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Antarctic Security and Adequacy of Legal Regulations

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Abstract: This paper critically examines the adequacy of the current legal framework governing Antarctica – the Antarctic Treaty System (ATS) – in addressing emerging security-related risks in the region. With Antarctica facing mounting environmental threats from climate change, increasing tourism, potential bioprospecting, and strategic interest from global powers, the paper explores whether existing legal instruments are sufficient to mitigate these challenges. The study identifies significant regulatory gaps and ambiguities using legal and content analysis of relevant literature. These include unclear provisions on bioprospecting and resource use, limited enforcement and inspection mechanisms, insufficient responses to maritime and human security risks, and the growing dual-use nature of scientific activities with possible military applications. The analysis suggests that while the ATS has thus far maintained peace and environmental protection, its effectiveness is undermined by geopolitical competition and evolving global demands. The paper concludes that without legal and institutional reforms, such as more precise definitions, stronger enforcement mechanisms, and enhanced transparency, the long-term stability and credibility of the Antarctic governance regime may be at risk.

Keywords: Antarctica, security, Antarctic Treaty System, climate change, environmental protection

1. Introduction

The global community is currently grappling with a range of pressing security concerns that extend beyond sovereign territories into areas beyond national jurisdiction – Antarctica being a prominent example[1]. Traditionally perceived as a domain devoted to peaceful scientific

[1] As S. Guggisberg (2025, 15) indicates, „Whereas the former four [outer space, the atmosphere, the highs seas, the Area] are generally considered global commons since they are undoubtedly accessible by all, Antarctica is viewed as an international resource domain, mainly because it is, in fact, governed by a limited number of States.

exploration, Antarctica has increasingly become a stage for subtle geopolitical maneuvering. Powers such as Russia and China visibly reinforce their roles in this vast area. At the same time, the United States finds itself under growing pressure to safeguard its geopolitical and environmental stakes in what is often referred to as the last global commons (Vassiliou 2021; Hemmings 2021, 14; Chaturvedi 2012, 271; Elzinga 2017, 104).

Antarctica spans a vast geographical expanse, encompassing the 14 million km² of continental landmass and islands and approximately 32 million km² of adjacent oceanic territory. Despite its remote and inhospitable conditions, the continent hosts a fluctuating seasonal population ranging from 1,000 to 4,000 individuals, primarily scientists and logistical personnel. Riffenburgh (2007, 47) noted that definitions of Antarctica's boundaries are context-dependent. Politically, the Antarctic Treaty sets the northern limit at 60° south latitude – a line that is both arbitrary and convenient, but excludes ecologically significant sub-Antarctic islands situated farther north. Conversely, the Convention on the Conservation of Antarctic Marine Living Resources utilizes the Polar Front as its defining boundary. This natural oceanographic feature, where cold Antarctic currents meet the warmer waters of surrounding oceans, is also supported by the Scientific Committee on Antarctic Research as the most ecologically meaningful demarcation. While this biologically and climatically informed boundary is scientifically sound, legal and administrative definitions often default to more simplified criteria for operational ease (Riffenburgh 2007, 47; see also Dodds 2012).

Seven nations – Argentina, Australia, Chile, France, New Zealand, Norway, and the United Kingdom – have staked territorial claims to segments of the continent at various points in the 20th century. Although not internationally recognized by all, including the United States, these assertions are grounded in various legal and historical rationales (Scott 2021a; Scott 2021b, 494; Medeiros & de Mattos 2019, 105). The claims made by Australia, the UK, France, New Zealand, and Norway often cite discovery and the principle of effective occupation (*terra nullius*) as justification. Meanwhile, Argentina and Chile emphasize not only historical presence and administrative control but also symbolic acts such as government-sponsored births and marriages to reinforce their sovereignty. These latter two also invoke colonial-era Spanish rights, referencing the 1493 Papal Bull as part of their legal argumentation (Bray 2016, 5; Vigni 2024, 34-38).

All pre-existing territorial claims were put on hold under Article IV of the 1959 Antarctic Treaty. While states did not formally abandon their claims, they agreed not to pursue new ones

This differentiation is now, with the Antarctic Treaty System's relative openness to new members, mostly a theoretical one".

or to expand those already made. This so-called "freezing" of sovereign claims means that although states may maintain jurisdiction over their citizens and research activities on the continent, they cannot extend formal sovereignty over additional areas. Thus, while Antarctica remains an area outside national jurisdiction, nationals from Treaty Parties remain subject to their home countries' legal authority. However, as Scott (2021b, 503) notes, some states, such as Australia, have recently expressed broader territorial interpretations regarding jurisdiction, meaning that Australia has claimed a general territorial basis of jurisdiction instead of personal jurisdiction as exercised by the other states having territorial claims to Antarctica.

Against this geopolitical and historical background, this study aims to assess whether Antarctica's current legal framework is adequate to address emerging security-related risks in the region. The research aims to identify any loopholes or ambiguities within these legal instruments. The methodology includes a legal analysis of Antarctic legal texts and a critical review of the relevant academic literature. By security in the Antarctic context, the author means protecting Antarctica's environment, personnel, and scientific activities and maintaining a cooperative, demilitarized governance system that prevents territorial disputes and ensures the continent remains a zone for peaceful purposes.

2. Security threats connected with Antarctica

As will be discussed below, Antarctica faces its most pressing challenges in the realm of environmental security, with key concerns including the impacts of climate change, such as rising temperatures and shrinking biodiversity, alongside the growing pressures of tourism, potential bioprospecting, and the future exploitation of mineral resources. Conversely, the continent poses risks to the rest of the world, particularly through the global repercussions of climate change and sea-level rise, which could be seen as existential threats to international or planetary security. Additionally, as human presence in Antarctica increases, so too do concerns related to human security, such as the need for reliable search and rescue capabilities, and the logistical demands of supporting visitors, mainly scientists and tourists, with essential services like food and healthcare (Rothwell et al. 2012, 12–13). Among these, climate change stands out as the most serious danger, creating a self-perpetuating cycle: human activity fuels climate change, which harms Antarctica, and the resulting environmental degradation, in turn, threatens human populations across the globe.

2.1. Climate change and biodiversity

The effects of the global climate crisis are becoming increasingly evident in Antarctica, where rising temperatures are accelerating ice melt across the continent. Scientific findings now suggest that the pace of environmental change in the region not only aligns with but sometimes surpasses the most severe projections made by the Intergovernmental Panel on Climate Change (IPCC). These developments have led to a marked deterioration of security conditions in Antarctica, particularly in light of the broader global consequences such changes could unleash (Hemmings et al. 2012, 6).

Glaciers and sea ice are retreating at alarming rates as ocean temperatures rise in the Southern Ocean. This process introduces growing volumes of freshwater into the oceans, thus intensifying global sea-level rise (Press 2020, 10). Research shows these changes are closely tied to atmospheric warming and oceanic shifts, which collectively influence marine biodiversity and Earth's climate system (Turner et al. 2009).

One of the significant environmental concerns linked to this transformation is biodiversity loss in the fragile marine ecosystems surrounding Antarctica. Native species, already adapted to extreme conditions, are now under pressure to adjust to shifting temperatures and ecological balances. Their ability to do so remains uncertain. Simultaneously, warmer conditions are enabling new species – previously unable to survive in Antarctic waters – to expand their range southward, often at the expense of native fauna. This biological shift has been particularly pronounced in the region west of the Antarctic Peninsula, where over the last 50 years, researchers have documented substantial declines in krill populations, fluctuations in phytoplankton density, and a southward migration of salps – organisms vital to the oceanic carbon cycle (Antarctic Climate Change and the Environment Report 2009; Martin 2016, 7).

Future warming is projected to further alter the composition and movement of marine species, with more temperate fish species likely to encroach into Antarctic waters. This could attract commercial fishing operations, intensifying resource competition and potentially displacing native species. The increasing presence of non-native organisms, a trend already underway, is expected to accelerate under climate-driven change, thereby threatening the ecological integrity of Antarctic habitats (Nyman 2017, 578). Adding to these concerns, new disease threats have emerged. In 2025, bird influenza (H5N1) cases were confirmed among dead birds in Antarctica, raising alarm over the vulnerability of polar wildlife to global disease transmission (Mountinho 2025; Le Page 2025).

As in previous assessments, Antarctica's most severe risks to global security stem from climate-related effects, chiefly rising sea levels. These, in turn, endanger coastal populations and ecosystems around the world. There are also growing human security concerns directly within the continent itself. Although Antarctica has no indigenous population (unlike the Arctic), human presence is steadily increasing due to the proliferation of scientific stations and a surge in tourism. While not permanent in the traditional sense, these temporary settlements are becoming more crowded and complex to manage. Emergencies such as fires, disease outbreaks, or ice collapse events involving tourist vessels would likely require complex, large-scale rescue efforts comparable to those in major disaster zones elsewhere (Rothwell et al. 2012, 17).

At the core of all these threats lies a dangerous feedback loop: anthropogenic climate change damages Antarctica, and the resulting environmental degradation further jeopardizes the future of humanity. The rise of the global mean sea level during the twentieth century was mainly driven by the thermal expansion of the ocean and by mass loss from glaciers and the Greenland Ice Sheet. Antarctica's contribution was initially limited but has increased in recent decades, adding about 7.4 millimeters to global mean sea level rise between 1992 and 2020. By 2100, Antarctica is projected to contribute around 0.11 meters under a low greenhouse gas emissions scenario and about 0.12 meters under a high greenhouse gas emissions scenario, with a wide range of possible outcomes. However, Antarctic contributions are expected to remain relatively small compared to other factors, because additional snowfall caused by warmer air temperatures may offset the losses from increased ice flow and surface melting. In fact, under all major emissions scenarios, Antarctica might even contribute negatively to global mean sea level rise until 2100, due to this compensating snowfall effect (Antarctic Climate Change and the Environment Report 2022, 57-58). As global warming disrupts ocean currents and marine systems in the Southern Ocean, climate change, fish stocks, and weather will be felt far beyond Antarctica's borders.

2.2. Resource exploitation

Antarctica is believed to be rich in mineral deposits, including valuable metals such as iron, copper, chromium, gold, nickel, and platinum, along with substantial reserves of hydrocarbons like coal and oil (Bateman 2012, 122; Foster 2012, 167; Nyman, 574). In the absence of viable commercial access to these resources, particularly in such remote and inhospitable terrain, the global community initially prioritized the development of legal agreements over resource competition. By establishing cooperative international frameworks, states sought to prevent geopolitical rivalry over strategic extraction, particularly among technologically advanced nations aiming to secure energy and raw materials for their national interests.

However, these legal arrangements – such as those under the Antarctic Treaty System – may come under increasing strain due to external pressures. Advances in extraction technology, intensifying climate change, and escalating global resource demand threaten to erode the consensus that currently sustains Antarctic governance (Nasu 2012, 22). Projections suggest that global energy consumption may rise by 50%, food requirements by a similar margin, and freshwater needs by 30%. In this context, energy access has become a cornerstone of foreign policy for rapidly industrializing states such as China and India. In particular, Asia is witnessing a widespread sense of energy insecurity shaping diplomatic and strategic behavior (Foster 2012, 162; see also Splettstoesser & Dreschhoff 2000).

Countries with established expertise in resource extraction, such as the United Kingdom, France, and Norway, are among the leading claimants in Antarctica. Other technologically advanced states, including the United States, Japan, and the former Soviet Union, have also been recognized as significant actors due to their capacity to conduct scientific and technical operations in extreme environments. In more recent years, China has emerged as a particularly active presence. Driven by scientific interests and potential resource opportunities, China has invested heavily in Antarctic infrastructure and logistics. Its strategic posture in the region is partly influenced by the prospect of discovering oil and other valuable raw materials, making resource access a key driver of its engagement with the ATS (Foster 2012, 161-162). Nonetheless, any exploitation of these non-renewable resources would pose a serious threat to Antarctica's fragile ecosystems.

In addition to non-living resources, Antarctica is also home to vital marine species, particularly krill and various fish stocks. These living resources are under growing pressure from illegal, unregulated, and unreported fishing and overexploitation. Countries like Australia, France, New Zealand, and South Africa have consistently raised concerns about the dual challenge of preserving environmental stability while maintaining sustainable fisheries – especially in the case of toothfish, a species that has become economically important in Southern Ocean fisheries over the past two decades (Rothwell et al. 2012, 15; Labour 2019, 32-36).

2.3. Tourism

Tourism has emerged as a growing source of environmental pressure in Antarctica in recent years. As more tour operators begin offering expeditions to the continent, concerns are mounting about the impact of human presence on its fragile ecosystems. The warming climate has made certain parts of the Antarctic Peninsula increasingly accessible, particularly for smaller, lower ice-class vessels such as charter boats catering to niche adventure tourism. While an industry-imposed cap currently limits the number of passengers to 500 per vessel, this threshold may come under pressure as sea ice recurs, enabling more frequent and widespread access (Martin 2016, 7).

Over the past two decades, the number of tourists visiting Antarctica has surged, increasing more than fivefold. Tour operators from the United States and China have played a leading role in this expansion. Existing governance mechanisms have struggled to keep pace with the growing scale of these activities and appear ill-equipped to prevent China from potentially promoting mass tourism on the continent (Brady 2020, 17).

Data from the International Association of Antarctica Tour Operators (IAATO) illustrates this rapid growth: during the 2006-2007 season, the number of visitors reached 29,530, a stark increase from approximately 6,000 in the early 1990s. Between 2018 and 2019, visitor numbers surpassed 56,000. Despite the disruptions caused by the COVID-19 pandemic, tourism numbers from October 2019 to April 2020 approached 74,000. Most visitors arrive either on cruise ships or via air links from South America, both of which present environmental risks due to the volume and frequency of traffic (Turner & Marshall 2011, 8; Jardine & Clack 2024; Bray 2016, 14–15; Kökyay 2022, 171).

The 2022-2023 tourist season saw a strong rebound in operations, though the final visitor count – 104,897 individuals – fell short of earlier projections made at the 44th Antarctic Treaty Consultative Meeting (ATCM XLIV). This discrepancy was primarily attributed to lower-than-expected occupancy rates aboard tourist vessels bound for Antarctica (IAATO 2022-2023; for more detailed analyses of the implications of tourism in Antarctica, see contributions in Hall & Saarinen 2010).

2.4. Militarization

Although the likelihood of military confrontation in Antarctica remains low under the Antarctic Treaty, the possibility of the region's militarization cannot be entirely dismissed, as historical precedents of dual-use research stations, the strategic value of polar regions, and potential geopolitical rivalries could create conditions for military activity (Hemmings, Rothwell & Scott 2012, 336). Under the Antarctic Treaty (1959), military activities are strictly limited to logistical support for scientific research. Countries such as Argentina, Australia, Brazil, Chile, China, New Zealand, Russia, and the United States currently deploy military personnel and resources by this provision, using them exclusively to support research operations (Martin 2016, 11; Brady 2020, 15–17).

However, concerns persist about the potential for military activities disguised as scientific endeavors, particularly in applied research contexts. Article VII(5)(c) of the Antarctic Treaty

(1959) obliges state parties to provide detailed reports on any military personnel or equipment they send to the region. While most parties comply with this requirement, China has frequently failed to disclose the full extent of its military involvement in Antarctic research projects. Analysts have noted that the role of the Chinese military in Antarctic operations has steadily expanded (Brady 2020, 15).

The Treaty's foundational principle that Antarctica should remain a demilitarized zone dedicated to peace and science, nonetheless, specific incidents have raised red flags. During the 2013-14 season, a logistics expert from China's People's Liberation Army (PLA) reportedly supported the BeiDou-2 satellite navigation system, a dual-use platform akin to GPS. However, China's AT Annual Report (2014) did not acknowledge this military role. Earlier, in the 2007-08 season (AT Annual Report 2008), PLA specialists assisted in constructing both a pier and a high-frequency radar installation at Zhongshan Station – technology that reportedly could interfere with U.S. polar satellites. These developments were publicly acknowledged in China but omitted from official disclosures to the Antarctic Treaty System, leaving relevant sections of its reports incomplete (Brady 2017b, 3–14)[2].

Russia, like China, appears to be viewing Antarctic governance through an increasingly securitized framework, prompting concerns about potential breaches of the continent's "peaceful purposes" mandate. In particular, Russia's deployment of ground-based space research and Global Navigation Satellite System (GNSS) facilities in the region is suspected of serving military objectives, such as supporting missile tracking operations (Dodds & Boulegne 2022).

China's polar activities similarly underscore the dual-use nature of Antarctic infrastructure. The Chinese polar research stations play a critical role in enhancing the capabilities of the PLA, particularly in the domains of command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR). These facilities contribute to the BeiDou satellite navigation system's operation, which supports civil and military functions such as missile

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[2] Several states openly report their military involvement in Antarctica through the Antarctic Treaty Annual Reports. For instance, in the 2024-2025 reports, Brazil disclosed the deployment of military personnel, ships, and aircraft used in scientific and logistical support. Similarly, India reported the presence of military personnel in its expeditions, Japan referenced the use of military vessels, and Peru acknowledged the involvement of military personnel, ships, and aircraft in its operations. The United States has also documented its military activity in the region. Notably, during the 2012-2013 Antarctic season, the U.S. launched a Department of Defense initiative, Operation Deep Freeze, which supports the U.S. Antarctic Program and the National Science Foundation (NSF). This initiative involves a coordinated effort by Air Force, Navy, Army, and Coast Guard personnel, all of whom contribute vital operational and logistical support to NSF-led scientific research. Both active duty and reserve components – including the National Guard – participate in this mission (Air Force News Service 2012). These military activities were transparently included in the U.S. Annual Reports for the 2012-2013 and 2013-2014 seasons.

guidance and global communications. China's 2012-2013 polar policy report explicitly acknowledged the strategic value of the polar regions for such systems, emphasizing their contribution to precision missile targeting and extended satellite coverage. Prior to the entry into force of the Antarctic Treaty in 1961, Antarctica was primarily regarded as *terra nullius*, which allowed states to operate with considerable freedom in establishing facilities and conducting activities. The Treaty subsequently froze sovereignty claims and established a governance framework restricting unilateral action and permitting extensive scientific research, subject to environmental impact assessments under the 1991 Madrid Protocol and its Annex I. Within this framework, China and other states have installed space tracking and ground-receiving stations that might otherwise be restricted to clearly defined sovereign territories. While these stations contribute to meteorological forecasting and scientific progress, they also carry dual-use potential, including applications relevant to coastal defence and military support. Similar facilities operated by Russia, India, and other Antarctic actors indicate a broader trend of strategic dual-use operations conducted under the guise of legitimate scientific research (Brady 2017b, p. 15).

Overall, the observable deterioration in climate conditions across Antarctica likely reflects long-standing biophysical changes that may begin to directly influence human activities, particularly food security linked to Southern Ocean fisheries. As environmental pressures mount, security-related concerns about tourism (e.g., safety risks, search and rescue operations, and fatalities) and bioprospecting (including environmental degradation and questions of liability) may also grow. Additionally, maritime security/safety challenges are likely to escalate as the melting of sea ice increases navigability, potentially resulting in the expansion of southern maritime trade routes, fishing fleets, and cruise operations. Despite these emerging risks, the Antarctic region presents no significant conventional security threats (Hemmings et al. 2012, 10, 14).

3. Applicable law and its adequacy to the XXI century

Antarctica is regulated by the Antarctic Treaty System (ATS), which is a set of legal documents comprising the 1959 Antarctic Treaty (AT) and several AT-related international agreements (the 1972 Convention for the Conservation of Antarctic Seals, the 1980 Convention on the Conservation of Antarctic Marine Living Resources, the 1991 Protocol on Environmental Protection to the Antarctic Treaty and its Annexes: I on Environmental Impact Assessment (1991), II on Conservation of Antarctic Fauna and Flora (1991), III on Waste Disposal and Waste Management (1991), IV on Prevention of Marine Pollution (1991), V on Area Protection and Management (1991) and VI on Liability Arising from Environmental Emergencies (2005; not yet in force) which address the issues of environmental protection and activities concerning living and mineral resources in the region. Measures adopted at the Antarctic Treaty Consultative Meetings through consensus only acquire legal force once all Consultative Parties approve them. Consequently, these instruments are considered integral components of the Antarctic Treaty System, but due to space constraints, only some of them are mentioned in this paper[3]. The Antarctic Treaty System was established to prevent conflict in Antarctica by limiting all activities to peaceful purposes. As such, Antarctica has become one of the most demilitarized regions in the world. Article I of the 1959 Antarctic Treaty explicitly prohibits all military activities, including establishing military bases or fortifications, conducting military manoeuvres, and testing weapons. Nevertheless, it permits using military personnel and equipment for peaceful purposes, particularly in supporting scientific research. This exception has led to concerns, especially in the case of China, whose lack of transparency regarding the extent of military involvement in its scientific programs has drawn international scrutiny (Antarctic Treaty 1959; Brady 2019, 15).

The Treaty also froze all territorial claims and prohibited the assertion of new claims or the expansion of existing ones (Art. IV.2), reinforcing the continent's legal status as a cooperative international space. Additionally, Antarctica was declared a nuclear weapons-free zone (Art. V), making this prohibition the Treaty's only explicit reference to environmental protection at the time. Over subsequent decades, however, the ATS has evolved to incorporate far-reaching environmental safeguards, which are discussed in greater detail later.

Importantly, the ATS guarantees freedom of scientific investigation and fosters international scientific cooperation (Arts. II and III), while reiterating the exclusive use of Antarctica for peaceful purposes (Art. I). Sovereignty disputes were set aside (Art. IV), allowing States to operate in Antarctica without prejudicing or advancing their legal positions on territorial claims (Rothwell et al. 2012, 2). This foundational emphasis on freedom of access, research, and cooperation underpins the continent's legal framework. While resource exploration or exploitation remains highly regulated, it is guided by the principle that such activities must serve the interests of humanity as a whole (Brady 2020, 15).

[3] "Measures, Decisions and Resolutions, which are adopted at the ATCM by consensus, give effect to the principles of the Antarctic Treaty and the Environment Protocol and provide regulations and guidelines for the management of the Antarctic Treaty area and the work of the ATCM. Decisions, which address internal organizational matters of the ATCM, and Resolutions, which are hortatory texts, are not legally binding on Contracting Parties. In contrast, Measures are legally binding on the Consultative Parties once they have been approved by all Consultative Parties" – Manual of Regulations and Guidelines Relevant to Tourism and Non-Governmental Activities in the Antarctic Treaty Area 2023, 2.

3.1. Climate change and biodiversity

Together with the 1972 Convention for the Conservation of Antarctic Seals, the 1980 Convention on the Conservation of Antarctic Marine Living Resources, the Madrid Protocol, and its Annexes focus on environmental protection and regulating activities involving the region's living and mineral resources. Climate change is not mentioned explicitly. As to environmental protection, the 1980 Convention on the Conservation of Antarctic Marine Living Resources aims to conserve the Antarctic marine living resources, which includes their "rational use" (Art. II (1) and (2)). The conservation principles aim to ensure that harvested marine populations in the CCAMLR Area are maintained at levels that support stable reproduction, ideally close to the point of maximum sustainable yield. They also emphasize preserving the ecological relationships between exploited species and those dependent on or connected to them, while restoring depleted populations to sustainable levels.

Additionally, the principles seek to prevent or minimize the risk of long-term, potentially irreversible changes to the marine ecosystem by considering the known and possible effects of harvesting, invasive species, related human activities, and environmental changes, all with the overarching goal of securing the long-term conservation of Antarctic marine living resources (Art. II (3)). Implementation of this Convention contributes to sustaining biodiversity in Antarctica, even though the term is not mentioned expressly. None of the examined legal acts uses the term "biodiversity". However, for example, Annex II to the Madrid Protocol states that "[n]o species of animal or plant not native to the Antarctic Treaty area shall be introduced onto land or ice shelves, or into water in the Antarctic Treaty area except in accordance with a permit" (Art. 4 (1)). Moreover, permits for taking[4] native Antarctic mammals, birds, or plants must be strictly limited to collect only the minimum necessary number of specimens. Any killing of native animals must involve only small numbers and must not exceed the capacity of local populations to recover through natural reproduction in the next season. Additionally, such activities must safeguard species diversity, protect vital habitats, and preserve the overall ecological balance within the Antarctic Treaty area. These provisions aim to protect the native species and sustain Antarctic biodiversity, which the introduction of alien species may threaten. Some of the Annexes to the Madrid Protocol are relevant to environmental protection. Annex III on Waste Disposal and Waste Management applies to all activities within the Antarctic

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[4] According to Art. 1 of Annex II, ""take" or "taking" means to kill, injure, capture, handle or molest, a native mammal or bird, or to remove or damage such quantities of native plants that their local distribution or abundance would be significantly affected".

Treaty area, including scientific research, tourism, and both governmental and non-governmental operations. It emphasizes the need to reduce waste generation and disposal as much as possible to limit environmental impact and avoid disrupting Antarctica's natural values, scientific work, or other legitimate uses. Proper planning must prioritize waste management practices such as minimizing waste at the source, recycling, and ensuring appropriate storage, disposal, and removal. Where feasible, waste taken out of Antarctica should be returned to the country where the activity originated or to another country equipped to handle disposal in line with international regulations. Furthermore, current and past waste sites and abandoned facilities must be cleaned up by those responsible for their creation or use (Art. 1).

Annex V of the Madrid Protocol (1991) establishes a framework for protecting and managing Antarctic areas with significant environmental, scientific, historic, or wilderness value. It creates three categories: Antarctic Specially Protected Areas (ASPAs), Antarctic Specially Managed Areas (ASMAs), and Historic Sites and Monuments (HSMs), with varying levels of access and management. Annex VI, adopted in 2005 but not yet in force, introduces rules on liability for environmental emergencies, requiring operators to prevent, respond to, and cover the costs of any damage they cause, with enforcement ensured by their respective states.

Despite these regulations, the ATS provides no explicit enforcement mechanism to address them. Enforcement under the Madrid Protocol relies primarily on national implementation, peer review, and dispute settlement rather than centralized authority. Article 13 obliges Parties to adopt domestic laws and regulations, while Article 14 provides for inspections of stations, ships, and aircraft by observers from other Consultative Parties, with inspection reports circulated publicly to encourage compliance. Environmental protection is further supported by mandatory Environmental Impact Assessments under Article 8 and Annex I, which require Parties to evaluate, report, and mitigate potential impacts of proposed activities. Annual reporting obligations (Article 17) and contingency planning for environmental emergencies (Article 15) also contribute to compliance, though inspections remain infrequent and liability rules under Article 16 are still incomplete (Annex VI not yet in force). Ultimately, these mechanisms depend heavily on self-reporting and voluntary cooperation[5].

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[5] There is also the Committee for Environmental Protection (CEP), established under Article 11 of the Madrid Protocol. As an advisory body to the Antarctic Treaty Consultative Meeting, its mandate is to provide expert advice and recommendations on implementing the Protocol, including environmental impact assessments, waste management, the protection of flora and fauna, marine pollution prevention, and the designation of specially protected areas. The CEP reviews information submitted by Parties, evaluates the state of the Antarctic environment, and develops guidelines and best practices to minimize human impact. However, its role is limited to advice and coordination: its recommendations only gain effect if adopted by the ATCM, and the enforcement

3.2. Resource exploitation

The AT did not regulate the matter of resource exploitation in Antarctica. In 1988, the Convention on the Regulation of Antarctic Mineral Resource Activities was adopted; however, it never entered into force due to France and Australia announcing that they would not sign the Convention, and that issue was resolved later by the Protocol on Environmental Protection (the Madrid Protocol, 1991), which designated Antarctica as a natural reserve devoted to peace and science (Art. 2 of the Protocol). According to Art. 3 of the Madrid Protocol, "[t]he protection of the Antarctic environment and dependent and associated ecosystems and the intrinsic value of Antarctica, including its wilderness and aesthetic values and its value as an area for the conduct of scientific research, in particular research essential to understanding the global environment, shall be fundamental considerations in the planning and conduct of all activities in the Antarctic Treaty area".

The Protocol prohibited any activities relating to mineral resources except for scientific research (Art. 7 of the Protocol). The exploitation ban shall be operative for at least 50 years, from 1998, when the Madrid Protocol entered into force (Art. 25) (Wyrozumska 1995, 184-185; Press 2020, 8). After 50 years, any Consultative Party may request a review conference to be convened. An amendment of the Protocol may "be adopted by a majority of the Parties, including 3/4 of the States which are Antarctic Treaty Consultative Parties at the time of adoption of this Protocol". Such an amendment enters into force "upon ratification, acceptance, approval or accession by 3/4 of the Antarctic Treaty Consultative Parties, including ratification, acceptance, approval or accession by all States which are Antarctic Treaty Consultative Parties at the time of adoption of this Protocol". The exploitation ban will continue if no new binding legal regime determines the conditions for Antarctic mineral resource activities (Art. 25). Hence, the ban does not have an expiration date. This understanding is reinforced by key declarations adopted at Antarctic Treaty Consultative Meetings – including in Baltimore in 2009 (Enhancement of Environmental Protection up to the Antarctic Convergence 2009), in Prague in 2019 (Prague Declaration on the Occasion of the Sixtieth Anniversary of the Antarctic Treaty 2019), and in Helsinki in 2023 (Helsinki Declaration on Climate Change and the Antarctic 2023) – that reaffirm the Parties' enduring commitment to the ban and to use Antarctica only for peace and science.

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of obligations depends on national implementation by individual Parties. As such, while the CEP strengthens Antarctic environmental protection's scientific and policy foundations, it does not constitute an enforcement body.

Looking toward the future, Rothwell, Scott, and Hemmings (2012, 16) anticipate that by around 2050, increasing global demand for hydrocarbons and other strategic resources may place considerable pressure on the ATS to reconsider its current prohibitions on mineral prospecting and resource exploitation in the region (see also Martin 2016). Geological assessments suggest that Antarctica holds vast untapped reserves, including an estimated 500 billion tons of oil and 300-500 billion tons of natural gas in continental deposits, with an additional 135 billion tons of oil located in the Antarctic shelf, particularly within the Ross Sea. Even more crucially, Antarctica's ice reserves are believed to contain approximately 70% of the world's freshwater resources (Brady 2020, 17).

Beyond hydrocarbons, bioprospecting in Antarctica is becoming an area of increasing interest and activity. Bioprospecting involves the exploration of natural environments to identify and collect biological and genetic materials for developing biotechnologies and may include product development, patenting, trials, and commercialization (Scott 2012, 293). Antarctica's unique biodiversity attracts bioprospectors for two main reasons. First, the largely unexplored organisms, especially extremophiles, present promising avenues for new biotechnological breakthroughs. Second, the extreme environmental conditions have led Antarctic organisms to evolve exceptional survival adaptations, offering genetic traits that could inspire innovative commercial applications (Joyner 2012, 197; Scott 2012, 293). For instance, certain Antarctic fish produce glycoproteins that function as antifreeze agents, enabling survival in freezing waters. These proteins have potential applications across various sectors, such as enhancing freeze tolerance in crops, extending the shelf life of frozen foods, improving surgical tissue preservation, and expanding aquaculture in cold environments (Joyner 2012, 199). Commercial products derived from Antarctic genetic resources, including krill oil supplements, antifreeze proteins, anticancer agents, enzymes, and cosmetic ingredients, are already on the market. Most of this bioprospecting activity targets marine species, particularly krill, with comparatively less emphasis on terrestrial and freshwater ecosystems.

Reports submitted to Antarctic Treaty Consultative Meetings reveal that the pharmaceutical and medical technology sectors account for approximately 23% of genetic resource applications. These are followed by the food and beverage industry (20%), molecular biology and biotechnology (18%), and other sectors such as industrial applications (12%), chemical processing (11%), cosmetics (6%), aquaculture and agriculture (6%), culture collections (3%), and environmental remediation (1%) (Joyner 2012, 200). These figures underscore the growing commercial appeal of Antarctica's unique genetic and biological resources, which, despite the regulatory framework currently in place, may lead to increased pressure for access and utilization shortly. The leading states involved in Antarctic bioprospecting include Japan, the United States, Spain, the United Kingdom, South Korea, Canada, Sweden, Russia, China, Chile, New Zealand, France, Belgium, India, Denmark, the Netherlands, Germany, and Poland – all Antarctic Treaty Consultative Parties (ATCPs) (Antarctic Treaty Consultative Meeting XXXV 2012; Antarctic Treaty Consultative Meeting XLI 2018).

Like mining, bioprospecting in Antarctica involves regulating access to biological resources and ensuring that any benefits arising from their use are distributed fairly and equitably (French 2012, 65; see also Hemmings 2010 for further discussion). Joyner (2012, 205) anticipates that shortly, bioprospecting activities will primarily concentrate on discovering and collecting new biological materials. Although some of these endeavours may eventually lead to commercial exploitation, they are expected to remain predominantly scientific in nature. This focus aligns with Article III of the Antarctic Treaty, which promotes international collaboration in scientific research, including sharing personnel and exchanging data and observations.

The risks linked to bioprospecting in Antarctica remain largely uncertain. While immediate environmental damage or harm to scientific integrity could stem from significant public opposition to the commercialization of genetic resources, the geopolitical and legal stability of the ATS is unlikely to be seriously threatened in the short term. Nevertheless, the long-term implications are less predictable. Certain forms of bioprospecting, notably if conducted under specific regulatory regimes within the ATS, may erode the collective benefits of the Antarctic governance framework and, in extreme cases, might even jeopardize the ATS's overall security (Joyner 2012, 208). A further complication involves distinguishing bioprospecting activities from general harvesting; hence, it is here that the ambiguity surrounding bioprospecting is particularly notable.

In 2005 (Resolution 7 (2005) - ATCM XXVIII - CEP VIII, Stockholm) and 2009 (Resolution 9 (2009) - ATCM XXXII - CEP XII, Baltimore), the Antarctic Treaty Consultative Parties addressed the issue of biological prospecting, recognizing its potential benefits for humankind and the need for strong governance. They reaffirmed that under Articles II and III, the Antarctic Treaty System ensures freedom of scientific investigation while requiring transparency, cooperation, and the free exchange of scientific results. The Parties also emphasized the importance of the Madrid Protocol's environmental safeguards, including provisions on environmental impact assessment, flora and fauna protection, and protected areas, as well as the role of the Convention on the Conservation of Antarctic Marine Living Resources in regulating marine resource use. In both years, governments were urged to draw national Antarctic programs' attention to their obligations under the Treaty, to share information and data on bioprospecting activities, and to keep the issue under active review within the Antarctic Treaty framework. This demonstrates continuity in treating biological prospecting as a matter requiring careful oversight to balance scientific progress with environmental protection and international cooperation.

Joyner (2012, 209-211) highlights three unresolved issues that could provoke political friction among Antarctic Treaty Consultative Parties. First, there is no universally accepted definition of biological prospecting as a scientific endeavour. Second, legal uncertainties persist regarding which entity has the jurisdiction to regulate access to genetic resources in Antarctica. Third, there are ongoing concerns about the equitable sharing of financial and other benefits arising from research on these genetic materials (see also Bray 2016, 16–17). The Protocol restricts any mineral resource-related actions to scientific research only, effectively banning commercial prospecting and extraction. However, the delineation between "scientific research" and "prospecting" is left to individual States' interpretation (Brady 2020, 17), allowing some countries to engage in resource-related activities under the guise of scientific work.

3.3. Tourism

Tourism is regulated only partly by the 1991 Madrid Protocol. Touristic activities should be undertaken according to the following principles that actually apply to all the activities in Antarctica: activities carried out in the Antarctic Treaty area must be carefully planned and executed to minimize harmful impacts on the Antarctic environment and its dependent and connected ecosystems. They should also be designed to prevent adverse effects such as disruptions to climate or weather patterns, significant harm to air or water quality, and major alterations to the atmosphere, land (including aquatic areas), glaciers, or marine environments. Additionally, such activities must avoid causing declines in animal and plant species' distribution, abundance, or productivity, further threatening endangered or vulnerable species, or damaging areas of notable biological, scientific, historical, aesthetic, or wilderness value (Art. 3 (2)). Environmental impact assessments also apply to tourism (Art. 8 of the Madrid Protocol and Annex I). The mass tourism that is expected in the future will jeopardize or at least challenge these principles. Mass tourism is also connected with the problem of waste, which the above-mentioned Annex III regulates.

The Antarctic Treaty Consultative Parties decided to establish a comprehensive framework to regulate tourism and other non-governmental activities in Antarctica, recognizing both the benefits and risks these activities bring. While tourism may enhance global awareness of Antarctica's value, its rapid growth raises concerns about environmental degradation, safety of visitors, and the potential strain on search-and-rescue capacities in an extreme and fragile environment – dimensions that carry direct human security implications. The framework is intended to be ambitious and flexible, ensuring that all activities are orderly, predictable, and coordinated so as not to undermine scientific or governmental operations, which are crucial for maintaining the stability of the Antarctic Treaty System. Beyond environmental protection, the framework also addresses broader security concerns such as the cumulative pressures of human presence, the need for precautionary measures against disasters or accidents, and the preservation of Antarctica as a zone of peace and science. By initiating a structured, multilateral process to finalize this framework before the 50th Antarctic Treaty Consultative Meeting in 2028, the Parties are reinforcing governance mechanisms that serve ecological sustainability and political and human security in Antarctica (Decision 5 (2024) - ATCM 46 - CEP 26, Kochi). Moreover, in 2019, the Antarctic Treaty Consultative Parties issued a Manual of Regulations and Guidelines Relevant to Tourism and Non-Governmental Activities in the Antarctic Treaty Area (2023), which is systematically updated by the Antarctic Treaty Secretariat and which contains all relevant documents addressing tourism, including General Guidelines for Visitors to the Antarctic (the recent and updated version from July 2025, however, is not yet included – General Guidelines for Visitors to the Antarctic 2025).

3.4. Militarization

Regarding the risk of militarization in Antarctica, there are three primary enforcement tools for Antarctic regulations: inspections, advance notification of activities, and exchanges of scientific personnel. However, the total number of inspections conducted at Antarctic stations under the Antarctic Treaty has been comparatively low. Notably, 22 stations have never been inspected, some of which are currently inactive. Among those most frequently inspected, Bellingshausen Station (Russia) tops the list with 15 inspections, followed by Artigas (Uruguay) and Great Wall (China) with 12 inspections each, Poland's Henryk Arctowski Station with 11, and Brazil's Comandante Ferraz Station with 10. Other stations have been inspected between one and eight times since the Treaty came into force. Moreover, the COVID-19 pandemic caused a halt in inspections during 2021 and 2022 (Secretariat of the Antarctic Treaty n.d.; Kökyay 2022, 173). Importantly, no Treaty violations were discovered during inspections, though these inspections tend to be brief, and inspectors may lack sufficient expertise to detect sophisticated breaches, especially in areas such as advanced military space research.

One contentious issue is the acceptability of Antarctic bases being used to send command signals to satellites that control weapons systems. Additionally, questions have been raised about the reliability and transparency of activity reports, particularly from China, whose submissions have been criticized for vagueness and potential concealment of military-related activities. While China asserts no military personnel are deployed in Antarctica, nations like the United States and New Zealand report significant military involvement in their Antarctic operations (Bateman 2012, 130; see also Secretariat of the Antarctic Treaty inspection reports at https://www.ats.aq/devAS/Ats/InspectionsDatabase?lang=e).

Looking ahead, the prohibition of military measures and the commitment to maintaining Antarctica exclusively for peaceful purposes may be increasingly challenged due to strategic rivalries in a multipolar world, especially between emerging powers such as China and India. The lack of clear definitions of “military measures” complicates enforcement because the Antarctic Treaty prohibits only explicitly military activities, yet many modern operations – such as dual-use scientific research, advanced communication systems, or logistics support – can serve both civilian and military purposes. Without precise criteria, it is difficult for the Consultative Parties to determine whether a state’s activities violate the treaty, creating ambiguity and potential loopholes for strategic behavior under the guise of peaceful purposes. The expanded use of Antarctic research stations for scientific activities with possible military applications, including support for offensive weapon systems, adds further complexity. The rising involvement of coastguards in law enforcement within Antarctic waters and the use of private security contractors in military roles may blur the boundaries of Treaty prohibitions. Furthermore, scientific research and technology development undertaken by civilian researchers and private entities with military potential further complicate interpretations. As these developments unfold, preserving Antarctica’s demilitarized status could become increasingly complex, particularly if “military measures” are interpreted broadly (Bateman 2012, 116, 118-119).

Dodds (2012, 105) observes that the ATS’s capacity to prevent or de-escalate conflicts remains largely untested since its inception. Although the 1982 Falklands War between the UK and Argentina is frequently cited, it occurred outside the Antarctic Treaty area and did not involve the disputed Antarctic Peninsula. The regime’s ability to manage a conflict within its jurisdiction has yet to be demonstrated. Unlike the 1940s, when Argentina, Chile, and the UK engaged in hostile actions such as dismantling rival scientific stations, such acts have not been recorded recently. Ideally, the ATS will not be forced to face such challenges.

However, the Russian aggression against Ukraine in February 2022 significantly affected Antarctic governance. At the 44th Antarctic Treaty Consultative Meeting held in Berlin, the Final Report was not adopted by consensus but by majority vote – the first such occurrence in the history of the Antarctic Treaty System. This unprecedented development underscores how extra-regional armed conflicts among Consultative Parties may erode the consensus-based decision-making that underpins Antarctic governance. From a security perspective, this development highlights a new vulnerability: the spillover of geopolitical rivalries into Antarctic diplomacy, thereby weakening the perceived stability and resilience of the Antarctic Treaty System (Final Report of the Forty-fourth Antarctic Treaty Consultative Meeting 2022).

4. Conclusions

The Antarctic Treaty System is the primary framework for managing virtually all security-related issues in Antarctica. Should the Treaty suddenly collapse, it would likely result in considerable uncertainty and disruption, especially concerning the sensitive topic of territorial claims on the continent (Rothwell 2012, 33). The ATS has faced multiple emerging challenges, including climate change, bioprospecting, the growth of Antarctic tourism, and maritime security/safety issues due to increased shipping in the Southern Ocean (French 2012, 67). Rothwell (2012, 50) suggests that "the ATS is beginning to show some signs of wear as Antarctica emerges from its polar isolation and becomes increasingly a part of the mainstream of international affairs. The key tipping point will most likely be sovereignty". In this vein, Chaturvedi (2012, 28) observes that the "Antarctic dilemma of climate security stems from the mismatch between 'securing the Antarctic' (both continent and Southern Ocean physically and environmentally) and 'securing the Antarctic regime' along with its core values. Central to this mismatch is the question of who truly represents Antarctica, its values, and to whom". Academics argue that while the Antarctic Treaty allows all nations to participate, only those conducting recognized scientific research on the continent are given decision-making rights. They advocate reform toward a more inclusive and democratic governance structure. Without such changes, there is concern that revisionist states might manipulate the Treaty to further their interests, potentially threatening the enforcement of maritime security/safety regulations in the region (Şeker & Çomak 2022, 21).

Countries such as China and Russia – sometimes termed "ATS changers" – seek to reshape the ATS by gradually reducing its conservation focus to enable economic exploitation. This strategy may be aimed at positioning themselves for territorial claims expected around 2048. The approach of this deadline has escalated competition, putting the ATS's future at risk. Central to this conflict is the debate over Antarctic mineral extraction, which divides those wanting to uphold the Treaty's conservation goals from those pushing for change. This dispute is intertwined with global competition, especially between China and the United States, over critical minerals and hydrocarbons. With global demands increasing due to population growth and the drive for green energy to meet climate targets, shortages could become acute by the 2030s, further complicating geopolitical dynamics (Jardine & Clack 2024).

While the ATS currently stands as a strong governance mechanism capable of temporarily averting conflict, its long-term durability faces pressures from two primary sources: the worldwide depletion of vital resources and Antarctica's growing geopolitical importance. The latter is partly due to the region's strategic value for hosting global navigation satellites and other dual-use technologies, which might be installed on the continent without immediately breaching the demilitarization principle (Vassiliou 2021).

In light of the above findings, while the ATS has thus far provided a resilient framework for the peaceful governance of Antarctica, it is increasingly ill-equipped to address the evolving security-related risks in the region. Environmental threats, particularly those linked to climate change and biodiversity loss, are growing more acute, yet existing regulations tend to be reactive and lack robust enforcement mechanisms. The ATS was designed in the 1950s-60s to preserve Antarctica for peace and science, not to address complex and accelerating environmental changes like climate-driven ice melt, biodiversity loss, or invasive species. The Protocol on Environmental Protection (1991) remains a landmark, but enforcement is weak, compliance is self-reported, and inspections are infrequent.

Legal ambiguities surrounding bioprospecting and resource exploitation – especially in the context of scientific research with potential commercial applications – highlight the need for more precise definitions and stronger regulatory oversight. Although central to the ATS, the prohibition on militarization is challenged by the rise of dual-use technologies and inconsistent reporting practices, with limited inspection capacity further weakening transparency. Meanwhile, the rapid growth of tourism and increasing human presence pose additional environmental and safety risks that are not fully addressed within the current legal instruments. It is worth noting that developing a Framework for the Regulation of Tourism and Other Non-Governmental Activities in Antarctica is in progress and should be completed by 2028. Maritime and human security concerns, including search and rescue operations capacity, are similarly under-regulated, and coordinated multinational emergency response capacity remains limited. Finally, strategic competition and sovereignty interests, particularly among major powers, may destabilize the cooperative foundation of the regime. The first breach of consensus in adopting the Final Report at the 44th ATCM in 2022 demonstrates how extra-regional conflicts can spill over into Antarctic diplomacy, weakening the perception of stability and resilience of the ATS. This shows that while the likelihood of direct confrontation in Antarctica remains low, external geopolitical rivalries can erode trust and consensus, which are the cornerstones of the system. Overall, while the ATS continues to serve as a cornerstone of Antarctic governance, its long-term adequacy will depend on its ability to adapt through greater legal clarity, vigorous enforcement, and enhanced multilateral cooperation. Most of these factors depend on the political will of the states, particularly state parties to the ATS.

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References

Antarctic Climate Change and the Environment Report: A Decadal Synopsis and Recommendations for Action (ACCE), 2022, https://documents.ats.aq/atcm44/att/atcm44_att111_e.pdf (accessed 25.08.2025).

Antarctic Treaty, 1959, https://www.ats.aq/e/key-documents.html (accessed 29.07.2025).

Antarctic Treaty Consultative Meeting XXXV, 2012, An Update on Biological Prospecting in Antarctica and Recent Policy Developments at the International Level, https://www.academia.edu/2394248/An_Update_on_Biological_Prospecting_in_Antarctica_and_Recent_Policy_Developments_at_the_International_Level (accessed 29.07.2025).

Antarctic Treaty Consultative Meeting XLI, 2018, Biological Prospecting in the Antarctic Treaty Area: An Update on Status and Trends, Including an Overview of activities of ATS bodies on biological prospecting and Recent Policy Developments at the International Level, https://documents.ats.aq/ATCM41/ip/ATCM41_ip029_e.doc (accessed 29.07.2025).

AT Annual Report 2007-2008, 2008, China, https://www.ats.aq/devAS/InformationExchange/ArchivedInformation?lang=e (accessed 29.07.2025).

AT Annual Report 2013-2014, 2014, China, https://www.ats.aq/devAS/InformationExchange/ArchivedInformation?lang=e (accessed 29.07.2025).

ATCM, 1991, Annex I on Environmental Impact Assessment https://www.ats.aq/devAS/ToolsAndResources/AntarcticTreatyDatabase?lang=e (accessed 29.07.2025).

ATCM, 1991, Annex II on Conservation of Antarctic Fauna and Flora, https://www.ats.aq/devAS/ToolsAndResources/AntarcticTreatyDatabase?lang=e (accessed 29.07.2025).

ATCM, 1991, Annex III on Waste Disposal and Waste Management, https://www.ats.aq/devAS/ToolsAndResources/AntarcticTreatyDatabase?lang=e (accessed 29.07.2025).

ATCM, 1991, Annex IV on Prevention of Marine Pollution, https://www.ats.aq/devAS/ToolsAndResources/AntarcticTreatyDatabase?lang=e (accessed 29.07.2025).

ATCM, 1991, Annex V on Area Protection and Management https://documents.ats.aq/keydocs/vol_1/vol1_9_AT_Protocol_Annex_V_e.pdf (accessed 29.07.2025).

ATCM, 2005, Annex VI on Liability Arising from Environmental Emergencies https://www.ats.aq/e/liability.html (accessed 29.07.2025).

Bateman, S., 2012, Strategic competition and emerging security risks. Will Antarctica remain demilitarised? In A. D. Hemmings, D. R. Rothwell and K. N. Scott, eds., Antarctic Security in the Twenty-First Century. Legal and policy perspectives. London & New York: Routledge, 116-134.

Brady, A.-M., 2017a, The past in the present: Antarctica in China's national narrative. In Handbook on the Politics of Antarctica, Cheltenham: Edward Elgar Publishing, 284-300.

Brady, A.-M., 2017b, Special Report. China's expanding Antarctic interests. Implications for Australia, Australian Strategic Policy Institute, https://www.aspi.org.au/report/chinas-expanding-interests-antarctica (accessed 29.07.2025).
Brady, A.-M., 2020, Antarctica as a Site of Strategic Competition: Optimal Responses for Australia and New Zealand. In: Antarctica 2050: Strategic Challenges and Responses, https://www.acmc.gov.au/sites/default/files/2020-04/Antarctica%20Booklet%20Final%2020200221.pdf (accessed 29.07.2025).
Bray, D., 2016, The geopolitics of Antarctic governance: sovereignty and strategic denial in Australia's Antarctic policy, Australian Journal Of International Affairs, DOI: 10.1080/10357718.2015.1135871.
Chaturvedi, S., 2012, The Antarctic 'climate security' dilemma and the future of Antarctic governance. In: A. D. Hemmings, D. R. Rothwell and K. N. Scott (eds.), Antarctic Security in the Twenty-First Century. Legal and policy perspectives, London & New York: Routledge, 257-283.
Convention for the Conservation of Antarctic Seals, 1972, https://www.ats.aq/devAS/ToolsAndResources/AntarcticTreatyDatabase?lang=e (accessed 29.07.2025).
Convention on the Conservation of Antarctic Marine Living Resources, 1980, https://www.ats.aq/devAS/ToolsAndResources/AntarcticTreatyDatabase?lang=e (accessed 29.07.2025).
Decision 5, 2024, ATCM 46 - CEP 26, Kochi, Development of a Framework for the Regulation of Tourism and Other Non-Governmental Activities in Antarctica, https://www.ats.aq/devAS/ToolsAndResources/SearchAtd?from=01/01/1958&to=01/01/2158&lang=e&cat=14 (accessed 25.08.2025).
Dodds, K., 2012, The Antarctic. A very short introduction, Oxford: Oxford University Press.
Dodds, K. and Boulegue, M., 2022, Ukraine: The impact on international collaboration in the Antarctic, The Council on Geostrategy's online magazine, https://www.geostrategy.org.uk/britains-world/ukraine-the-impact-on-russias-posture-and-international-collaboration-in-the-antarctic/ (accessed 29.07.2025).
Elzinga, A., 2017, The continent for science. In Handbook on the Politics of Antarctica, Cheltenham: Edward Elgar Publishing, 103-124.
Enhancement of Environmental Protection up to the Antarctic Convergence, Resolution 1, 2009, ATCM XXXII – CEP XII, Baltimore, https://www.ats.aq/devAS/Meetings/Measure/442?utm (accessed 25.08.2025).
Final Report of the Forty-fourth Antarctic Treaty Consultative Meeting, 2022, Berlin, Germany 23 May - 2 June 2022 Volume I, https://documents.ats.aq/ATCM44/fr/ATCM44_fr001_e.pdf.
Foster, C. E., 2012, Antarctic resources and human security. In: A. D. Hemmings, D. R. Rothwell and K. N. Scott (eds.), Antarctic Security in the Twenty-First Century. Legal and policy perspectives, London & New York: Routledge, 154-171.
French, D., 2012, Regime integrity qua Antarctic security: embedding global principles and universal values with the Antarctic Treaty System. In: A. D. Hemmings, D. R. Rothwell and K. N. Scott (eds.), Antarctic Security in the Twenty-First Century. Legal and policy perspectives, London & New York: Routledge, 51-69.
General Guidelines for Visitors to the Antarctic, 2025, Resolution 4 (2025) - ATCM 47 - CEP 27, Milan, https://www.ats.aq/devAS/Meetings/Measure/852 (accessed 25.08.2025).
Guggisberg, S., 2025, A Conceptual Framework of Non-use and Non-use Measures. In: S. Guggisberg and C. Blanchard (eds.), Non-use Measures for Global Goods and Commons in International Law, Leiden/Boston: Brill Nijhoff, 9-36.
Hall, C. M. and Saarinen, J. (eds.), 2010, Tourism and Change in Polar Regions. Climate, environments and experiences, London and New York: Routledge.
Helsinki Declaration on Climate Change and the Antarctic, 2023, Resolution 2 (2023) - ATCM XLV – CEP XXV, Helsinki, https://www.ats.aq/devAS/Meetings/Measure/806?utm (accessed 25.08.2025).

Hemmings, A. D., 2010, Does Bioprospecting Risk Moral Hazard for Science in the Antarctic Treaty System?, Ethics in Science and Environmental Politics, 105, 5-12.

Hemmings, A. D., 2021, “The philosophy of law in the Antarctic” in D. Bunikowski and Alan D. Hemmings, eds., *Philosophies of Polar Law* (London: Routledge, 2021).

Hemmings, A. D., Rothwell, D. R. and Scott, K. N., 2012, “Antarctic Security in a Global Context (Chapter 17),” in Alan D. Hemmings, Donald R. Rothwell and Karen N. Scott, *Antarctic Security in the Twenty-First Century* (London: Routledge).

International Association of Antarctica Tour Operators, 2023, Report of the International Association of Antarctica Tour Operators 2022-23, https://documents.ats.aq/ATCM45/WW/ATCM45_WW013_e.pdf (accessed 29.07.2025).

Jardine, S. and Clack, T., 2024, Geopolitics and security in the changing Antarctic. Hot War. In T. Clack, Z. Meral and L. Selisny (eds.), Climate Change, Conflict and (In)Security, London & New York: Routledge.

Joyner, Ch. C., 2012, Bioprospecting as a challenge to the Antarctic Treaty. In: A. D. Hemmings, D. R. Rothwell and K. N. Scott (eds.), Antarctic Security in the Twenty-First Century. Legal and policy perspectives, London & New York: Routledge, 197-214.

Kökyay, F., 2022, Impact of security dilemma on Antarctic militarization, Polish Polar Research 43 (2): 165–185.

Labour, L., 2019, “Antarctic Resources and Tourism,” in *Antarctica 2050: Strategic Challenges and Responses*, https://www.acmc.gov.au/sites/default/files/2020-04/Antarctica%20Booklet%20Final%2020200221.pdf (accessed 29.07.2025).

Le Page, M., 2025, H5N1 flu is now killing birds on the continent of Antarctica, https://www.newscientist.com/article/2471611-h5n1-flu-is-now-killing-birds-on-the-continent-of-antarctica/ (accessed 25.08.2025).

Manual of Regulations and Guidelines Relevant to Tourism and Non-Governmental Activities in the Antarctic Treaty Area, 2023, https://documents.ats.aq/atcm45/ww/atcm45_ww017_e.pdf (accessed 25.08.2025).

Martin, J. A., 2016, *Antarctic Climate Change Security*, https://ir.canterbury.ac.nz/handle/10092/14096 (accessed 29.07.2025).

Medeiros, S. E. and de Mattos, L. F., 2019, Antarctica as a South Atlantic Maritime Security Issue. In E. Duarte and M. C. de Barros (eds.) Maritime Security Challenges in the South Atlantic. Cham: Palgrave Macmillan, 105-128.

Mountinho, S., 2025, Deadly avian flu strain is spreading rapidly in Antarctica, https://www.science.org/content/article/deadly-avian-flu-strain-spreading-rapidly-antarctica (accessed 29.07.2025).

NASA, n.d., Ice Sheets, https://climate.nasa.gov/vital-signs/ice-sheets/?intent=121 (accessed 18.01.2025).

Nasu, H., 2012, Law and policy for Antarctic security: an analytical Framework. In: A. D. Hemmings, D. R. Rothwell and K. N. Scott (eds.), Antarctic Security in the Twenty-First Century. Legal and policy perspectives, London & New York: Routledge, 18-32.

Nyman, E., 2017, Contemporary security problems. In Handbook on the Politics of Antarctica, Cheltenham: Edward Elgar Publishing, 571-583.

Prague Declaration on the Occasion of the Sixtieth Anniversary of the Antarctic Treaty, 2019, Final Report of the Forty-second Antarctic Treaty Consultative Meeting, Appendix 1, https://documents.ats.aq/ATCM42/fr/ATCM42_fr001_e.pdf (accessed 25.08.2025).

Press, T., 2020, “Antarctica 2020-2050: challenges for Australia and New Zealand,” in *Antarctica 2050: Strategic Challenges and Responses*, https://www.acmc.gov.au/sites/default/files/2020-04/Antarctica%20Booklet%20Final%2020200221.pdf (accessed 29.07.2025).

Protocol on Environmental Protection to the Antarctic Treaty (The Madrid Protocol), 1991, https://www.ats.aq/e/protocol.html (accessed 29.07.2025).

Resolution 7, 2005, ATCM XXVIII - CEP VIII, Stockholm, Biological Prospecting, https://www.ats.aq/devAS/ToolsAndResources/SearchAtd?lang=e&from=01/01/1958&to=01/01/2158&cat=0&top=33 (accessed 25.08.2025).
Resolution 9, 2009, ATCM XXXII - CEP XII, Baltimore, Collection and use of Antarctic biological material, https://www.ats.aq/devAS/ToolsAndResources/SearchAtd?lang=e&from=01/01/1958&to=01/01/2158&cat=0&top=33 (accessed 25.08.2025).
Riffenburgh, B. (ed.), 2007, Encyclopaedia of the Antarctic. Volume 1 A-K Index, New York: Routledge.
Rothwell D. R. (2012) The Antarctic Treaty as a security construct. In: A. D. Hemmings, D. R. Rothwell and K. N. Scott (eds.), Antarctic Security in the Twenty-First Century. Legal and policy perspectives, London & New York: Routledge, 33-50.
Rothwell, D. R., Scott, K. N. and Hemmings, A. D., 2012,"The search for 'Antarctic security'. In: A. D. Hemmings, D. R. Rothwell and K. N. Scott (eds.), Antarctic Security in the Twenty-First Century, London: Routledge.
Scott, K. N., 2012, Scientific rhetoric and Antarctic security. In: A. D. Hemmings, D. R. Rothwell and K. N. Scott (eds.), Antarctic Security in the Twenty-First Century. Legal and policy perspectives, London & New York: Routledge, 284-306.
Scott, S. V., 2021a, National encounters with the International Court of Justice: avoiding litigating Antarctic sovereignty, Melbourne Journal of International Law, 21, 1-18.
Scott, S. V., 2021b, The irrelevance of non-recognition to Australia's Antarctic territory title, International & Comparative Law Quarterly, 70 (2), 491-503.
Secretariat of the Antarctic Treaty, n.d., Inspections Database, https://www.ats.aq/devAS/Ats/InspectionsDatabase?lang=e (accessed 18.01.2025).
Şeker, B. Ş. and Çomak, H., 2022, Antarctic and Arctic Maritime Security Interaction within Liberalism, Realism And Critical Theories. In: B. Ş Şeker, H. Çomak and M. ÖUltan (eds.), Global Maritime Geopolitics, London: Transnational Press, 9-23.
Splettstoesser, J. F. and Dreschhof, G. A. M. (eds.), 2000, Mineral Resources Potential of Antarctica. Washington: American Geophysical Union.
Turner, J. et al., 2009, Antarctic Climate Change and the Environment, Cambridge: SCAR.
Turner, J. and Marshall, G. J., 2011, Climate Change in the Polar Regions, Cambridge: Cambridge University Press.
Vassiliou, A., 2021, Antarctica – Future Conflict Zone?, Finabel, https://finabel.org/antarctica-future-conflict-zone/ (accessed 29.07.2025).
Vigni, P., 2024, Territorial Claims to Antarctica. In: Y. Tanaka, R. L. Johnstone and V. Ulfbeck (eds.) The Routledge Handbook on Polar Law, New York: Routledge, 33-46.
Wyrozumska, A., 1995, Ewolucja statusu prawnego Antarktyki a państwa trzecie, Łódź: Wydawnictwo Uniwersytetu Łódzkiego (The Evolution of the Legal Status of Antarctica and Third States, in Polish).