Cosmic Collision Course

Power Dynamics and Geopolitical Implications of Space Debris Management in the Quadrilateral Security Dialogue Countries

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Abstract

This article delves into the relationships among the Quadrilateral Security Dialogue (Quad) countries and their approaches to space debris management. As the Quad nations enhance their collaboration in space exploration and security, this study addresses three key research questions. Firstly, it examines how the management of space debris illuminates power dynamics within the Quad countries—and the resulting implications for their joint endeavors in space exploration and security. Secondly, it investigates the extent to which the space debris policies of the Quad align with their broader geopolitical interests in the Indo-Pacific region, shaping their interactions with other spacefaring nations. Lastly, it explores the need to establish accountability for space debris retrieval and analyzes the existing legal frameworks surrounding this issue. The article contends that effective space debris management has become a critical element of the Quad's cooperative efforts in space, with existing policies reflecting the countries' geopolitical interests. Furthermore, it underscores the significance of fostering accountability and international cooperation in the realm of space debris management.

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The Quadrilateral Security Dialogue (Quad) is a strategic forum established in 2007, comprising four democratic nations: the United States, Australia, Japan, and India. The initiative aims to promote a free, open, and inclusive Indo-Pacific region by addressing shared regional challenges and fostering cooperation in various areas, such as maritime security, infrastructure development, and disaster relief. The Quad countries have held several meetings at different levels of government, with an emphasis on strengthening their partnership in response to the evolving geopolitical landscape.

In recent years, the Quad has expanded its scope to encompass emerging areas of cooperation, such as cybersecurity, climate change, and space exploration. Recognizing the strategic importance of space, the Quad established a Space Working Group (SWG) in 2021 to enhance coordination and collaboration in space activities, particularly in areas like satellite communication, Earth observation, and space situational awareness.

Space debris management has become a crucial aspect of the Quad's collaborative endeavors in space, with particular emphasis within the SWG dedicated to the long-term sustainability of outer space activities.[1] The increasing volume of space debris poses a significant threat to satellite functionality and human spaceflight safety. As the Quad countries expand their presence in space, addressing the space debris challenge becomes vital to ensure the sustainability and security of their space activities.

The SWG plays a pivotal role in facilitating dialogue and cooperation among the Quad countries regarding space debris management. Through this platform, member nations have committed to sharing best practices, coordinating efforts to track and monitor space debris, and exploring joint initiatives to develop technologies for space debris mitigation and removal. Additionally, the group aims to align their respective national policies on space debris, enhancing the coherence and effectiveness of their collective efforts. By actively engaging in these endeavors, the Quad countries have emerged as influential actors in promoting the long-term sustainability of the space environment, contributing to the broader objective of fostering a free, open, and inclusive Indo-Pacific region.[2]

Geopolitical Interests and Space Debris Policies

The geopolitical interests of the Quad countries and their space debris policies are intricately intertwined, given the strategic importance of space for national security, economic growth, scientific advancement, and international influence. Space is a crucial domain for national security, with satellites providing essential capabilities like communication, navigation, and Earth observation, which are vital for military operations. Managing space debris becomes imperative to safeguard these assets from collision risks, ensuring the uninterrupted functioning of these systems. Therefore, Quad nations share a common interest in collaborating on space debris policies to protect their collective security interests.

The space research industries contribute significantly to the economies of the Quad nations. The United States possesses a robust private space industry, while India, Japan, and Australia are experiencing substantial growth in space sectors. Space debris poses a threat to commercial satellites and future space operations, potentially impacting these economic interests. Collaborating on space debris

[1] "Quad Joint Leaders' Statement" (press release, Press Information Bureau, Government of India, 24 May 2022), https://pib.gov.in/.

[2] Ankit Panda and Benjamin Silverstein, "It's Time for the Quad to Chart a Bold Course on Space Governance," *The Diplomat*, 21 October 2021, https://thediplomat.com/.

management can help safeguard these economic assets and ensure the continued growth of the space sector.

Space exploration and scientific research are also vulnerable to space debris. By cooperating on space debris management, the Quad nations can ensure that space remains accessible for scientific missions and that the benefits of space research can be shared widely.

Furthermore, leadership in space debris management can enhance the international influence of Quad nations. By adopting a proactive stance on this issue, the Quad can demonstrate its commitment to responsible behavior in space, contribute to the development of international norms and rules, and shape the global agenda on space sustainability. While individual Quad nations have taken significant steps to mitigate space debris (fig. 1), there is a pressing need for the bloc to come together and formulate comprehensive guidelines for space debris management.[3]

For effective cooperation on space debris management, the Quad countries can engage with a variety of international and regional organizations and forums, including but not limited to the following:

- **United Nations Office for Outer Space Affairs (UNOOSA)**: UNOOSA plays a crucial role in promoting international cooperation in the peaceful use and exploration of space, as well as the utilization of space science and technology for sustainable economic and social development. Collaborating with UNOOSA can provide the Quad nations with a platform to share best practices, develop international guidelines, and advocate for responsible behavior in space. By engaging with UNOOSA, the Quad countries can contribute to the global efforts in ensuring the long-term sustainability and peaceful utilization of outer space.
- **International Telecommunication Union (ITU)**: The ITU acts as a critical partner in allocating global radio spectrum and satellite orbits. Given that space debris can pose interference risks to these orbits and radio frequencies, the ITU serves as a valuable platform for the Quad nations to propose new rules and guidelines related to space debris. By engaging with the ITU, the Quad countries can contribute to the development of measures to mitigate space debris and ensure the continued functionality and integrity of satellite systems, safeguarding the global radio spectrum and satellite orbits for present and future space activities.

[3] Benjamin Silverstein, "The Quad Needs More Than Bilateral Agreements to Achieve Its Space Goals," Carnegie Endowment for International Peace, 20 May 2022, https://carnegieendowment.org/.

- **European Space Agency (ESA)**: The ESA has been at the forefront of studying and promoting measures for space debris mitigation. Collaborating with the ESA provides an opportunity for Quad nations to share knowledge and technology, fostering valuable exchanges in the field of space debris management. Additionally, coordination with the ESA can facilitate joint efforts in space debris tracking or removal, promoting a collective approach to address the challenges posed by space debris. By leveraging the expertise and resources of the ESA, the Quad countries can enhance their capabilities in mitigating space debris and contribute to the overall sustainability of space activities..
- **Association of Southeast Asian Nations (ASEAN)**: Several ASEAN nations are actively developing their space capabilities and showing a growing interest in space sustainability. Collaborating with ASEAN offers an opportunity for the Quad nations to work together in promoting responsible space practices within the region. The Quad countries can engage with ASEAN to foster dialogue, share expertise, and explore potential collaborations on technical and policy initiatives related to space debris management. By working hand in hand with ASEAN, the Quad nations can contribute to the advancement of space sustainability efforts in Southeast Asia, fostering a cooperative and inclusive approach to address the challenges of space debris.

Bringing together nations from diverse regions with varying aspirations, capabilities, and aims not only serves as an invitation for other countries to join the initiatives but also adds a crucial layer of accountability to the initiative. This collaboration enables countries to share cutting-edge technologies and Earth observation satellite data, akin to the objectives of the SWG within the Quad. By holding countries accountable for their unsustainable actions in outer space, this collective effort promotes responsible behavior and fosters a sense of responsibility among all participating nations.[4]

Accountability for Space Debris Retrieval/Removal

International organizations have consistently introduced new initiatives to monitor, regulate, and delineate the scope of outer space activities. These initiatives encompass the following organizations and their respective efforts:

[4] Ken Moriyasu, "Quad expands cooperation to space at first in-person summit," *Nikkei Asia*, 25 September 2021, https://asia.nikkei.com/.

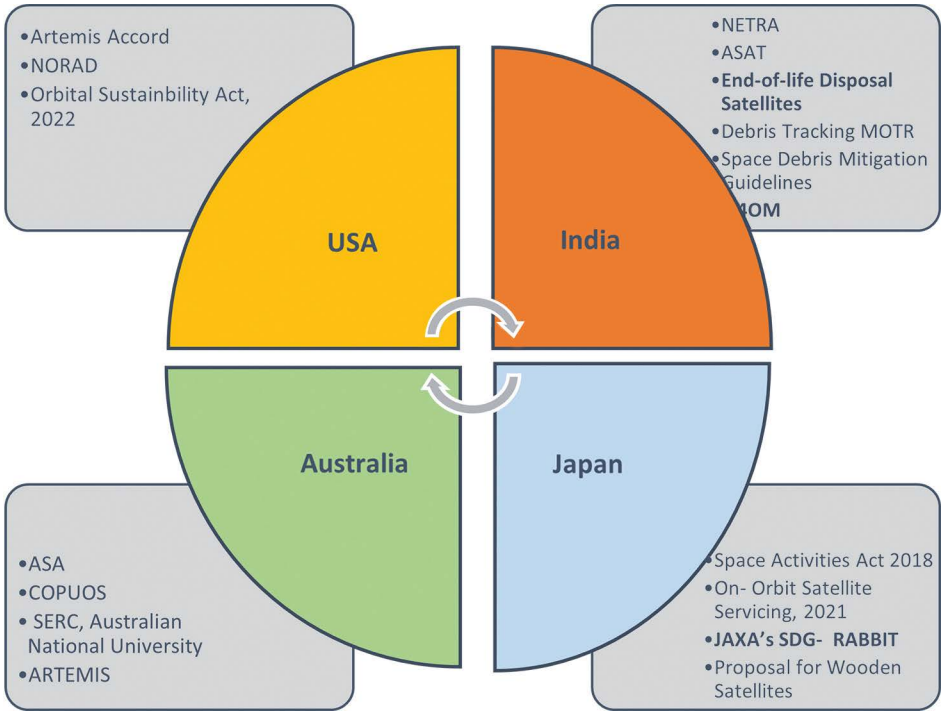

Figure1. Individual initiatives by Quad nations for space debris management (author's compilation)

- **Outer Space Treaty (OST) (1967)**: The OST serves as the cornerstone of international space law, establishing that outer space, including the moon and celestial bodies, is beyond the appropriation of any nation and should be utilized for the common benefit of all countries. The treaty also holds parties are liable for damage caused by space objects they launch.
- **The Rescue Agreement (1968):** This agreement primarily addresses the rescue and return of astronauts and the return of launched objects that return to Earth. While not directly dealing with space debris removal, it is part of the broader legal framework governing space activities.
- **Liability Convention (1972):** This convention outlines the liability of launching states for damages caused by their space objects on Earth's surface or to other spacecraft. However, it does not specifically address space debris removal.
- **Registration Convention (1975)**: This convention requires states to register their space objects with the United Nations, aiding in the identification and tracking of space debris. Although it does not explicitly focus on debris removal, it plays a crucial role in enhancing space situational awareness.

- **UN Committee on the Peaceful Uses of Outer Space (COPUOS) and Inter-Agency Space Debris Coordination Committee (IADC) Guidelines (1993):** COPUOS and IADC have jointly developed guidelines for the long-term sustainability of outer space activities, including recommendations for debris mitigation and prevention. These guidelines, although nonbinding, represent international consensus on best practices for managing space debris.

Together, these international agreements and guidelines form a comprehensive legal framework for regulating outer space activities, addressing issues of ownership, liability, registration, rescue, and the mitigation of space debris.

However, have primarily focused on identifying and raising awareness about the issue of space debris, without providing concrete mechanisms for debris removal or resolving the accountability aspect of debris management. The existing regulations have certain drawbacks, including the following:

1. **Lack of specific regulations**: The current legal framework lacks specific regulations dedicated to space debris removal, resulting in regulatory gaps and unclear responsibilities for debris management.
2. **Nonbinding guidelines**: The guidelines issued by COPUOS and IADC , while offering valuable recommendations, are not legally binding. This voluntary nature may lead to inconsistent implementation and adherence to best practices among space actors.
3. **Ambiguity in liability and responsibility**: The existing legal framework does not provide clear definitions regarding the responsibility for space debris removal and the associated costs. This ambiguity can lead to inaction or disputes among states regarding their obligations.
4. **Technical challenges:** Space debris removal poses significant technical challenges, and the current legal framework falls short in providing guidance on how to address these challenges or support the development of debris removal technology.
5. **Jurisdiction and ownership:** The legal framework does not sufficiently address jurisdictional and ownership matters related to space debris. This lack of clarity complicates the process of removal and disposal, especially when debris ownership is unclear or when multiple parties are involved.
6. **Nonstate actors and commercial activities:** The current legal framework primarily focuses on state responsibility, which may not adequately address the increasing presence of nonstate actors and commercial space activities. Additional considerations and regulations are necessary to address space debris generated by these entities.

7. **Limited international cooperation mechanisms**: The existing legal framework lacks comprehensive mechanisms to foster international cooperation in space debris removal. Given the global nature of the problem, enhanced collaboration among nations is essential to effectively address the issue.
8. **Uncertainty regarding classification and ownership:** The Outer Space Treaty does not provide clear guidance on the classification and ownership of space debris, making it challenging to determine ownership rights and responsibilities. This ambiguity can hinder debris removal efforts.[5]

The Space Treaty prohibits states from interfering with or disrupting space objects under the jurisdiction of others. This raises questions about the extent of jurisdiction over space objects and the removal of debris generated by other entities. Additionally, there is no explicit clarification on unclaimed debris and how it should be addressed within the legal framework.[6]

Addressing these limitations and ambiguities within the legal framework is crucial for effective space debris management. Future efforts should focus on developing specific regulations for debris removal, clarifying liability and responsibility, fostering international cooperation, and providing guidance on technical challenges and ownership issues to ensure a sustainable and secure space environment.

International Cooperation and Potential Solutions

Despite the existence of various international initiatives, the lack of strict and binding rules remains a significant challenge in preventing and removing space debris and addressing the associated risks to space activities. There is a pressing need to establish clear accountability for space debris within international law and agreements. This entails defining the responsibilities of relevant stakeholders in preventing the creation of new debris, mitigating risks posed by existing debris, and addressing damages caused by space objects. Several incidents in the past two decades have underscored the criticality of space debris management and the imperative for accountability:

- **China's antisatellite test (2007)**: In 2007, China conducted a highly controversial antisatellite missile test, deliberately destroying one of its own weather

[5] Alexander Karl, "Active removal of space debris—Discussing technical and economic issues," *Aerospace Research Central*, 29 November 2012, https://arc.aiaa.org/; and Carl Q. Christol, "Scientific and legal aspects of space debris," *Acta Aeronautica*, October 1994, https://doi.org/.

[6] Matteo Frigoli, "Between Active Debris Removal and Space-Based Weapons: A Comprehensive Legal Approach," in *Space Security and Legal Aspects of Active Debris Removal*, ed. Annette Froehlich (Cham: Springer, 2019), 49–70, https://link.springer.com/.

satellites, the Fengyun-1C. This test resulted in the creation of more than 3,000 trackable debris fragments, along with numerous smaller pieces, substantially augmenting the population of debris in low Earth orbit. The repercussions of this incident serve as a stark reminder of the urgency to establish accountability and deter reckless actions that contribute to the proliferation of space debris.

- **Iridium 33 and Cosmos 2251 collision (2009)**: In 2009, a significant collision occurred between two satellites: the operational commercial satellite Iridium 33 owned by the United States and the nonoperational government-owned satellite Cosmos 2251 from Russia. The collision resulted in the fragmentation of both satellites, generating a multitude of debris fragments. This incident serves as a poignant reminder of the imperative to establish accountability for effectively mitigating the risks associated with existing debris, including nonoperational satellites.
- **Reentry of spacecraft**: Notable instances of spacecraft reentry, such as Russia's Mir space station in 2001, China's Tiangong-1 space laboratory in 2018, components of the Chinese Long March 5B rocket, and the International Space Station's (ISS) evasive maneuver to avoid the approaching Russian satellite Cosmos 1408, have raised concerns regarding the risks involved. Although no severe injuries or significant property damage were reported, these incidents underscore the potential dangers associated with uncontrolled reentries and emphasize the necessity for accountability in managing space debris.[7]

Incorporating accountability into international laws will contribute to the following:

- **Prevention and mitigation**: By establishing clear accountability, countries and other actors will be motivated to proactively prevent and mitigate space debris, recognizing the potential consequences and liabilities associated with irresponsible actions. This will encourage the adoption of best practices, technological advancements, and collaborative efforts to reduce debris generation and enhance space debris mitigation measures.
- **Compensation for damages**: With clear accountability, determining liability and allocating responsibility for damages caused by space debris becomes more straightforward. This clarity facilitates the process of seeking compensation

[7] Yannick Radi, "Clearing Up the Space Junk: On the Flaws and Potential of International Space Law to Tackle the Space Debris Problem," *ESIL Reflections* 12, no. 2 (9 March 2023), https://esil-sedi.eu/.

from the responsible party, ensuring that those impacted by debris-related incidents can be appropriately compensated for any harm or losses incurred.

- **Debris removal**: Accountability incentivizes entities to actively participate in debris removal efforts. When accountable for objects they launch into space, even after those objects become debris, there is a direct interest in supporting or undertaking debris removal initiatives. This can drive the development of debris removal technologies, collaborative missions, and international cooperation to address the accumulation of space debris.
- **Foster international cooperation:** Accountability plays a vital role in fostering international cooperation on space debris management. Clear accountability measures encourage countries to align their interests and cooperate in sharing technology, data, and expertise to effectively manage space debris. This collaboration can include joint research and development initiatives, information sharing platforms, and the establishment of common standards and guidelines for responsible space activities.

By integrating accountability into international laws and agreements, these actions will help prevent and mitigate space debris, ensure fair compensation for damages, drive debris removal efforts, and foster international cooperation in addressing the challenges posed by space debris.

Conclusion

Space debris management presents a significant opportunity for cooperation among Quad members. The Quad countries possess the capability to establish a collaborative framework among themselves to effectively address the space debris issue. Such efforts will not only contribute to the sustainability of outer space activities but also serve as an invitation to other regional actors to join in this important cause. The Quad's commitment to space debris management reflects its recognition of the sustainability imperative, geopolitical interests, and its capacity to mobilize international cooperation. By proactively addressing space debris, the Quad demonstrates its commitment to a safer and more sustainable space environment for the benefit of all.

Space security and sustainability are common areas of interest among Quad members, as all countries actively engage in space activities that are integral to their national security, economic development, and scientific pursuits. However, space debris poses a significant risk to these assets and activities, necessitating collaborative efforts by the Quad members to effectively manage and mitigate this challenge and ensure the long-term sustainability of space operations.

One crucial aspect of space debris management is demonstrating responsible behavior in space. By working together in this endeavor, the Quad members can underscore their commitment to responsible conduct, countering perceptions of space as solely a domain of military competition. This cooperative approach allows the Quad to assume leadership in setting international norms and standards for space activities, aligning with established guidelines such as the IADC guidelines.

Enhancing technological cooperation is another essential aspect of effective space debris management. This collaborative effort among the Quad countries facilitates the development and sharing of advanced technologies required for tracking, monitoring, and potentially removing space debris. By pooling their expertise and resources, the Quad members can not only address the immediate challenge of space debris but also strengthen their overall technological cooperation.

Considering the geopolitical context, the Quad's interest in space debris management extends beyond the direct threat posed by debris. It also serves to counterbalance China's influence in space and challenge China's record on space debris management. By taking the lead in promoting space sustainability, establishing norms, rules, and capabilities for debris management, the Quad sets a benchmark for responsible behavior that stands in contrast to China's actions.

Moreover, space debris management offers an opportunity for Quad cooperation to deepen and foster trust among its members. Addressing this complex technical challenge requires sustained collaboration, data sharing, and potentially joint operations. By working together on space debris management, the Quad enhances cooperation and builds confidence, strengthening their collective resilience in addressing future challenges.

To achieve effective space debris management, the Quad can collaborate with other regional organizations and countries through various means. Sharing data on space debris can improve tracking and prediction globally, contributing to enhanced space safety. The Quad's advanced space capabilities position it to assist other countries and organizations in capacity building for debris management, including sharing best practices, offering technical assistance, and collaborating on research and development. Additionally, the Quad can actively participate in the development of international norms, rules, and standards for space debris management through engagement in international forums and voluntary initiatives. Collaboration with other regional organizations, such as ASEAN, the European Union, or countries with emerging space capabilities, can further enrich knowledge exchange and joint efforts in space debris tracking and removal.

While countering China's influence is a part of the Quad's approach, it is equally important to demonstrate a constructive and cooperative model for space activities. Space debris management, with its emphasis on shared challenges and the pursuit

of global public goods, plays a pivotal role in showcasing the Quad's positive engagement in the realm of space affairs. ✪

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