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LEGAL MECHANISMS FOR PREVENTING THE MILITARIZATION OF OUTER SPACE AND THEIR ENVIRONMENTAL SIGNIFICANCE

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ПРАВОВЫЕ МЕХАНИЗМЫ ПРЕДОТВРАЩЕНИЯ МИЛИТАРИЗАЦИИ КОСМИЧЕСКОГО ПРОСТРАНСТВА И ИХ ЭКОЛОГИЧЕСКОЕ ЗНАЧЕНИЕ

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Abstract. The militarization of outer space poses not only geopolitical risks but also significant threats to the environmental sustainability of the near-Earth orbit. This article explores the international legal mechanisms aimed at preventing the deployment and use of weapons in space. It analyzes the foundational treaties, including the Outer Space Treaty of 1967, the Liability Convention of 1972, and other UN resolutions and soft law instruments. Particular attention is paid to the environmental implications of space militarization, such as the increase in space debris and the risks of contamination from nuclear-powered satellites and anti-satellite weapon tests. The paper argues for the strengthening of legal frameworks to ensure both the peaceful use of outer space and the protection of its fragile environment, proposing a harmonization of space law and environmental law principles.

Аннотация. Милитаризация космического пространства создаёт не только геополитические риски, но и серьёзные угрозы экологической устойчивости околоземной орбиты. Рассматриваются международно-правовые механизмы, направленные на предотвращение размещения и использования оружия в космосе. Анализируются основополагающие договоры, включая Договор о космосе 1967 года, Конвенцию об ответственности 1972 года, а также другие резолюции ООН и инструменты «мягкого права». Особое внимание уделяется экологическим последствиям милитаризации космоса, таким как увеличение засорённости космоса и риск загрязнения окружающей среды ядерными спутниками и испытаниями противоспутникового оружия. Обосновывается необходимость укрепления правовых рамок для обеспечения как мирного использования космического пространства, так и защиты его хрупкой окружающей среды, и предлагается гармонизация принципов космического права и права окружающей среды.

Keywords: outer space law, demilitarization, environmental protection, space debris, international treaties, peaceful use of space, space militarization, legal mechanisms, sustainable space activities, environmental security.

Ключевые слова: космическое право, демилитаризация, охрана окружающей среды, космический мусор, международные договоры, мирное использование космоса, милитаризация космоса, правовые механизмы, устойчивая космическая деятельность, экологическая безопасность.

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Outer space, once a domain reserved for peaceful scientific exploration and symbolic geopolitical competition, is rapidly evolving into a contested and potentially militarized arena. Since the launch of Sputnik in 1957, states have recognized the strategic value of space assets, leading to a proliferation of national space programs with both civilian and military objectives. Although international law has long emphasized the peaceful use of outer space, current trends in military modernization and the development of anti-satellite weapons (ASAT) raise serious concerns regarding both international security and environmental sustainability [3].

The foundational legal framework for governing outer space activities is based on the 1967 Outer Space Treaty, which prohibits the placement of nuclear weapons and weapons of mass destruction in orbit or on celestial bodies. However, it does not explicitly prohibit conventional weapons or the militarization of space through non-lethal means [6]. This legal ambiguity has allowed for the continued development of military space programs, dual-use satellites, and defensive systems under the guise of peaceful use [4].

In parallel, the environmental consequences of militarizing space are becoming increasingly severe. The intentional destruction of satellites, missile tests, and other military activities have dramatically increased the amount of space debris, posing threats to all operational spacecraft and endangering the long-term sustainability of outer space activities [11]. Events such as the 2007 Chinese ASAT test and India's 2019 Mission Shakti operation generated thousands of debris fragments, many of which remain in orbit, creating persistent collision hazards [5].

This article investigates the current international legal mechanisms designed to prevent the militarization of outer space and evaluates their effectiveness in addressing emerging environmental threats. The central argument is that a more integrated approach, combining principles of space law with international environmental law, is necessary to safeguard space as a peaceful and sustainable domain for future generations.

Methodology

This research adopts a qualitative, interdisciplinary approach grounded in international legal analysis. The primary method is doctrinal legal research, which involves the systematic examination of existing international treaties, legal doctrines, and soft law instruments relevant to outer space governance. Key legal sources include the Outer Space Treaty (1967), the Liability Convention (1972), and related resolutions of the United Nations General Assembly [6, 7].

To understand the environmental dimensions of these legal instruments, the study also draws on comparative legal analysis, examining the overlap between space law and international environmental law. Instruments such as the Rio Declaration on Environment and Development and the Espoo Convention on Environmental Impact Assessment are analyzed to extract applicable environmental principles [8, 10]. The goal is to assess how these principles — such as the precautionary principle, sustainable development, and the polluter-pays principle — can inform and strengthen the regulation of space militarization.

Case studies form an integral part of the methodology. Specific events, including the 2007 Chinese ASAT test and India's Mission Shakti in 2019, are examined as concrete examples of the consequences of military activity in outer space. These cases are analyzed in relation to their legal justifications, the resulting debris, and the international responses they triggered [1, 3].

In addition, policy reports and technical assessments by space agencies and expert organizations are reviewed to understand the current scale of space debris and military-related risks. This includes data from the Secure World Foundation, NASA's Orbital Debris Program Office, and the Inter-Agency Space Debris Coordination Committee [2, 5, 12].

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The normative dimension of the study involves proposing legal reforms and governance models that can better address the intersection of military restraint and environmental sustainability in space. Recommendations are derived from best practices in other domains of international law, with the goal of promoting transparency, accountability, and the peaceful use of outer space.

Results

The analysis of current international legal instruments reveals significant gaps in the regulation of outer space militarization, particularly concerning environmental protection. Table 1 below summarizes key international agreements and soft law documents based on their relevance to the prohibition of weaponization and their attention to environmental sustainability.

Table 1

COMPARATIVE ANALYSIS OF LEGAL INSTRUMENTS RELATED TO SPACE MILITARIZATION AND ENVIRONMENTAL CONCERNS

Legal Instrument	*Prohibits Weaponization*	*Environmental Focus*
Outer Space Treaty (1967)	Partial (only WMDs)	Weak
Liability Convention (1972)	No	Moderate (post-damage focus)
UN GA Resolution 75/36 (2020)	No (non-binding behavioral norms)	Emerging
IADC Debris Guidelines (2007)	No (technical recommendations only)	Strong (space debris emphasis)
Rio Declaration (1992)	No (environmental framework)	Strong

The Outer Space Treaty (OST) remains the foundational legal instrument for the governance of space activities. It explicitly prohibits the placement of weapons of mass destruction (WMDs) in Earth orbit, on the Moon, or on other celestial bodies. However, it does not address conventional weapons, military satellites, or dual-use technologies that may serve both civilian and military purposes [6]. While the treaty affirms that outer space shall be used exclusively for peaceful purposes, the interpretation of "peaceful" has varied among states, allowing for the continued growth of military space infrastructure. From an environmental perspective, the OST is vague, offering no specific provisions to prevent the pollution of space or the protection of orbital ecosystems.

The Convention on International Liability for Damage Caused by Space Objects complements the OST by outlining mechanisms for damage compensation when a space object causes harm to other states or their citizens [7]. It introduces a fault-based liability regime for collisions in space and absolute liability for surface damage on Earth. While this convention addresses the aftermath of harmful activities, it is reactive rather than preventive. It does not restrict the militarization of space or require states to adopt precautionary environmental measures. Its environmental significance lies in offering legal recourse for transboundary damage but lacks deterrent power.

This recent resolution reflects growing international concern over space security and sustainability. It calls upon states to develop norms, rules, and principles of responsible behavior in outer space [9]. However, as a non-binding resolution, it carries no legal enforcement mechanisms. Its importance lies in fostering dialogue, transparency, and voluntary commitments. From an environmental standpoint, the resolution acknowledges the importance of avoiding debris-generating activities and supports transparency in national space policies. Still, without obligatory provisions, it serves more as a soft diplomatic tool than a concrete legal instrument.

The Inter-Agency Space Debris Coordination Committee (IADC) developed technical guidelines to limit the creation of space debris, especially from operational spacecraft, upper stages, and fragmentation events [2]. These guidelines are non-binding but widely accepted as best practices. They recommend post-mission disposal procedures, passivation of fuel tanks, and

controlled re-entries. Although not directly linked to weaponization, they address the environmental fallout of military actions, particularly debris from anti-satellite (ASAT) tests. Their strength lies in technical specificity and international endorsement, but their weakness is the absence of legal accountability for violations.

Although not part of space law per se, the Rio Declaration sets out important principles of international environmental law, including the precautionary principle, polluter-pays principle, and intergenerational equity [8]. These principles can and should inform the governance of space activities. For instance, applying the precautionary principle would justify banning debris-generating military tests in orbit, even without conclusive evidence of long-term harm. The Rio Declaration provides a valuable normative foundation for integrating environmental protection into space law, particularly as space becomes increasingly congested and contested.

In summary, while several legal and quasi-legal instruments touch on either space security or environmental preservation, none of them effectively bridges both domains in a binding, enforceable way. The Outer Space Treaty and the Liability Convention form the backbone of international space law but fail to address emerging military threats and their ecological implications. Soft law tools like the UNGA Resolution 75/36 and the IADC Guidelines promote responsible behavior but rely on voluntary compliance. The Rio Declaration offers a model for integrating environmental ethics into space governance, yet its principles have yet to be fully applied in the space context.

Thus, the findings highlight the urgent need for a cohesive legal framework that integrates demilitarization objectives with environmental sustainability, filling the regulatory vacuum that currently allows harmful military activities to proceed in space with little consequence.

To understand the practical consequences of military actions in space, four high-profile incidents were analyzed (Table 2), focusing on the quantity of debris created, the operational altitude, and the environmental impact.

Table 2

MILITARY ACTIVITIES IN OUTER SPACE AND THEIR ENVIRONMENTAL CONSEQUENCES

Event	*Debris Created. pieces*	*Altitude, km*	*Impact on Environment*
China ASAT Test (2007)	3437	865	High
USA Operation Burnt Frost (2008)	174	247	Low
India Mission Shakti (2019)	400	300	Moderate
Russia Cosmos-1408 Destruction (2021)	1500	480	High

On January 11, 2007, the People’s Republic of China conducted a direct-ascent anti-satellite (ASAT) missile test, destroying its aging Fengyun-1C weather satellite at an altitude of approximately 865 km. The event resulted in the creation of 3,437 pieces of trackable debris, making it the single most damaging debris-generating event in history [3]. The high altitude of the destruction meant that many of the resulting fragments remained in orbit for over a decade, posing serious collision risks to operational satellites and the International Space Station (ISS). The global response to the test was overwhelmingly negative, with multiple spacefaring nations condemning the action for its long-term environmental impact. This test became a turning point in discussions on the need for legally binding norms against debris-producing military actions in space.

On February 21, 2008, the United States executed Operation Burnt Frost, a missile defense operation that involved shooting down the malfunctioning USA-193 satellite at an altitude of 247 km. Officially justified on the grounds that the satellite’s hydrazine fuel tank posed a risk upon uncontrolled re-entry, the operation generated 174 fragments of debris, most of which decayed within weeks due to the low altitude [5]. While critics argued that the action could be viewed as a

demonstration of ASAT capabilities, the U.S. emphasized its controlled nature and environmental precautions. This case is frequently contrasted with the Chinese test because of its limited and short-lived impact on the orbital environment.

On March 27, 2019, India conducted its first successful ASAT test under Mission Shakti, destroying a live satellite at an altitude of approximately 300 km. The test created around 400 debris fragments, with roughly two-thirds re-entering the atmosphere within weeks. However, at least 60 pieces remained in orbit for months after the event, raising questions about the risks of even low-altitude ASAT operations [1]. International reactions were mixed: while India was applauded domestically for demonstrating strategic capability, several global space agencies, including NASA, criticized the move as irresponsible and potentially hazardous. The incident underscored the challenge of regulating ASAT activities within current legal frameworks that lack enforcement power.

On November 15, 2021, Russia launched a direct-ascent ASAT missile that targeted and destroyed the defunct Cosmos-1408 satellite at an altitude of 480 km. The action resulted in the formation of approximately 1,500 pieces of trackable debris, alongside thousands of smaller, untrackable fragments [12]. The ISS had to conduct multiple avoidance maneuvers in the following weeks due to the elevated collision risk. Unlike the US and Indian tests, the Russian test occurred in a densely populated orbital region, dramatically increasing the chance of future accidental collisions. The global community, including the European Space Agency (ESA), condemned the action as irresponsible and urged the development of new legal safeguards against similar future events.

These four events reveal a consistent pattern: debris generated from military actions presents long-term risks to both manned and unmanned space operations, regardless of the altitude. Although lower-orbit tests result in faster re-entry and atmospheric burn-up, they still contribute to short-term risks and may damage critical infrastructure. Tests conducted above 400 km are particularly dangerous, as debris may persist in orbit for decades, threatening operational satellites, navigation systems, and even the viability of entire orbital zones.

Legally, these incidents expose the weaknesses of current international frameworks. None of the responsible states faced legal repercussions under the Outer Space Treaty or Liability Convention, as these instruments do not explicitly prohibit such actions unless actual damage occurs to other parties. Moreover, there is no binding global treaty that bans ASAT tests or imposes debris mitigation obligations in the context of military operations.

These findings reinforce the urgency of developing a new generation of space governance mechanisms, which would not only prohibit debris-generating military tests but also embed principles of environmental responsibility and orbital sustainability in future agreements.

A graphical representation of these events (Figure 1) illustrates the scale of debris produced, reinforcing the urgent need for regulatory control.

Figure clearly illustrates the disproportionate scale of debris created by different ASAT (anti-satellite) operations. The 2007 Chinese ASAT test produced over 3,400 fragments — by far the most severe single source of military-related space debris. In contrast, Operation Burnt Frost by the USA in 2008 generated relatively few long-lasting fragments, due to its low altitude and carefully calculated impact trajectory. India’s 2019 test and Russia’s 2021 test show intermediate and high impacts respectively, with Russia’s action raising considerable international alarm due to the destruction of Cosmos-1408 in a heavily used orbital regime.

This figure highlights a critical regulatory gap: no current international treaty effectively prohibits or penalizes debris-generating military actions, even when their environmental risks are

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substantial and long-term. The absence of enforceable environmental standards within space law allows states to proceed with such actions without facing legal consequences [3, 11].

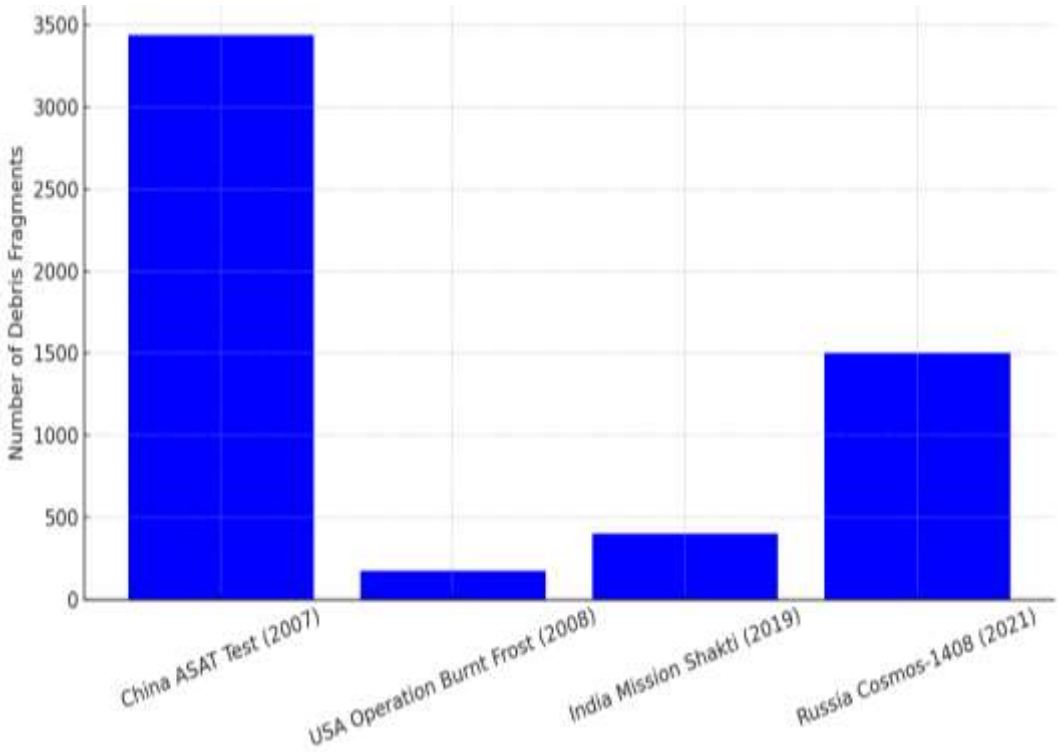

Figure. Number of Debris Fragments Generated by Selected Military Space Activities

The figure thus reinforces the central argument of this paper — that the integration of environmental principles into binding space law is urgently needed to preserve the sustainability and safety of the near-Earth orbital environment.

Discussion

The findings presented in this article underscore a critical paradox in international space governance: while the dangers of militarization and space debris are well-recognized, there is a notable absence of binding legal mechanisms that can effectively prevent or sanction such environmentally hazardous military actions. The current legal architecture—comprising foundational treaties, liability frameworks, and soft law—fails to address the dual-use nature of modern space technologies or the ecological risks of debris-generating activities.

One of the core issues is the limited scope of the Outer Space Treaty [6]. While it establishes a general principle of peaceful use and prohibits WMDs in space, it does not explicitly ban the deployment or testing of conventional weapons or anti-satellite technologies. This legal silence has allowed state actors to pursue military objectives under the justification of national defense or technological advancement [4]. As demonstrated by the cases analyzed, ASAT tests by China, India, Russia, and the USA have been carried out without any legal consequences under international law, despite their severe impact on the orbital environment.

Moreover, the fragmentation between space law and environmental law exacerbates the problem. Environmental principles such as the precautionary principle and intergenerational equity, though enshrined in the Rio Declaration, are not directly codified into space treaties [8]. This legal separation reflects outdated institutional thinking from the Cold War era, where space governance was largely driven by security concerns rather than environmental sustainability.

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The Liability Convention (1972) is similarly limited in effect [7]. It imposes responsibility only after damage has occurred and does not operate as a preventive measure. In cases of ASAT tests that do not cause immediate cross-border damage, there is no activation of the Convention's provisions, rendering it ineffective as a deterrent. The absence of pre-launch notification or debris accountability standards for military operations is a particularly glaring gap in the legal framework [12].

Soft law instruments such as the IADC Debris Mitigation Guidelines (2007) and UN GA Resolution 75/36 (2020) attempt to fill this void by encouraging transparency, best practices, and non-debris-generating behavior [2, 9]. However, their non-binding nature limits compliance and enforcement, especially among states with strategic military interests in space. In practice, adherence to these norms depends on political will rather than legal obligation, making them unreliable safeguards in high-tension scenarios.

Another major challenge is the lack of an institutional enforcement mechanism. Unlike terrestrial environmental treaties, which may involve reporting obligations, compliance committees, or arbitration processes, space law relies primarily on state self-reporting and diplomacy. The UN Committee on the Peaceful Uses of Outer Space (UNCOPUOS) has no enforcement powers, and there is no equivalent of an international environmental court to hear cases involving orbital pollution or reckless military activity in space.

In light of the above, there is a growing call among scholars and policymakers for the development of a new generation of space law that integrates environmental standards, enhances military transparency, and strengthens accountability. This could include a legally binding International Agreement on Space Debris Prevention, modelled after arms control treaties, that sets enforceable limits on high-risk activities, mandates notification of ASAT tests, and penalizes non-compliance through sanctions or liability mechanisms.

The integration of environmental impact assessments (EIAs) into national and international space project planning could also serve as a preventive tool, obliging actors to consider the long-term implications of their actions. Similar tools have already been adopted in the Espoo Convention and could be adapted for space use [10].

Finally, the growing involvement of private actors in space necessitates an updated legal regime that applies not only to states but also to commercial entities operating under national jurisdiction. Current legal doctrines place responsibility on states for non-governmental space activities, but enforcement remains largely theoretical in the absence of domestic legislation or international pressure.

In conclusion, the legal response to the militarization of space remains fragmented, outdated, and insufficiently responsive to the environmental realities of the 21st century. Addressing this will require a shift from passive legal formalism to active legal innovation, rooted in shared responsibility for the preservation of the orbital commons.

Conclusion

The growing militarization of outer space presents a multifaceted threat not only to international security but also to the sustainability of the orbital environment. As this article has demonstrated, current legal instruments — while foundational — are insufficient to address the complex and evolving nature of military space activities, particularly their environmental consequences.

The Outer Space Treaty and related conventions provide basic governance principles but fall short in prohibiting conventional weapons or mandating environmental safeguards. High-profile ASAT tests by China, the United States, India, and Russia have resulted in thousands of debris

fragments, some of which will persist in orbit for decades, underscoring the urgency of legal reform.

Furthermore, the disconnect between space law and environmental law has created a normative vacuum, enabling harmful military actions to occur with limited or no accountability. Non-binding guidelines and soft law instruments, although valuable in promoting best practices, lack enforcement mechanisms and are subject to geopolitical interests. To safeguard the peaceful and sustainable use of outer space, the international community must pursue the development of binding legal frameworks that integrate environmental principles, restrict debris-generating military operations, and establish mechanisms for monitoring, enforcement, and redress. Without such reforms, the continued weaponization of space will not only undermine global stability but also jeopardize the future of scientific, commercial, and humanitarian space endeavors.

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