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The Geopolitics of Space Junk: International Security and the Governance of an Increasingly Crowded Orbit

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Abstract

Low Earth orbit (LEO) is becoming a problem as large as nuclear deterrence during the Cold War – because of the growing proliferation of space debris in the orbital environment. Despite the increasing scientific alarm, space debris remains a technical issue external to the state and international security issues and is seen as a pollution problem. This paper investigates the geopolitics of space debris in the context of international relations theory, in particular the governance issues which are created by the growing congestion of space. The study draws on the ideas of regime theory, global commons theory, liberal internationalism and the securitization theory to create a multi-theoretical analytical framework for the effectiveness of international governance of orbital debris. The research uses a qualitative case study approach, based on three critical incidents: the 2007 Chinese ASAT test, the 2009 Iridium-Cosmos collision, and the 2021 Russian ASAT test. The paper examines the efficacy of current international legal frameworks and the opportunities for a more stringent governance regime using doctrinal, policy document and process analysis. The results uncover a fragmented, weak and ineffective governance system that is unable to address the interconnected and escalating problems of orbital congestion, commercial proliferation and great-power competition. The paper argues for the necessity of the political will and institutional adaptation to effective debris governance in addition to technological innovation, and suggests that the best way forward in the future is a polycentric governance approach.

Keywords: space debris, Kessler Syndrome, international regime theory, global commons, space governance, orbital congestion, securitization, active debris removal

1. Introduction

Background

Humanity's relationship with outer space has undergone a dramatic transformation. Once the exclusive domain of superpower governments during the Cold War, Space is now a bustling arena of commercial enterprise, scientific exploration, and strategic competition. Private companies launch thousands of satellites for global internet connectivity; nations deploy constellations for communications, navigation, and surveillance; and scientists peer deeper into the cosmos than ever before. Yet this expansion has come at a cost: the steady accumulation of debris in Earth's orbit now threatens the very sustainability of space activities.

As of 2025, the orbital environment contains over 5.4 million pieces of debris larger than 10 centimeters, with millions more smaller fragments traveling at velocities exceeding 7.9 kilometers per second (Ruzzeddu et al., 2026). Each piece carries kinetic energy comparable to that of a speeding automobile—sufficient to cripple or destroy operational satellites upon impact. The European Space Agency estimates that the total mass of debris in orbit exceeds 14,500 tons, a figure that continues to grow despite increased attention to mitigation measures.

The problem is not merely technical or environmental; it is fundamentally geopolitical. Space debris sits at the intersection of competing national interests, commercial imperatives, and collective action problems. The risk of the Kessler Syndrome, a self-sustaining cascade of collisions that could render Earth's orbit unusable for generations highlights the governance failure inherent in current approaches (Malavika N T, 2026). Existing treaties, including the Outer Space Treaty (1967) and the Liability Convention (1972), provide broad principles of cooperation and liability but lack enforceable mechanisms to prevent catastrophic harm. The UN COPUOS Space Debris Mitigation Guidelines and Long-Term Sustainability Guidelines remain voluntary "soft law" instruments with limited enforcement capacity.

Research Questions

This paper addresses the following research questions:

1. What theoretical frameworks best explain the governance challenges posed by space debris?
2. How effective are existing international legal and institutional mechanisms in addressing the space debris problem?
3. What factors constrain or enable effective international cooperation on debris governance?
4. What pathways exist for developing a more robust governance regime for orbital debris?

Significance of the Study

The theoretical importance of the research is that it helps to explain the governance of space, while the practical significance is that it provides the policy makers involved in the challenge of space debris with input. Given the growing speed of commercial space activities and increased competition between great powers, it is important to understand the politics of debris governance in order to ensure outer space's long-term sustainability as a common good for all humanity. The research incorporates several theoretical frameworks and uses a multi-faceted approach that is strictly qualitative, both of which provide a contribution to academic knowledge and policy-relevant knowledge.

2. Literature Review

The Scale and Scope of the Space Debris Problem

The number of academic publications on space debris has significantly increased in the last 20 years, as the awareness of the situation of space debris congestion has grown. The exponential increase in the debris population, the hazards to the operational satellites, human space flight and the potential catastrophic consequences of collision cascades have been documented by scholars. First postulated by Donald Kessler in 1978, the Kessler Syndrome is now a key concept in the discursive debates surrounding debris, and refers to the moment of self-maintenance of the debris population.

Recent studies have been more comprehensive and include consideration of the environmental, economical and security issues surrounding space debris. Malavika N T (2026) sets out and defines space debris as a specific type of environmental pollutant and posits that it has been ‘forgotten’ in the governance of global commons, following the ‘Cassandra effect' that sees credible warnings remain unheeded until it

is too late. The transition from voluntary to binding environmental protection has far-reaching governance implications from voluntary mitigation measures in the past to binding measures in the future.

Commercial actors' involvement in the debris problem has been highlighted over the past few years. The number of objects in orbit has grown to the point that mega-constellations are now being launched, such as SpaceX's Starlink, China's Thousand Sails and Amazon's Project Kuiper and are causing a significant challenge for space traffic management. These constellations are reported to have problems like collision, radio frequency interference, and ensuring that post mission disposal of thousands of satellites is carried out (Mannion, n.d.).

International Legal Frameworks

The existing international legal regime governing outer space activities has been dependent on the "Cold War treaties. The non-appropriation, freedom of exploration and state responsibility for national space activities are basic principles outlined in the Outer Space Treaty (1967). The Convention on the Liability of Space Objects (1972) provides for the liability of a space object for damage, based on the notion of fault. In the Registration Convention (1976) states are obligated to keep registers of space objects. Until now, however, the provisions in this law have been completely lacking. Suwijak and Blount (2025) note that there is so far no international law that explicitly stipulates active debris removal responsibilities and liabilities, which hinders cooperation and cost sharing. In addition, there is no universal definition for space debris, which makes the situation more confusing for space regulation aspects and ownership. Several studies have come to the results that the existing law is not adequate to deal with the increasing problem of orbital debris. Important normative developments have been accomplished by the UN COPUOS Space Debris Mitigation Guidelines (2007) and Guidelines for the Long-Term Sustainability of Outer Space Activities (2019), but the voluntary nature of the two sets of guidelines makes them somewhat less effective. These are not binding recommendations (Ruzzeddu et al., 2026, p. 247), but rather recommendations that should be followed if states are to make space activities sustainable over the longer term. The Inter-Agency Space Debris Coordination Committee (IADC) is an ad hoc technical coordinating body, not a legal or governing body, but voluntary.

Geopolitics and Great-Power Competition

Due to the recent advances in space debris, the geopolitical interest of space debris has become the focus of scholars. Mannion (n.d.) considers some of the legal and policy questions that comprise the space debris problem, but instead concentrates on a discussion of the status of international law regarding space debris. She notes that understanding the situation where there is no coordination between the two most important drivers of space activity (the United States and China) increases the danger of harmful space debris consequences such as collision cascades. Bilateral cooperation with China is impeded by a U.S. law known as the Wolf Amendment, which was viewed as an obstacle to the effectiveness of global governance. Cook (2025) relies on the liberal internationalist theory as well as the theory of Mutually Assured Destruction (MAD) from the Cold War to show that space debris poses a strategic threat, which is growing, and that can be matched in strategic significance to the nuclear deterrence of the Cold War. This line of argument translates to the international security aspect of debris governance, requiring international cooperation and international accountability measures to address this issue. The author suggests to establish a new principle of customary international law which forbids in space kinetic actions that "foreseeably cause 'long term', 'widespread' and 'severe' environmental damage. There are two more "dimensions" to debris governance, namely security matters and the dual use nature of space technologies. Some scholars have noted (Suwijak & Blount, 2025) that active debris removal technologies would be required to clear the debris in the orbital

environment, but would have the potential to be weaponised, which would also heighten the need for international cooperation. The civilian/military distinction blurring civilian/military space activities further complicates governance.

Governance Theory and Space

The works of scholars on the field of space governance have been inspired by the injection of international relations theory.International relations theory has led to a considerable amount of literature in the field of space governance. Aliberti, Napier and Beischl (2016) use the regime-based analysis approach to discuss the potential for enhanced governance for debris mitigation, debris removal and space traffic management. They show game theory payoff matrices like Stag Hunt, Battle of the Sexes and Prisoners Dilemma to illustrate different setups of the payoff matrices and any possible variations in payoff matrices. The existing literature on debris governance is inspired by the environmental literature and the regime theory, with a focus on concept of "global common" for space.

Elinor Ostrom's principles of cooperative management of shared resources have been applied to explain the management of shared space (e.g. space as a global commons) and the management of collective action problems (e.g. space debris) (Palit et al., 2025). In search of alternatives to the broad reform of the treaties, politically feasible options have been proposed in the light of polycentric governance approaches which have been inspired by Ostrom's institutional analysis.

Similarly, epistemic communities' influence on space governance has also been touched upon. Research has focused on the role of 'knowledge' or epistemic experts in large-scale projects in space sustainability, as a case study play by space debris threat. According to this literature, existence of expert communities in agenda setting and establishment of norms, especially in the arena of technical complexity is very critical.

Gaps in the Literature

Although the literature on governance of space debris has gained in depth, there are a few areas where there is still a gap. Little empirical evidence has existed that explains which debris-generating events lead to which type of responses by the system – in this case governance.First, there exist limited empirical analysis regarding the linkages between types of debris occurring and type of response from the system – in this case, type of governance response. Secondly, the nature of securitization processes and interactions with cooperative governance has been under-researched. Third, there are still gaps in the theory of the role of nonstate actors, especially of commercial entities in debris governance. Fourth, we have seen that the use of polycentric governance theory in the case of space debris has been mostly theoretical and some empirical testing of the application is scarce. The paper fills in these gaps by analyzing case studies from a comparative perspective using a multi-theoretical approach.

3. Theoretical Framework

Regime Theory

The study is based on regime theory. According to Krasner (1983), an international regime is "a set of implicit or explicit principles, norms, rules, and decision-making procedures around which actor expectations converge in a given area of international relations" (p. 2). This definition is especially suitable for the analysis of space debris governance since that area lies at the point where environmental protection, security, commerce and technology come together and involves a variety of state and non-state actors. Regime theory has a number of advantages when it comes to this study. It focuses on the institutional structures such as principles, norms, rules, and procedures that influence the way actors behave in the

orbital domain. It also gives us the means of evaluating the effectiveness of the current system of governance and of spotting any deficiencies. Furthermore, it allows for an analysis of regime change, covering the conditions under which new norms arise and existing rules are altered. When regime theory is applied to the question of space debris governance, it shows that the institutional situation is fragmented. The Outer Space Treaty includes general principles but does not contain specific rules concerning debris mitigation. The Liability Convention offers a liability system based on fault yet has never been put to the test in real situations. The UN COPUOS guidelines are examples of normative advances but are still voluntary. As Aliberti et al. (2016) show, game theory models can help to explain the various configurations of interests that influence the outcomes in respect of specific issues—debris mitigation, debris removal, and space traffic management.

Global Commons Theory

Another theoretical approach is offered by the theory of the global commons, a theory that stems from the work of Ostrom (1990) and others. Just as the high seas and Antarctica are regarded as global commons, outer space is also seen in this light since these areas have traditionally been considered to be beyond the reach of any one State or of human jurisdiction in general. The framework and concepts associated with the global commons highlight the collective action problems that occur when shared resources are managed, owing to the fact that the various actors have an incentive to over-exploit the commons while at the same time absorbing only a small part of the costs resulting from its degradation. This theory is particularly relevant to space debris. Orbital space exhibits the typical features of a common-pool resource in that it is subtractable when one person uses it, another finds it more difficult to do so and at the same time it is non-excludable since it is difficult to prevent people from gaining access to orbit. The accumulation of debris is an example of the 'tragedy of the commons', because the external costs associated with generating debris are not taken into account and the individuals who are generating it do not consider these costs, leading as a result to the deterioration of the common resource. Solutions based on Ostrom's principles have inspired some researchers to propose polycentric approaches to the governance of orbital debris. The principles put forward by Ostrom have been used in order to support the idea of adopting polycentric solutions for the governance of orbital debris. These particular approaches stress the importance of relying on hierarchical and nested governance institutions, adopting a step-by-step method of imposing sanctions, and involving stakeholders in both the creation and enforcement of rules. The issue of equity is also raised in the context of the global commons: as Palit, Dias and Hazra (2025) point out, existing governance mechanisms tend to reinforce inequality by benefiting the global north while disadvantaging the global south, which in turn raises questions.

Liberal Internationalism

A third theoretical view, liberal internationalist theory, centers on international cooperation, cooperation through institutions, and the importance of international law. Cook (2025) employs liberal internationalist theory to conceptualize space debris as a matter of survival and the need for a collective mindset of restraint and law-making through new norms. Liberal internationalism calls for focusing on certain aspects, which are relevant for debris governance.

First, it suggests that information, transaction costs reductions, and some form of mechanism of monitoring and enforcement are all key facets of international institutions' role in facilitating cooperation. Second, it emphasizes the necessity to have common points of interest and values as a basis for maintaining cooperative partnerships in government.

Third, it acknowledges the influence by non State actors, i.e. epistemic communities, businesses and civil society on the formation of international norms and rules. The application of the liberal internationalist view is especially relevant in this regard for an understanding of the possibility for normative development in debris governance.

Their language comes to us from the humanitarian and environmental law movement and Cook (2025) argues that such a norm ought to be codified in a new customary international law norm to prohibit kinetic actions in space, which are likely to cause 'long term, widespread and severe' environmental harm. As a result of this, the method adopted does not rely on new treaties to resolve the depletion of the orbits, and the consideration of customary law opens up a flexible and politically viable avenue for bridging this.

Securitization Theory

The Copenhagen School (Buzan et al., 1998) has developed what is called ‘securitization theory’ which offers a fourth theoretical approach to the framing of space debris as a security threat. Securitization is a process which makes an issue appear like it is an existential threat and therefore calls for special measures, which cannot be taken within the normal political processes. These implications for governance in the securitization of space debris are important. If debris is considered a threat to security, it will be treated as such, following the rules of national security, which are to keep information secret, to act unilaterally, and to compete strategically, instead of the rules of environmental governance, which are to be open, cooperative, and act collectively. This is seen in the practice of space situational awareness, which is dominated by security actors, and information sharing is limited due to fears of military capabilities being revealed. The securitization process also sheds light on the dual-use issue that exists with debris remediation technologies. Debris removal technologies are vital to the clean-up of the orbital environment, but may be used as a weapon, which makes international cooperation difficult. As the movement of civilian and military space activities has blurred, it has made governance efforts more difficult and has been observed by several scholars (Suwijak & Blount, 2025; Mannion, n.d.).

4. Research Methodology

Research Design

The method used in this study is a qualitative research with comparing the case study method. Where the boundaries between the phenomenon and its context are not sharply defined, where the phenomenon is not around ‘the edges’ but is true to scale and livelihoods, characterising contextually meaningful political issues, the case study approach is most apt.

Case studies are especially suitable for research questions that ask how and why because the investigator has less control over what will happen; and when the research is targeting a phenomenon in the present, as Yin (2014) argues. The research design utilizes three analytical approaches, all being supportive and complementary of one another: Overview of basic doctrinal analysis of instruments of international space law (treaties, UN documents and soft law documents). Analysis of national space policies, diplomatic texts and international organization documents through policy documents. To track critical incidents and governance developments three process traces will be completed. This multiple methods strategy will allow for triangulation of the findings from various sources and multiple methods of analysis, thereby increasing the validity and reliability of the research (George & Bennett, 2005).

Case Selection

It discusses three important events that have shaped the space debris space and the discussion around space debris governance:

Case 1: Chinese ASAT Test from 2007. China launched a direct-ascent ASAT missile test 11 January 2007, destroying their own Fengyun-1C weather satellite. This produced more than 3,000 orbitable trackable objects more than is typical for a single launch ever before. The security aspects of debris production in the case and state accountability issues.

Case 2: Irridium/Cosmos Collision 2009. On 10 Feb 2009, the operational Satellite, Iridium 33, collided with the defunct Russian Satellite called 'Cosmos 2251' leading to the creation of more than 2000 pieces of detectable debris. This first time when two satellites collided in orbit, the collision was only accidental and both satellites were full intact within each other.

Case 3: Russian ASAT Test 2021. Russia on November 15, 2021 successfully tested its first direct-ascent ASAT against its own Cosmos 1408 satellite, which left more than 1,500 objects that were measureable and visible to the ground, and required the crew to put their safety concerns to the test in the International Space Station. There is no doubt that the landmark incident persists even in the face of international condemnation seemingly because the "big five" maintaining that the large-scale production of debris is in their best interests.The greatest take away from this case is that, despite the condemnations, the "big five" Nations continue to undertake debris-producing activities seemingly in their favour.

The cases have been chosen because of three criteria:

1. significance in debris environment;
2. representation of various kinds of debris generation events (deliberate destruction and unintentional collision); and
3. variability in the international response. The case selection helps to make the analysis possible on how different kinds of events promote different governance reactions.

Data Collection

This study was conducted using data from several sources:

Primary Legal Sources: The Outer Space Treaty (1967)

The Liability Convention (1972)

The Registration Convention (1976)

The Space Debris Mitigation Guidelines of UN COPUOS (2007)

The UN COPUOS Guidelines for the Long-Term Sustainability of Outer Space Activities (2019)

National space legislation and policies

Secondary Sources:

Peer-reviewed journal articles on topics relating to space law,

Reports from international organizations (UNOOSA, ESA, NASA, IADC) policy briefs and working papers published by research centres.

Official Documents: i) Diplomatic statements and UN General Assembly resolutions.

Documents created by the National Space Policy

The minutes and reports of international organisation meetings are recorded.

Media Sources

Data Analysis Method

There are multiple steps in analyzing data:

Stage 1: Legal Mapping: The first step will consist of systematic mapping of the international space debris law regime. This encompasses determining relevant provisions in a treaty, soft laws and customary norms in international law. The Legal framework studied includes the scope, content and enforcement mechanisms of all legal instruments in existence which can be used.

Stage 2: Case Analysis: The second phase of the project consists of extensive analysis of each study case. Analysis of each case covers the following: (a) event and debris impacts; (b) international response; (c) governance implications and (d) lessons for the effectiveness of the regime. Causal mechanisms in the field: process tracing.

Stage 3: Comparative Analysis: Third, the cross case comparison of patterns and variation is used. Analysis focuses on what different kinds of events generate which kinds of governance responses, the influence of great power politics on the way responses are formulated and the impetus provided or obstructed to effective governance.

Stage 4: Theoretical Synthesis: The final stage combines the outcomes of the legal mapping, case analysis and comparative analysis to evaluate the power of the theoretical framework to explain and/or to draw implications for policy and practice.

Validity and Reliability

To improve the validity and reliability of research there are several methods used. Using more than one type of data source and more than one type of analysis means there is less risk of bias and more confidence in findings. Case descriptions are detailed and analytical procedures are clearly and cleanly documented for purposes of replecitating and reliability assessment. Adopting a structured theoretical approach, which aids in creating discipline in analysis and allows for the accumulation of knowledge.

Research Limitations

This study has several limitations that should be acknowledged. The first is the case study approach which restricts the extrapolating of findings but helps in enhancing the external validity by means of the comparative design. Consequently, the study is limited, second, to documents that have been published publicly, and thus does not necessarily show all of the diplomatic and strategic considerations. Third, with the rapid changes in space activity, findings could need updates as new developments in space activities take place. Fourthly, the study was restricted to non-interviews of practitioners and policymakers, potentially valuable for their insights on governance. Last, the study primarily concentrates on state actors, and does not explore in great detail the role that commercial actors play in debris governance.

5. Case Study Analysis

Case 1: The 2007 Chinese ASAT Test

Event Description:

China tested its own experimental anti-satellite weapon by shooting down the defunct Fengyun-1C weather satellite, on January 11, 2007 at approximately 865 km of altitude. It was conducted by a ballistic missile fired from a kinetic kill vehicle (KKV) at the Xichang Satellite Launch Center (XSLC). An estimated 150,000 smaller fragments (Mannion, n.d.) and 3,000 to 3,500 pieces of trackable debris (approximately 10cm or greater in size) were created (Mannion, n.d.). This is the largest debris cloud in history in orbit.

International Response:

There was an immediate and overwhelming international reaction to the Chinese ASAT test, that was overwhelmingly condemnatory. Strong protest was made by the United States, Japan, Australia, Canada, and other countries. Test is “inconsistent with China's stated desire to promote the peaceful use of outer space” and “inconsistent with international norms,” says U.S. State Department (2007). The European Union states that its "grave concern" must be followed by a "Code of Conduct for Outer Space Activities”.

The official Chinese reaction was very defensive and they responded that The test would be "purely defensive," the Chinese government said, and would not infringe on China's current international legal obligations. The Chinese officials pointed out that the Outer Space Treaty bans the orbiting of weapons of mass destruction, but doesn't ban the testing of ASATs. In essence, this is a correct legal claim but it pointed to the legal deficiencies in the international law regime.

Governance Implications:

The Chinese ASAT test of 2007 posed a few interesting governing questions. It first exemplified that as is, international law was not sufficient to prohibit activities that generate debris. So, the prohibitions against weapons of mass destruction in the Outer Space Treaty persuaded countries to not take action against kinetic ASAT weapons. The compensation for damages was set out in the Liability Convention, but this convention had not been tested and was challenging to enforce. The 2007 test brought the lack of accountability to the surface of debris creation.

The 2007 test uncovered the legal gaps which allowed debris to be produced without accountability. Secondly, it helped in the emergence of soft law norms. In the wake of this test, the UN COPUOS has been to move the Space Debris Mitigation Guidelines as they were adopted in 2007.UN COPUOS has also accelerated the work on the Space Debris Mitigation Guidelines after the test, which were adopted in 2007. These guidelines set out best practices for mitigation of debris - including disposal requirements after mission completion. Their voluntary nature, however, did not help them much. Thirdly, it further intensified the dangerous relationship of insecurity in space. In response, the United States and other countries rushed their own military space programs, developing both counter space and defensive capabilities. they have also been investing in space situational awareness (SSA) capabilities. This particular event increased the rivalry and mistrust among great powers (Mannion, n.d.).

The 2007 test has instructed regime theory to identify the fragility of the current regime and order. Creation of debris was not prevented by the principles of peaceful use and state responsibility of the Outer Space Treaty. No specifications on debris generation were included in the norms and rules for space activity, and the processes regarding the decisions made on the enforcement were almost nonexistent. The test had global commons aspects, as a representations of tragedy of commons. China has learned to benefit from the benefits of ASAT capability but the costs of debris production is externalized. This behaviour was allowed by the lack of appropriate governance measures. As a test, it showed how debris can be used weaponized in a passive manner from the point of view of the securitization. China's debris field could also deny a space user action space should it be blocked by the debris field, a type of "area denial" that could hamper enemy operations. The literature has been deficient in addressing this form of debris, as a "passive weapon.Little has been written on this aspect of debris as a "passive weapon.

Case 2:The 2009 Iridium-Cosmos Collision

Event Description:

The Iridium 33 U.S. communications satellite and a Russian defunct Cosmos 2251 satellite crashed at an altitude of about 789 km over Siberia on 10th February 2009. Both satellites were destroyed creating over 2000+ satellite fragments which are trackable and many smaller ones. The collision occurred for the first time in history of satellite operations unintentionally between two entire satellites (NASA, 2009). The crash happened when the two satellites were passing through the same orbit at the same time traveling in opposite directions at the relative orbit speed of 11.7 kilometres per second.

Such a collision was very rare, thought to be about 1 in 10,000, but with the growing number of particles orbiting the earth there were growing risks of these collisions. A conjunction had been identified by the

U.S. Space Surveillance Network, but not a warning had been issued as Cosmos 2251 was already dead and incapable of being maneuvered (Johnson, 2010).

International Response

It was not heavily criticised as the Chinese ASAT test, the 2009 case of collision resulted in a somewhat muted and technical response. The US and Russia, which had two satellites involved, issued statements of acknowledgement of the collision and an intent to increase space situational awareness. Iridium Corporation issued statements about the loss of one satellite and the slight impact of the loss on its constellation. International community was concerned, but did not blame.

IADC made announcements about the higher potential to orbital debris and the need for the mitigation measures. The UN COPUOS commented on the Collision in the context of the UN COPUOS Long-Term Sustainability guidelines under development. However, there was no criticism or penalties against them. It was unfortunate that there was little international response due to a number of factors. Prominent among these is the fact that it was an accident, rather than a deliberate one. Second, both satellites were very much under the wings of great space powers; hence, blaming was pointless. Thirdly, it was difficult to determine the exact cause of the event as a result of breaking a norm. There was not an explicit and obvious violation of existing norms. Fourth, the complexity of the technology reflected in the event complicated the issue of responsibility attribution for the non-expert. Lastly, it was difficult to ascertain who is responsible for the event as it was difficult to get non-experts to understand the technical processes involved.

Governance Implications

There were a few governance takeaways from the collision of 2009. Most importantly, it showcased the effect on accidents resulting from colliding in the more busy orbit. The event offered empirical support to the Kessler Syndrome idea, and raised the importance of enhancing SSA.

Secondly;, the collision was a reminder of the need for existing debris mitigation methods, since the existing system failed in this case. Cosmos 2251 had been in orbit for more than 16 years without being disposed of after the mission ended, in violation of the 25-year guidance of the satellites must be removed from orbit after mission phase “mitigation” criteria. The event underscored the issue on how to enforce the mitigation guidelines for “retired” satellites.

Third, the event spurred action aimed at improving space traffic management. The United States and Russia set up bilateral communication channels in the field of space situational awareness. The U.S. Department of Commerce began measures to transfer space traffic management from the Department of Defense to the civil sector. However, I would like to point out through this analysis that these developments were only incremental and not transformative.

Case 3: The 2021 Russian ASAT Test

Event Description

In November 15, 2021, Russia had tested a direct ascent anti-satellite weapon (ASAT), destroying an old defunct satellite, ‘Cosmos 1408’, at around 480 km altitudes. The test created over 1,500 big and small pieces of debris that could be tracked and an estimated hundreds of thousands of smaller fragments. The ruin pile intervened with the orbit of the International Space Station (ISS) which was hosting seven astronauts; it was necessary for the astronauts to take emergency refuge in the docked Soyuz and Crew Dragon spacecraft for several hours; (NASA, 2021).

International Response

The China test and the 2009 case of collision had not mobilized such massive international condemnations as the Russian test. The U.S. was leading the way with a statement from Secretary of State Antony Blinken

stating that the U.S. had been “dismayed by the test and considers it reckless and irresponsible, representing a danger to the safety and security of the International Space Station and other human spaceflight operations, as well as the long-term sustainability of outer space” (U.S. Department of State, 2021).

This topic was also discussed in the UN Security Council by the U.S. The EU, NATO, the UK and other countries stated that they condemn the test. Germany's Foreign Minister branded it "an irresponsible and aggressive act. The international condemnation was remarkable for the range and depth of roll-out, evidence of the fact that there is an international consensus against ASAT testing due to its threat of space sustainability. In response, Russia was defensive and dismissive. The test's success was said to be "successful" by Russian authorities, although they had claimed it wasn't an attack on international law. However, poisonous gases were not released by the test, the threat to the ISS was not created by it, defense minister Sergey Shoigu said that the test was held according to international rules. While expressing his concern that Russia could use ASATs against the U.S., the Russian side dismissed such U.S. fears as "hypocritical," and said past U.S. ASAT tests were an example of hypocrisy, too. At its 2022 session the UN COPUOS addressed the test, with many member states calling for a bans on ASAT testing. The General Assembly of the United Nations adopted, in 2022, a resolution that called for not authorize destructive tests of ASATs by states, which was sponsored by 85 countries. The resolution, however, was not binding and did not mention specific states.

Governance Implications

There were important governance implications of the 2021 Russian ASAT test. First, it proved that countries with a large influence on space desired national security over a collective good practise for space sustainability. In spite of the international community reaching a consensus on ASAT testing and debris creation, Russia went ahead with its own test. Second, the event proved to be a destabilizing factor in the process of normative change to ASAT rather than a catalyst.

Second, it was seen to contribute to the process of normative change, but not in the undermining direction of destructive ASAT testing. A norm against ASAT testing started when the UN General Assembly resolution came out and as more and more international condemnations against such tests issued. However, because the resolution itself was not binding and there were no sanctions as a result, it did not have much effect.

Thirdly, the test showcased the security dilemma in space. To the U.S. and its allies, the Russian test was seen as an indicator of the Russians' prowess and a provocation to the "old order. The U.S. and others responded with increased efforts in counterspace, continuing to push forward a counterspace security dilemma.

Fourth, the need for existing laws/legal approaches to be inadequate was emphasised. Kinetic ASATs were not covered by the Outer Space Treaty ban on WMDs. The Liability Convention didn't specify any procedures regarding compensation for debris damages. The guidelines of the UN COPUOS were non-binding.

Comparative Analysis

The patterns, seen in the three case studies are the following:

Based on the comparative analysis several patterns can be identified: First, purposeful ASATs attract far greater international reactions as compared to those when it occurs by accident. The 2007 and 2021 ASAT tests received much criticism from the international community, but the 2009 collision did not. This is a

pattern that is suggestive of the separation of deliberate and inadvertent acts in international law and norms.

Secondly, the international community's reaction to the tests of ASAT have changed with years. This 2021 Russian test attracted more and more intense criticism than the Chinese test, indicating the recent trend of international condemnation of the risks ASAT testing. The trend in this pattern would indicate towards a norm that destructive ASAT testing to be banned.

Third, governance interventions have been ambiguous in nature, not deep-rooted in substantive change. No fundamental changes were observed in the governance regime with either the ASAT test, nor the accidental collision. Responding, however, has been mostly in terms of normative development, and minor institutional modifications. This trend is a result of the limit of space made available by great power tensions, as well as the lack of any mechanism to enforce that space. Fourth, the space security dilemma has taken a long time to get worse. The tests of the 2007 China and the 2021 Russia were part of the arms race, in response, and the US and others invested in counter space capabilities. This can be a pattern of activities that contributes to tensions with security issues, not collaboration.

6. Implications of the Study

Theoretical Implications

The results obtained from the research conducted in this study have a number of implications for the theoretical approach developed in Section 3.

Regime Theory: The results show the usefulness of the regime theory as a tool for studying space debris governance. The current system of governance has many drawbacks such as fragmentation, non-enforcement, and non-effectiveness. The challenges are introduced by debris creation and the principles and norms laid out in the Outer Space Treaty are inadequate. There are no rules or decision making processes in place and if present these are voluntary and non-enforcement. Yet the results indicate that there is also the possibility of regime evolution, based on regime norms, as the rise of international agreement to ban ASAT experiments shows.

Global Commons Theory: The results clearly indicate that the global commons concept is applicable to space debris. In each case study, the tragedy of the commons' dynamics can be seen, (individual actors internalize benefits while externalizing costs) actions taken by actors generate benefits for themselves, but costs other users of the space. In an Absent effective governance mechanisms, this can happen more often. The findings do indicate, however, that Ostrom's rules for polycentric governance can help get us there; with an increased awareness of shared vulnerability, co-operation may be the key.

Liberal Internationalism: International institutions do promote cooperation, albeit in isolated instances, such as the COPUOS guidelines of the UN or for example the dialogue of the U.S.-Russia SSA. However, mutual values and good mutual institutions are lacking, which lowers the cooperative potential, especially in the case of security concerns. The results indicate that an internationalist liberal framework at the heart of the modern concept of liberal internationalism needs to be complemented with power-politics and security dimensions.

Securitization Theory: The obtained results allow for the validity of the proposal of using securitization theory for space debris. The packaging of debris in terms of a security issue has two impacts. On the other hand, it can hinder cooperation by fostering feelings of agreement.It can help cooperation by making one feel more vulnerable, on the other hand, it can make one feel more "agreed" which can prevent cooperation. At the same time it can hinder collaboration by fostering lack of transparency and

collaborative work over a sense of revelation and cooperation. Space debris is linked to the security dilemma, which is also an outcome of space debris creation activities.

Policy Implications

The results have several policies and practices implications. Norm Development. Together, this international agreement may provide a way for better debris governance, via normative development. The UN General Assembly resolution which called on States to refrain from carrying out "destructive" ASAT tests, although not binding, is an important step toward the development of a customary international law norm. The States should be promoting the normatively development in this regard continuance. Polycentric Governance. These results indicate that governance regimes based on ideas thoroughly developed by Ostrom in the context of common-pool resources could be an alternative path, politically viable to more complete treaty reform. Multiple overlapping governance institutions at various levels with coordination and mutual adjustment processes are the core of the polycentric governance. In terms of Space Debris, this would include parallel with European Space Agency (ESA), national and international (UN COPUOS) programmes and Stakeholder participation as well as graduated sanctions. Technical Cooperation. The results point to the need for cross-border technical cooperation for the trust building and governance. Although limited, there is an instance of dialogue between the U.S. and Russia on SSA, which supplies a platform for dialogue and collaboration between both countries. States should continue to establish and expand technical cooperation arrangements – both information sharing and collision avoidance coordination and through joint research on debris remediation technology. Commercial Engagement. The results indicate that actors in the private sector are increasingly involved in debris governance. Governance processes need to be engaged in to address the proliferation of Mega-constellations and the emerging space commercial sector. States could explore options for engaging industry in policy development and for self-regulation in industry.

Pathways for Future Governance

Based on the findings of this study, several pathways for future governance can be identified:

Based on the results of this study, there are a number of avenues for future governance that can be identified:

Pathway 1: Treaty Reform

The most complete and holistic approach could be to undertake a treaty or renegotiate treaties or agreements to cover space debris and do an overall reform through treaty. But the results indicate that for the moment, treaty reform is unlikely in a geopolitical setting where binding commitments are hard to obtain and where great powers in this world seems to be at odds with each other.

Pathway 2: Normative Development

The more modest approach would be continuation of the development of the norms with the help of UN resolutions and of voluntary rules and the new development of customary international law rules. Results indicate that this "approach" is already in existence: there’s an increasing international consensus to not allow ASAT tests.

Pathway 3: Polycentric Governance

A middle way would be to create several governance initiatives at appropriately different levels of scale and wriggle room developed for co-ordination and mutual adjustment. This solution is based on Ostrom's theory on how to most effectively govern a community's shared goods and has been suggested by multiple academics (Palit et al., 2025; Ruzzeddu et al., 2026).

Pathway 4: Technical Cooperation

A complementary approach would be to extend technical cooperation, sharing of information, collision avoidance coordination, joint generation research on the possibilities of improving debris remediation technologies, etc. The results clearly indicate that technical cooperation can help generate confidence and assist with enhancing governance more generally.

7. Conclusion

In this paper, space debris geopolitics was discussed within the framework of international relations theory, and the governance issues space debris in a crowded orbital environment poses, were highlighted. The study adapted the regime theory, global commons theory, liberal internationalism theory and Secretion theory, which are related to the issue, to make a multi-theoretical analytical framework used to ascertain the potential of international governance of orbital debris. The methodological approach used in the research was a qualitative kind of case study based on the analysis of three critical incidents: the 2007 Chinese ASAT test, the Iridium-Cosmos test in 2009 and the Russian ASAT test in 2021.

The results show that governance frameworks are weak and not coordinated, are poorly enforced, and lack the capability to deal with the growing complexity of orbital congestion, commercialization, and great power rivalry. This current system of laws was developed following Cold War treaty negotiations and lacks details and sanctions. The guidelines, which are an initiative developed by the UN COPUOS, are important normative developments but are not enough to prevent or deter debris generating activities. Governance is also restricted by the great power competition and securitization dynamics. Progressive steps can be taken based on normative development; there is a growing consensus and opinion against ASAT. Experiments in polycentric governance, based upon Ostrom's renowned work on common pool resources, offer a viable, and politically viable, alternative to complete treaty reform. The importance of Technical Cooperation to build trust and to enable wide collaboration.

With the broadening use of outer space, the need for effective space debris governance is also growing. The orbital environment is a limited and finite resource providing vital functions that are essential for modern society such as communication, navigation, weather forecasting, scientific research and national security. Only technological innovation and political will and adaptation of institutions can ensure its long-term sustainability. This paper also offers a theoretical model and methodology to aid in grasping the political process that will influence the future of Space Governance. The research combines several theoretical approaches and uses methodologically rigorous qualitative methods, both for enriching the academic knowledge and for the production of policy-relevant knowledge. The results highlight the importance of ongoing research and policy work around this crucial subject.

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