

Memo on Space Debris Summit & Active Debris Removal

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Abstract

The US should propose an international summit and agreement to submit space debris reduction targets, goals, and plans, within the confines of the Outer Space Treaty, to energize forward looking accountability, and incentivize industry support. Furthermore, the US should establish an Active Debris Removal (ADR) inter-agency office to support commercial and government ADR through domestic and international regulations and coordination.

This policy is modeled after the hybrid-legal structure of the Paris Agreement within the United Nations Framework Convention on Climate Change Treaty, and will ensure continued access to space by:

- Generating broad, global participation essential for debris prevention, mitigation, and removal;
- Supporting emerging economies pursuing space capabilities, while flattening the risk curve through moderate ADR investment;
- Enabling nation-drive contributions with bottom-up targets that allow governments to consider their varying degrees of responsibility; and,
- Creating financial and recognition-based incentives through legalized transparency and reporting of government and commercial goals on a public stage.

Summary

Now is the time for the United States to lead a global, strategic initiative charting a new course in the effort to combat space debris. With millions of fragment clouds, and discarded hardware proliferating orbital regimes^[1], US national systems operate at increased risk. Furthermore, cascading effects can disproportionately impact global infrastructure and amplify the possibility of harm and injustices in communities dependent on space to alleviate poverty. Donald Kessler, retired head of NASA's orbital debris program, said that the problem becomes drastically more expensive the longer we wait. He argues that space activities could be rendered unfeasible for decades because of ablation cascade – a scenario where space debris collisions cause a domino-effect resulting in an overwhelming number of debris^[2]. It is in the best interest of all countries to take on this global hazard with an international and collaborative lens.

The Paris model allows for an iterative and bottom-up solution to the problem and may be a pathfinder for future collaboration.

There are many differences between earth's biosphere and celestial domains but US space leadership should take lessons learned from the climate and environmental community regarding how to create an international, joint front in the fight against space litter. While a wholesale transfer of doctrine between earth's environment and the outer space environment would oversimplify the variances between the bodies of law, the United Nation's described the lessons and comparisons fruitful in reviewing law^[3]. If the Paris Agreement has shown to be a promising bottom-up accountability model where nations commit to goals they set, the space community should adopt a similar

[1] The Aerospace Corporation. Retrieved on 29 February 2021 from <https://aerospace.org/article/space-debris-101>

[2] Wheeler, J. (2014). Space debris: the legal issue. Retrieved on 19 March 2021 from <https://www.aerosociety.com/news/space-debris-the-legal-issues/>

[3] Ad Hoc Committee on the Peaceful Uses of Outer Space, Report, 67, 68, U.N. Doc (A/4141) July 14, 1959.

framework to address space debris. Gershon Hasin, international law lecturer at Yale Law School, writes, “The interactions observed so far indicate that the implementation of dynamic nationally based targets, similar to the method chosen in the Paris Agreement, will generate broad participation essential for successful debris mitigation^[4].”

Furthermore, in alignment with Space Policy Directive-3^[5], and the US Space Priorities Framework^[6], ADR must play a role in long-term orbital regime sustainability. However, there is no market for ADR and technology currently exists only in the Research & Development (R&D) demonstration phases^[7]. Neither the Department of Commerce (DoC), NASA nor the US Space Force have an official ADR portfolio. Given the variety of regulatory agencies, and international gray areas in the Outer Space Treaty (OST) and Liability Convention, the US space community will need an inter-agency office to clarify the path, facilitate international dialogue, write Memorandums of Understanding between nations, and give commercial companies confidence and top-cover to elevate ADR investments.

Survey of Existing Legal Considerations

Law and regulations concerning ADR activities, the existence of debris, and accidents generated by debris should be examined. Depending on the ADR methodology, ADR activities must consider domestic agencies and their policy requirements. This includes the Federal Aviation Administration, who regulate launch and re-entry, Federal Communications Commission, who regulate radio frequency deconfliction, National Oceanic and Atmospheric Administration, who regulate remote sensing, and Department of State who regulate International Traffic in Arms Regulations^[8]. The laws and regulations of the international community must be considered as well such as the assignment of orbital slots by the International Telecommunication Union, export controls, consent, ownership, intellectual property transfer, technology sharing, liability, and acceptable risk posture.

The Paris Agreement model is not perfect, but still serves as a good blueprint for space debris intervention.

The existence of space debris has vague legal oversight. Of the five international treaties sustaining space law, the OST has some relevance to protecting the space environment from orbital rubbish. Article I states that the use and exploration of outer space “shall be carried out for the benefit and in the interests of all countries.” Ram Jakhu, professor of international space law, suggests this is enough to say that states have an obligation to mitigate debris because it can hinder other state interests, however, to date no nation has attempted to invoke Article I to address the spiraling space debris problem^[9]. Article VII of the OST says that each state “is internationally liable for damage to another State Party”, but Daria Diaz, an environmental attorney, argues that “littering the outer space environment does not, per se, give rise to international liability.” Article IX is another section of the OST that calls on nations “to avoid their harmful contamination”. Nevertheless, “harmful contamination” is not defined and leaves to question whether space debris rises to the level of “harmful contamination.” Despite the good which came from the OST, it leaves those nations who litter in outer space with immunity. Daria Diaz writes that “Although the OST contains

[4] Hasin, G. (2021). Confronting Space Debris Through the Regime Evolution Approach. *International Law Studies*.

[5] Space Policy Directive-3. (2018). Retrieved on 30 April 2021 from <https://www.federalregister.gov/documents/2018/06/21/2018-13521/national-space-traffic-management-policy>

[6] United States Space Priorities Framework. The White House. 2021.

[7] May, C. (2021). Center for Space Policy and Strategy. Triggers and Effects of an Active Debris Removal Market.

[8] Way, T. Koller, J. (2021). Center for Space Policy and Strategy. Active Debris Removal: Policy and Legal Feasibility.

[9] Jakhu, R. Ahmad, T. (2017). The Outer Space Treaty and states’ obligation to remove space debris: a US perspective. Retrieved on 6 April 2021 from <https://www.thespacereview.com/article/3370/1>

directives that arguably relate to intentional creation of space debris, these provisions are ambiguous and lack real enforcement capabilities [10].

The Convention on Registration of Objects Launched into Outer Space and Convention on International Liability for Damage Cause by Space Objects have relevance to assigning responsibility to state actors. The Registration Convention requires states to register spacecraft belonging to the launching state to address obligations under Article VI of the OST requiring state responsibility and supervision of their space objects[11]. The Liability Convention says that if damage is “being caused elsewhere than on the surface of the earth to a space object of one launching State... by a space object of another launching State, the latter shall be liable...” Ram Jakhu argues this is justification that states must monitor and control their space debris and could be required to pay compensation if damage is caused. However, Louis Matignon, doctor in space law, says the Liability Convention “does not define this notoriously ambiguous term [fault], nor does it establish a standard of care for those conducting outer space activities[12].” Domestically, the Commercial Space Launch Amendments Act also requires commercial companies provide indemnification against legal liability to the government for \$500 million during launch and object re-entry[13].

What we have seen with a Paris model is industry incentive (both financial and recognition-based) and energy to lean forward as champions of the cause.

Steven Freeland, from Sydney University School of Law, argues that soft law must be considered because the rapid pace of technological advancement and geopolitics moves the international community away from treaties, that could not have anticipated today’s environment, towards soft-law guidelines and practices, and potentially “a revised interpretation of the legal obligations under a treaty[14].” There may be argument that customary law exists because general recognition and conformity of practices are in place with the adoption of similar guidelines and standards to mitigate debris, and acknowledgement of practices like the 25-year “rule” for objects in low earth orbit to reenter the atmosphere.

Ram Jakhu brings up several judicial cases that may apply to space debris and international law. The International Court of Justice (ICJ) findings in the Corfu Channel case examined damages at sea may have applicability to leaving harmful debris in space. The Iron Rhine Arbitration calls for a “duty to prevent” significant harm to the environment, and the ICJ says that prevention is a customary rule in the Pulp Mills case[15]. Finally, Sean Murphy discusses principles of common heritage and common concern in the areas of the high seas, deep seabed, Antarctica, and outer space by specifically calling attention to the Stockholm Declaration. He writes “the principle is usually interpreted as requiring a state to exercise diligence in seeking to prevent “significant” damage.” A foundational

[10] Daria Diaz. (1993). Trashing the Final Frontier: An Examination of Space Debris from a Legal Perspective: <https://www.jstor.org/stable/43291146?seq=1>

[11] General Assembly – Twenty-Ninth Session. Convention on Registration of Objects Launched into Outer Space. Retrieved on 18 April 2021 from https://www.unoosa.org/pdf/gares/ARES_29_3235E.pdf

[12] Matignon, L. (2019). International Liability for Damage Caused by Space Objects. Retrieved on 10 April 2021 from <https://www.spacelegalissues.com/space-law-international-liability-for-damage-caused-by-space-objects/>

[13] Leon, D. (2012). U.S. House Approves Commercial Launch Indemnity Extension through 2014. Retrieved on 30 April 2021 from <https://spacenews.com/32349us-house-approves-commercial-launch-indemnity-extension-through-2014/>

[14] Freeland, S. Jakhu, R. (2016). The Relationship Between the Outer Space Treaty and Customary International Law. SSRN. Retrieved on 8 April 2021 from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3397145

[15] Jakhu, R. Ahmad, T. (2017). The Outer Space Treaty and states’ obligation to remove space debris: a US perspective. Retrieved on 6 April 2021 from <https://www.thespacereview.com/article/3370/1>

case to this is the Trail Smelter dispute which established a principle of environmental law and transboundary pollution^[16].

But rather than waiting for the Kessler Effect to create new court hearings, is there a feasible way to address this topic now?

The Opportunity & Political Support

Considering the risks with a paint chip striking the Cupola observation module, and debris created after the collision between the Russian COSMOS and Iridium satellite, and anti-satellite missile tests^[17], space debris is acknowledged as a global hazard. While the international community has time to fix the problem, efforts must be undertaken now as organizations like SpaceX, OneWeb, Telesat and Amazon have announced plans to launch mega-constellations that would squeeze orbital regimes with an extra 40,000 satellites in the next decade.

Many global injustices have been alleviated because of US space leadership

Space debris is a topic that political parties, and countries can find common ground on. We are currently amid a historical convergence of interest in space debris as a public bad. The US, under separate White House Administrations, continues to show support for this issue through NASA's Orbital Debris Program Office, US Space Force's free space-track.org publication, updating the Orbital Debris Mitigation Standard Practices^[18], writing the National Orbital Debris R&D Plan^[19], and setting internal regulations to prevent debris such as Section 25.114(d) of Title 47 in the Code of Federal Regulations^[20]. John Lauder writes, "Under both Republican and Democratic administrations, the United States has collaborated with other nations and the commercial space sector on developing several non-legally binding 'norms of behavior' for operations in space, including best practices to avoid collisions and mitigate space debris^[21]."

Internationally, we see China passing national regulations for debris mitigation, Russia updating best practices and guidelines for technology development, the European Space Agency and Indian Space Research Organization establishing technical means of debris mitigation, and the International Organization for Standardization and United Nations Committee on the Peaceful Uses of Outer Space publishing voluntary guidelines. Hasin writes, "differentiation based on national interests... may be acceptable to most, or even all, members of the international community^[22]." Furthermore, an Inter-Agency Space Debris Coordination Committee (IADC) brings together technical representatives of all the countries with significant space programs, including Russia, China, India and the United States, and serves as an example of a *surprising form of cooperation when political will exists*.

The Paris Agreement model is not perfect, but still serves as a good blueprint for space debris intervention. Unlike the Kyoto Protocol, which put forth a top-down approach, with financial penalties that did not take into consideration key operational difficulties, a Paris Agreement model takes a bottom-up approach and would require

[16]Murphy, S. (2006). Principles of International Law. *West Academic Publishing*.

[17]Sheetz, Michael. (2019). Why in the next decade companies will launch thousands more satellites than in all of history. Retrieved on 13 February from <https://www.cnbc.com/2019/12/14/spacex-oneweb-and-amazon-to-launch-thousands-more-satellites-in-2020s.html>

[18]US Government (2019). Retrieved on 26 April 2021 from https://orbitaldebris.jsc.nasa.gov/library/usg_orbital_debris_mitigation_standard_practices_november_2019.pdf

[19]National Orbital Debris Research and Development Plan. (2021). Retrieved on 25 April 2021 from <https://trumpwhitehouse.archives.gov/wp-content/uploads/2021/01/National-Orbital-Debris-RD-Plan-2021.pdf>

[20]47 CFR § 25.114 - Applications for space station authorizations. Retrieved on 26 April 2021 from <https://www.law.cornell.edu/cfr/text/47/25.114>

[21]Lauder, J. Klotz, F. Courtney, W. (2020). How to Avoid a Space Arms Race. Retrieved on 30 April 2021 from <https://www.rand.org/blog/2020/10/how-to-avoid-a-space-arms-race.html>

[22]Hasin, G. (2021). Confronting Space Debris Through the Regime Evolution Approach. *International Law Studies*.

“all states to put forward their best efforts through “nationally determined contributions,” and to report regularly... on their implementation efforts^[23].” This soft accountability approach, relying on legalized transparency and domestic and international pressure to meet goals set on a public stage, is shown to have made it through domestic and international political scrutiny, and has led to promising goals and review processes. David Held and Charles Roger write that that Paris Agreement “may hold lessons for how to govern other cross-border issues” and suggests the model depends on innovative development, and a dynamic global ecosystem with “many interdependent parts” interacting “in mutually facilitative ways^[24].” This is an important acknowledgment because the Paris model provides flexibility for iterative and evolving technology, and national-driven solutions to address the challenges of space debris.

A key part of the Paris Agreement is that the agreement operates within the United Nations Framework Convention on Climate Change Treaty. A summit and agreement on space debris can operate as a soft law within the already existing OST. This approach is useful because it shows a mechanism for modernizing the OST to consider the technology, and evolution of space as a global common to space as a competitive and opportunistic entity.

ADR has received support as well and was referred to in the National Orbital Debris R&D Plan as the third element essential to orbital risk management. The Vice Chief of Space Operations recently told the Foreign Policy Research Institute (FPRI) that he would “pay by the ton” for debris removal^[25]. Experts at the Center for Orbital Debris Education and Research have made the case for the government to establish dedicated inter-agency group to support international ADR agreements, incentivize commercial development (financial and recognition), support navigating the regulatory environment, clarify the law, and provide top-cover for industry investment^[26].

In contrast to limiting debris “by system design”, and tracking debris with sensors, which has received billions of dollars of investment funding through the Federal Government, ADR receives little market or public attention today. These investments are pivotal to continue but must be balanced with ADR to achieve long term sustainability of orbital regimes. Moreover, the ADR goals can be quantified and allow for reliable cost estimates. Dr. Darren McKnight has identified the 50 most worthwhile pieces or clouds of debris to remove based on algorithmic criteria^[27]. Furthermore, NASA models show that a modest removal of about 5 satellites or rocket bodies a year can flatten the curve in space debris proliferation and removing more enables even greater sustainable models for space^[28].

Global Justice

Multiple lenses of justice, such as fairness and equity, can be considered. It can be argued that western countries have made it more challenging and expensive for emerging countries to enter space by introducing massive amounts of debris. If space operations become unfeasible, this could interfere with millions of small businesses connecting with the global economy and fighting poverty. But, in the author’s opinion, the strongest case for justice is accountability.

[23]Murphy, S. (2006). Principles of International Law. *West Academic Publishing*.

[24]Held, D. Roger, C. (2018). Three Models of Global Climate Governance: From *Kyoto to Paris and Beyond*. <https://doi-org.ezp-prod1.hul.harvard.edu/10.1111/1758-5899.12617>

[25]Erwin, S. (2021). U.S. Space Force would support commercial services to remove orbital debris. *SpaceNews*. <https://spacenews.com/u-s-space-force-would-support-commercial-services-to-remove-orbital-debris/>

[26]Johnson, K. Jones, T. (2020); CODER Conference.

[27]Darren McKnight. (2020). “Identifying the 50 Statistically Most-Concerning Derelict Objects in LEO,” in *Acta Astronautica*, Volume 181, p. 282-291.

[28]Orbital Debris Program Office. (2021). “Debris Remediation,” NASA, <https://orbitaldebris.jsc.nasa.gov/remediation/>

While removing volatile debris created by the Chinese and Russians is considered the most essential ADR activity in the near term, the United States is still the largest contributor to space debris^[29]. This was not done through reckless intent, but rather while trying to prove new technology, preserve national security, and reach for the stars. Many

... while updating guidelines and sharing best practices is a good thing, it is not enough.

global injustices have been alleviated because of US space leadership, such as enabling telecommunications, mobile services, transactions, and tools to lessen poverty. The US, in the spirit of global responsibility and goodwill, has established free services like SERVIR that provide alerts to developing countries about flooding and remote wildfires, space-track.org to help with space object tracking, and the Global Positioning System.

Nonetheless, for decades, vague international law, and the ability to generate large amounts of funding for space operations has benefited the United States who had free reign of the space environment. China, India and others conformed to US standards with impunity. Today, an international approach to space debris responsibility is in order. Iris Young writes, “Political responsibility in relation to structural injustice, then, certainly should involve making demands on state and international institutions to develop policies that limit the ability of powerful and privileged actors to do what they want without much regard to its cumulative effect on others, and to promote the well-being of less powerful and privileged actors^[30].” As countries emerge with their own space pursuits, and global critical infrastructure continues to rely on sustainable space, the US and others must take accountability for the vast amounts of debris they created.

It is not in the US interest for other countries to emulate debris creation and repeat the same argument used to justify CO2 emissions, which entails pointing at decades of US industrial growth through dirty energy. That is one of the reasons the US is undergoing efforts to publish standards and share best practices with the international community. But there is only so much momentum this approach can build. What we have seen with a Paris model is industry incentive (both financial and recognition-based) and energy to lean forward as champions of the cause. An international model is also a great mechanism for accountability. Simon Zadek emphasizes that accountability must include “answerability” and “enforceability”. Accountability can be achieved when we know who is accountable, have capability to enforce accountability, and have consensus from a community regarding a decision^[31]. While the Paris model gives way for soft-answerability and soft-enforceability, it garners national and industry excitement, new levels of transparency, and a desire to be victorious on the public stage^[32].

Nationally based targets generate broad participation essential for successful debris mitigation, acknowledges varying “degrees of responsibility, and allows emerging space economies to prosper

Backward-looking accountability, with the aim of finding who can be blamed and sued, is not the only lens for accountability, nor good enough. Iris Young examines **forward-looking responsibility** and how all actors connected can address violations “in the effort to remedy injustice^[33].” The Kessler Effect has not happened yet. Downstream

[29] Mosher, D. Kiersz, A. (2017). These are the countries on Earth with the most junk in space. *Business Insider*. Retrieved on 29 March, 2021 from <https://www.businessinsider.com/space-debris-garbage-statistics-country-list-2017-10>

[30] Young, I. (2011). “Responsibility across Borders,” in *Responsibility for Justice*. Oxford University Press.

[31] Zadek, S. (2016). “The Meaning of Accountability,” in *Business and Human Rights: From Principles to Practice*. Routledge Publishers. Pp. 240-242.

[32] Cornwall, W. (2020). The Paris climate pact is 5 years old. Is it working? *Science Mag*. Retrieved on 29 April 2021 from <https://www.sciencemag.org/news/2020/12/paris-climate-pact-5-years-old-it-working>

[33] Young, I. (2011). “Responsibility across Borders,” in *Responsibility for Justice*. Oxford University Press.

injustices impacting developing countries are still avoidable. When the US recognizes their outer space endeavors have generated hazardous debris, and declares new goals and a commitment to make it right, this will be a sign of leadership and honesty that other countries will emulate.

The forward-looking accountability model is complemented by a realization-focused perspective of justice – which emphasizes “the importance of the prevention of manifest injustice in the world, rather than seeking the perfectly just.” Preventing a collision cascade in space is not the end-all dream of a perfectly just world. Rather, with a realization-focus context, the US takes steps to influence actual behavior, and curve injustices we can physically see^[34]. This is important to highlight because the space community should not wait to act until a new OST is written that corrects all the problems, disagreements and issues seen in outer space. The Paris model allows for an iterative and bottom-up solution to the problem and may be a pathfinder for future collaboration. Furthermore, a nation-driven solution aligns to a recent UNCOPUOS report acknowledging the varying “degrees of responsibility in the clearing of space debris” between nations and protects emerging space economies allowing them benefit from developing space technology^[35].

Conclusion

The space orbital environment around earth is unimaginably huge. Imagine a piece of paper placed on the sidewalk outside the empire state building. If the space between the sidewalk and the piece of paper made up all the earthly domains (land, sea and air), then the distance between the sidewalk and the top of the empire state building is the distance between low earth orbit to geosynchronous earth orbit. For decades, orbit has been thought of as an infinite, immense volume that humankind did not have to worry about effecting. This paradigm is shifting, and the space community now acknowledges the rate of collision is drastically increasing and maintaining a safe space environment is a worthy sustainability goal.

This soft accountability approach, relying on legalized transparency and domestic and international pressure to meet goals set on a public stage, is shown to have made it through domestic and international political scrutiny, and has led to promising goals and review processes.

The proposal outlined in this memo will not come without challenges. Finding funds to support international engagements and ADR will likely require the DoC, NASA and US Space Force to look within their combined \$40 billion dollar/year budget. Many ADR solutions employ exotic and cutting-edge technologies, such as lasers, electrodynamic tethers, solar sails, harpoons, aerogel, magnets and grappling arms, all of which present technical challenges. Many legal discussions and MOUs between nations and international bodies will have to take place to ensure mutual consent between ADR servicer and debris owner. And, similar to the Paris Agreement, sincere ratifiers may be diluted by what Simmons calls false positives, not committing to the emerging norm, and false negatives, committing to the norm but refusing to agree based on principle^[36].

[34]Sen, A. (2009). “Introduction: An Approach to Justice” in the *Idea of Justice*. Cambridge: Harvard U. Press. Pp 1-27.

[35]UN Report of the Committee on the Peaceful Uses of Outer Space. 2019. General Assembly. Sixty-second session.

[36]Simmons, 2009. Referenced in: Sikkink, K. Schmidt, A. Mukarji, D’Alesandri. (2020). Peace through Law? International Law, Norms, and the Decline in Wars of Aggression.” Unpublished manuscript.

These challenges are expected, and with the political support seen to address space debris, there is reasonable pathway to overcome them. However, while updating guidelines and sharing best practices is a good thing, it is not enough. A new report by the Center for Strategic International Studies suggests that nations are making little progress in establishing rules and norms of behavior^[37]. Furthermore, space rubbish will not go away if we focus on system design improvements and debris tracking alone.

*ADR goals can be quantified and allow for reliable cost estimates...
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bodies a year can flatten the curve in space debris proliferation.*

The United States should adopt the global debris remediation framework in this memo. It allows for a model to work within legal constructs, energize a joint international commitment to remediate space debris, create market incentive, and contribute to long-term sustainability.

[37]Erwin, S. (2020). Study raises new concerns about lack of governing norms in space. *Space News*. Retrieved on 27 April 2021 from <https://spacenews.com/study-raises-new-concerns-about-lack-of-governing-norms-in-space/>