of stations, shelters, camps, ships, aircraft, and other forms of logistical support; scientific programs; leisure activities; and, activities that could affect the purpose of the zones designated as protected areas.<sup>21</sup>

Moreover, the Parties agreed to establish ways to prepare, disseminate and apply EIA procedures applicable to activities that they have planned jointly in the Antarctic Treaty area.<sup>22</sup> In addition, they shall promote the exchange of experiences to encourage the harmonization of their domestic legislation in aspects such as compliance and response to emergencies, as well as other measures aimed at ensuring the full application of the protection agreements of the Antarctic environment and its dependent and associated ecosystems.<sup>23</sup>

Finally, the Protocol establishes that its provisions do not affect stricter obligations assumed by the Parties in the Antarctic Treaty, its additional instruments, or the Recommendations adopted by the Consultative Meetings of such Treaty.<sup>24</sup>

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20. Available at <https://bit.ly/32onFoe>.

21. Article III. Protocol on the protection of the Antarctic Environment between Chile and Argentina.

22. Ibid, article VI.

23. Ibid, article IX.

24. Ibid, article XI.

The description of the key elements regarding the Protocol on the protection of the Antarctic Environment between Chile and Argentina, shows its relevance when regulating Antarctic EIA. Chile must consider international commitments, especially when they refer to scientific studies, cooperation, environmental monitoring, and sharing information. This will result in stronger regulation and better international cooperation.

## Conclusions

Antarctica is crucial for the world, as it plays a fundamental role in global climate and is the most important source of fresh water, among other features. It also has a very fragile ecosystem that requires strict measures to be preserved. In this context, protecting the Antarctic environment must have the utmost relevance and priority, with EIA as the main instrument to this end.

This instrument evolved internationally to become a far-reaching tool in environmental protection going beyond national jurisdictions. The ATS has incorporated EIA in its Protocol and thematic Annex, giving Parties the responsibility to regulate the Antarctic EIA procedure.

Chilean Antarctic Statute has been a significant step towards this end, reinforcing and enhancing the national Antarctic institutional framework, specifying legal powers, and assigning functions to competent authorities (Ferrada Walker, 2021: 7). Nonetheless, further action is required in regulating Antarctic EIA. To this end, consideration to the experience gained over two decades of national EIA will be fundamental, as well as international guidelines and commitments acquired on the matter.


Protecting the uniqueness of the Antarctic environment and its dependent and associated ecosystems is paramount not only for science and research, but also as a key element in addressing climate change and to preserve the health of our planet.


## References

- BERMÚDEZ SOTO, Jorge (2015). *Fundamentos de Derecho Ambiental*. Valparaíso: Ediciones Universitarias de Valparaíso.
- CURRIE RÍOS, Robert and Paulina Sandoval Valdés (2021). “Elementos para una legislación climática efectiva y el necesario cambio de paradigma en la gestión ambiental”. *Revista Actualidad Jurídica*, 44: 449-481. “Antarctic Climate Change and the Environment”
- FERRADA WALKER, Luis Valentín (2012). “Evolución del Sistema del Tratado Antártico: Desde su génesis geoestratégica a sus preocupaciones ambientalistas”. *Revista de Derecho* (Universidad San Sebastián), 18: 131-151.
- FERRADA WALKER, L. V., M. Bruna Opazo, D. Caldera Herrera, C. Flores Barros, G.

- Gajardo Flores, C. Lazen Muñoz, C. Sepúlveda Illanes, B. Silva Ordóñez, G. Sutherland Condorelli y F. Vicencio Araneda (2021). *Reflexiones sobre la nueva Ley Chilena Antártica*. Available at <https://doi.org/10.34720/79qh-x532>.
- HEMMINGS, Alan and Lorne Kriwoken (2010). “High level Antarctic EIA under the Madrid Protocol: State practice and the effectiveness of the Comprehensive Environmental Evaluation process”. *International Environmental Agreements: Politics, Law and Economics*, 10: 187-208. DOI: [10.1007/s10784-010-9119-5](https://doi.org/10.1007/s10784-010-9119-5)
- IPCC (2021). Summary for Policymakers. In *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press. In Press.
- KLEKOCIUK A. Y B. WIENECKE (2016). “Antarctic environment: Global importance of Antarctica”. In *Australia state of the environment 2016*. Australian Government Department of the Environment and Energy, Canberra. Available at <https://bit.ly/3mC5uII>.
- UNEP (1987). “Goals and Principles of Environmental Impact Assessment”, Decision 14/25, June 17, 1987.

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