Ritha
VOLUME II
NOVEMBER 2025

e-ISSN: 3049-4060

Orbital Waste and Environmental Justice: Equity Challenges of Space Debris

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Abstract

The article addresses the growing environmental and moral crisis caused by orbital debris, presenting the issue as one of environmental justice. It highlights the unjust manner in which the risks and benefits have been distributed in space activities, thus, the Global South has been affected the most. The research delves into the philosophical concepts of the world, such as fair access, burden sharing, and intergenerational equity. It supports collaborative governance and Indigenous perspectives in space stewardship. It also moves the reader to consider the indeterminate legal and regulatory issues, especially in the case of India, and the influence of private corporations. Some practical implications are the need for education, advocacy and collaborative governance to ensure fair and sustainable outer space.

Keywords: orbital debris, environmental justice, stewardship, collaborative governance, sustainable.

I. Introduction: Environmental Justice in the Orbital Commons

The 21st century has seen humanity's relationship with space change from a dream to a vital organ of the Earth system. However, the proliferation of satellites and the congestion of orbital routes have given rise to an adverse environmental and ethical crisis – orbital debris, commonly

referred to as “space junk.” This escalating issue is beyond the technical and regulatory aspects; it is an environmental justice issue. The Earth's space around the orbit, which was once considered limitless and pristine, is a shared but still fragile domain where the disparities of access, risk, and responsibility are being revealed very clearly.

Currently, there are more than a hundred million particles of various sizes that orbit our planet, ranging from millimeter-sized pieces up to whole lifeless spacecraft. The implications of space debris, which can include the destruction of satellites caused by the impact and the exclusion from access to space for a long time, fall largely on countries and communities that are minimally responsible for debris creation. Such a situation is like the occurrence of environmental injustices in the degradation of nature on land.

Space as a "global common" has always been an idea based on international treaties, the 1967 Outer Space Treaty being one of the most prominent examples, which goes on to describe space as "the province of all mankind." However, the growing commercialization and the privatization of space activities—only the extremely few most powerful countries and big companies have been behind the doing of such—have made it questionable if this concept still holds considerable value.According to the definition, a common is not merely an area with shared access but also one with shared governance and protection—features that are, by and large, missing in the current direction of space development. As stated in the editorial by Janssen and Yap, the orbital domain is the place "where the critical infrastructures for modern society are located" and, hence, should be managed with the same urgency and inclusivity as other Earth-based commons like the atmosphere or the oceans.[1]

The dangers of space debris, for instance, are not evenly distributed. The Global South nations, which are mostly devoid of space capabilities, are very much dependent on satellite services for monitoring the climate, agriculture, communication, and disaster response—the congestion in the orbit that is left unchecked puts these services at risk. This fact brings in an environmental justice issue with a new angle, namely the difference between the groups of people who benefit from the exploitation of the orbit and those who suffer the consequences. Similarly, to the case of marginalized communities on Earth that are often situated near pollution sources and other environmental hazards they had no hand in causing, the populations that are vulnerable and

[1] Marco A. Janssen, *Governing Outer Space as a Commons is Critical for Addressing Commons on Earth,* 18 IJC 32, 32-38 (2024).

scattered in different parts of the world may also, due to the unsustainable practices of a few dominant players, find themselves not only without access to space-based technologies but also denied the benefits they would have gotten from such technologies. The article employs a combination of legal argument, moral consideration, and world facts (for example, India's "Debris-Free Space Missions")[2] to persuade readers of theposition on social justice and environmental sustainability as part of space governance.

Addressing the equity challenges related to space junk in orbit demands a change in how we think about space, not as a new frontier for rivalry but as a delicate common area that needs joint care. Justice for the environment in the space area would imply, among other things, the guarantee of unbiased access, equal involvement in administration, and the tracing of culprits for environmental damage, be it in space or on Earth.

II. Conceptual Foundations

Defining Environmental Justice in Outer Space

The congestion of space with satellites, mega-constellations, and orbital debris has led to the inevitable environmental justice in outer space: after all, fairness, inclusivity, and accountability should be the central features of the new environmental justice. At the same time, the article reminds us that space has become extremely crowded with new activities and businesses coming from everywhere. This means that environmental sustainability is at the very core of policy and legal debates, and this is something the article also calls attention to.[3]Yet, it is still paramount to grasp that space is still a very delicate common, one that is compatible with ethical standards, rights for responsible care and use by all users in this community.

The basis for this idea is the principle of fair access. For instance, the use of technology in Earth observation, telecom, and climate data should not be limited only to rich spacefaring nations or powerful commercial companies. Everyone, especially the less developed countries,

[2] *India Aims to Achieve Debris-Free Space Missions by 2030: ISRO Chief,* NDTV (Apr. 16, 2024), https://www.ndtv.com/india-news/india-aims-to-achieve-debris-free-space-missions-by-2030-isro-chief-s-somanath-5455368.

[3] Harshada Rajput, *Environmental Protection in Outer Space: Towards a Legal Framework for Sustainable Space Use,* 7 IJLLR 8187, 8187-8195 (2025).

should be allowed to benefit from the space industry, provided it is a common property of the entire human race. As one expert puts it, the act of denying space only to the powerful and letting them thus monopolize its resources is nothing but another colonial move where justice and equity get weakened at the same time.

Fairness is, at the same time, very closely related to the concept of burden sharing: the litter in our orbit is something that we are polluting with, regardless of who we are. That is why even the countries that have hardly ever launched satellites or have had little to do with space debris will be the ones hit by collision and therefore lose access to the advantageous orbit positions. The fairer distribution of both advantages and obligations is what will ensure a more just system.

Procedural justice is just as important: the voices of the Global South, Indigenous groups, and even the yet unborn should be part of shaping how space is governed. At present, governance is in the hands of established space powers. For justice to be real, multilateral inclusion—in rulemaking, governance, and oversight—must replace the current mode of exclusive decision-making.

Intergenerational equity is another aspect to consider: the debris we create today is a threat to the orbital environment of tomorrow. This is more than just policy—it is a moral commitment to those who will need a safer, cleaner space long after the current actors have left. In the words of one analysis, "the tragedy of the commons" is a metaphor that very well captures the problem with space debris and is used to demand urgent reforms.

Together, reflecting environmental justice in space entails the development of legal, moral, and technical frameworks that:

- Establish and enforce debris-mitigation standards,
- Require open environmental assessments,
- Create diverse governance bodies,
- Promote data sharing across the planet, as well as the development of the necessary capacity.

These measures would change outer space from a crazy playground with no rules to a territory of shared management—one that raises every person on Earth, goes beyond time, and respects the idea that investigating the universe should not be the same as the injustices that have

happened on Earth. Exploration, in fact, would become a promising model for fairness, collaboration, and ethical development.

Historical Context: Colonialism, Resource Exploitation, and Outer Space

The colonial past, which was marked by the plundering of resources and the taking away of lands, is not only a thing of the Earth's history—it is very much audible in the way human beings are dealing with space right now. The word frontier is often applied to space as the next wild resource frontier, which is still looking for mining and territorial expansion in the same way that colonial powers used to divide continents for raw materials.[4] The language of space-mining is very similar to that of ecological imperialism, which means that the same way they do on Earth, they just extend the logic of extraction to such places where the celestial bodies are not seen as already inhabited worlds but as reserves of valuables.[5]This idea is supported by the maps of space which are derived from old colonial maps and depict space as terra nullius—a place devoid of life so far and thus very much ready for any new claims and conquests.[6]NewSpace businesses, which are influenced by the settler-colonial way of thinking, are basically following the same path of takeover that goes with the capitalist expansion, they are combining the old feelings of frontier with resource exploitation that is forward-looking and thus have become the biggest of such kind in the world.[7]

The continuation of colonial ideas that come with the management of space, therefore, is not by accident, but it is a direct link to the past. If history on our planet can be taken as a teacher, it will only teach the lesson of one extraction without justice which only leads to the deepening of inequalities. The acknowledgment of this history is necessary if we are to create fairer frameworks for the exploration of space—those that would be based on common stewardship rather than on domination of the past.

Space Debris: An Extension of Environmental Racism?

[4] Sid Simpson et al., *Towards a critical space theory: The instrumental politics of space exploitation,* EJPT 1, 13-18 (2024).
[5] Thomas Cheney, *The Extra-Planetary Mine: Space Mining as Continuity,* 30 Env't & Hist. (Liverpool Univ. Press) 353, 357-358 (2024).
[6] Alessandra Marino, *Astroenvironmentalism as SF Bordering (and Ordering) Otherworldly Ecologies,* 15 Environmental Humanities 25, 31 (2023).
[7] Hannah Hunter & Elizabeth Nelson, *Out of Place in Outer Space? Exploring Orbital Debris through Geographical Imaginations,* 12 Env't & Soc'y 227, 234 (2021).

Space debris is usually depicted as a technical annoyance that is detached from normal injustices. However, a deeper understanding of the issue uncovers the link of environmental racism, which is not only confined to the Earth but also spreads into space. The negative impact of orbital pollution or waste is not distributed evenly among people. As an example, the uncontrolled reentry of the satellite Cosmos 954 in 1978 resulted in radioactive debris being widely scattered in Northern Canada, a place where the local Indigenous Dene and Métis communities are concerned about the contamination caused by it.[8] These places were regarded as "empty," hence allowed the authorities to both neglect the cleanup of the area and ignore the cultural as well as the ecological damages. In the same vein, the areas over which rockets are launched and the paths along which they are disposed of are usually going to be the least populated or inhabited by the most marginalized people. The latter are the ones who, due to these activities, will be getting the short end of the stick and practically made into ecological "sacrifice zones."[9] On top of everything else, the invisible space debris continually reminds us of how environmental injustice has existed for hundreds of years. In other words, it enables the actors who are in the strongest positions to shift the negative impacts of their activities on those who have the least visibility, power, and access to justice. One way to tackle such a problem is by identifying the space which is not only a technical and diplomatic challenge but also a justice imperative that calls for acknowledging and compensating the unequal struggle for the cleaning of the orbital dark.

Indigenous Perspectives and the Ethics of Space Stewardship

Indigenous worldviews are an essential and often disregarded perspective in the space-community relationship. In manyindigenous cultures, according to which the cosmos is not a separate entity but one that is intimately linked with earth relations, thus being a "Country" of another kind. This all-encompassing and non-dominating care system, however, is implemented through different channels—ceremonial, spiritual, and environmental—which, while very different in many aspects from each other, all heavily rely on each other as a whole, may not quite be so different in terms of the interrelationship between the heavens and the earth. For instance, Aboriginal Australian ideas revolve around the principle of a "custodial ethic," the notion that man is not the owner but rather the caretaker of earth, water, and the sky

[8] Health Canada, *Previous nuclear incidents and accidents: COSMOS 954,* Canada.ca https://www.canada.ca/en/health-canada/services/health-risks-safety/radiation/radiological-nuclear-emergencies/previous-incidents-accidents/cosmos-954.html.
[9] Julie Michelle Klinger, *Environmental Geopolitics and Outer Space,* 26 Geopolitics 1-38 (2019).

and so on. The standard of obligation extends to generations yet to come.[10] The contrast between such models and that of the mega-constellation-type extractive logic and the commercialization of space is enormous.

Besides, Indigenous astronomy—rituals that became a part of the peoples' heritage—unalterably needed to keep the sky dark not only for purposes of orientation or calendar-making but also to maintain the life of their very own traditions and knowledge systems. It seems that the issue of satellite proliferation is even more serious if we consider that one of the main drawbacks is that it is slowly but steadily wiping out the dark sky and as a consequence the communities that used to rely on the dark sky as the main source of their cosmic heritage. The latter is a form of cultural erasure, which calls for immediate attention.[11]

To reconcile these differing perspectives, moral principles such as "the ethical place of engagement" and "two-eyed seeing" have been developed. The "ethical space" allows a respectful forum where Aboriginal and Western ways of knowing coexist, whereas "two-eyed seeing" supports simultaneous use, as both systems of knowledge were brought together to leverage their strengths.[12] Such frameworks are proposing shared governance, respect for one another, and the redistribution of power not only in the case of ecological changes but also for cultural survival.

With numerous lunar missions on the horizon and novel governance programs such as the Artemis Accords, the inclusion of Indigenous views is not only a token of recognition but also a change of paradigm. This new stance obliges us to rethink traditional oppositions that pit conquest against degradation, now turning to care, even exchanges, and a pledge of acting responsibly—be it for earth, space or the heritage of others, not only those that gaze upon the stars.

Science is not the sole component of Indigenous groups' astronomical knowledge. It is at once spiritual, narrative, and survival tied. Calendars, motifs, and cultural narratives are all guided by stars.

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[10] *First Nations Australian Traditional Custodianship*, WIKIPEDIA, https://en.wikipedia.org/wiki/First_Nations_Australian_traditional_custodianship.
[11] *Indigenous astronomy*, WIKIPEDIA, https://en.wikipedia.org/wiki/Indigenous_astronomy.
[12] Melissa K. Nelson & Graeme Reed, *Indigenous critiques and recommendations for reclaiming nature-based solutions,* 122 PNAS 1, 7-8 (2025).

If we want to preserve space as a common good, it will have to be managed following the principles that are far beyond the mere technological race. One of the most important moves that we could make towards the space just and sustainable future is by incorporating the Indigenous ethical frameworks into the space policy.

III. Disparate Impacts of Space Debris

Impact of Space Debris on the Environment and Space

Space debris is a problem that is beyond the space surrounding the Earth. Space debris has a direct impact on the atmosphere and ecosystems of our planet. The causes of the changes may be the emissions and metal particles released by rocket launches into the upper atmosphere. The alteration of the planet's absorption or reflection of heat may result from these tiny particles. This will contribute to either global warming or cooling effects; however, scientists are still figuring out the comprehensive implications of it. The particles that have been re-entered or deposited are the sources of pollution in the environment, along with oceans and land areas.[13] More frightful is the fact that there are no environmental protection regulations or sustainability criteria that can be used to estimate the environmental impact of these emissions. Without the existence of clear standards, it becomes difficult for governments or companies to manage space activities in such a manner that space and Earth are not damaged. In order to achieve real sustainability, we need policies that not only look at the release of the rocket but also take into account the hidden environmental costs from the entire launch process, including the production and disposal of the rocket.

The problem is so urgent that its effects have already been felt at the local level. Back in 1997, Lottie Williams, a lady from Oklahoma, was hit on the shoulder with space debris that had fallen - a piece of a Delta II rocket.[14]Although she was not physically harmed, it is the only documented incident of a person directly impacted by space junk. Later in 2022, big pieces of debris from a SpaceX rocket were scattered over a field in the Australian countryside,[15]

[13] Elwyn Sirieys et al., *Space sustainability isn't just about space debris: On the atmospheric impact of space launches*, 3 MIT Science Policy Review 143, 143 and 147 (2022).

[14] *First person hit by space junk,* GUINNESS WORLD RECORDS, https://www.guinnessworldrecords.com/world-records/114727-first-person-hit-by-space-junk.

[15] Elsa Maishman, *Space debris Australia: Piece of SpaceX capsule crashes to Earth in field,* BBC (Aug. 22, 2022), https://www.bbc.com/news/world-australia-62414438.

frightening the locals and raising questions about the adequacy of safety measures during the return of the devices. These events, although extremely rare, are signs of increasing danger as more space flights are taking place. The situation could deteriorate in a way that what is falling from space would no longer be regarded only as abandoned technical materials but safety threats for the public could emerge.

The Unequal Impacts of Space Debris on Earth Communities

Our orbit is transforming into a high-velocity junkyard loaded with old satellites and debris, and the communities on Earth are experiencing the consequences of the shock waves that are already happening, with those who are the least equipped to face the situation being hit the hardest. In less developed areas, the essential or emergency infrastructures such as satellite-based communication or crisis monitoring systems, that are heavily reliant on a few satellites only, an accident of any one of these satellites may result in a country being totally isolated. Besides this, they are short of the money and the technology required for both the monitoring of the debris and for relocating their assets from the danger zone.[16] Wealthy countries, on the other hand, not only launch a higher number of satellites but also have a greater say in the various global debris-tracking networks, thereby giving them more of an advantage and making the gulf between both sides wider.

More than that, the planet suffers from these occurrences, which are invisible to the naked eye, with serious consequences for the atmosphere. As an increasing number of satellites choose to abandon their orbits, the process of safely burning them in the middle atmosphere is taking place. This could have negative effects on the ozone layer or change the atmospheric chemistry, and these are only the first stages of the realization of the consequences.[17]Moreover, while the release into space is presented as a "cleaning" method, the results can be unexpected and can last for a very long time. The potential for the health and environmental issues that would occur from this and affect certain groups more is great, especially those who live in the Global South.

This is a technical issue of a political and ethical nature as well. The technological advances derived from space travel such as climate-related data, internet accessibility, and agricultural monitoring, are distributed unevenly, and, logically, so are the risks involved. The spread of

[16] Ella Wunderlich1 & Ishita Banerjee, *The Trash Above: The Impact of Space Debris and Its Ethical Implications for Future Space Endeavors,* JESTI 212, 214.
[17] Patrick Flamm et al., *Space sustainability through atmosphere pollution? de-orbiting, atmosphere blindness and planetary environmental injustice,* 12 SAGE Journals 140, 140-147 (2024).

economic and social vulnerabilities across the planet will show which poor communities are the ones that will face the harshest consequences of satellite malfunction or breakdown, while at the same time gaining the least from space infrastructure.

The disparity between the two situations requires remedies based on fairness. Sharing of debris-tracking data and collision avoidance instruments, for a start, should be done with a priority being countries that are little resourced. Capacity-building projects, taking their pattern from examples like UNOOSA's "Access to Space for All," ought to support the promotion of equal conditions.[18] Besides that, the re-entry procedures should be formed under the scope of atmospheric justice, thus necessitating an interdisciplinary study of the atmosphere, not only the space from which the pollution is coming. By putting money in satellites that have a longer life and technologies for removal, both the environmental and equity burdens can be reduced.

While redefining the long-term environmental aspect of space activities, social fairness is the point that cannot be compromised at any time. The availability of space should not be a new field in which rich rampers move costs to the less fortunate. Handling orbital debris as a global, systemic problem rather than just congestion in space implies safeguarding human settlements, in particular, the ones that have the least protection.

Who Bears the Burden? Global Disparities in Space Debris Risks

The ever-increasing debris that is orbiting the Earth is not only a technical problem but also the story of inequality expressed through satellites and shrapnel. As Long and Huang emphasize, the clean-up of space debris that belong to other countries is limited by the law; any country that wants to remove the discarded objects of another has to legally secure the right by either the consent of the original launching state, a UN mandate, or in case of emergency; otherwise, the remover may be held the cause of the incident and thus, the clean-up becomes a less attractive issue.[19]That means only those spacefaring nations with legal and diplomatic power can clear space dangers effectively, thus the ability to do so is a privilege.

On the other side, people from the Global South rely more on satellite services—weather forecasts, communications, agricultural monitoring—but lack the means to protect themselves

[18] *Access to Space for All,* UNOOSA, https://www.unoosa.org/oosa/en/ourwork/access2space4all/index.html.
[19] Jie Long & Chuying Huang, *Obligations and liabilities concerning the active removal of foreign space debris: A global governance perspective,* 222 Acta Astronautica 422, (2024).

from space debris dangers. They are often the victims of accidents in orbit without being heard, while they take very little part in the debris problem.

At the same time, industrialized countries have both technology and policy tools at their disposal: they are in control of debris-tracking capabilities, have a say in space law, and can remove satellites with the help of advanced technology. This further strengthens the existing inequality—the ones that benefit the most are also the least the ones to take care of the risk and the clean-up.

The way to close this gap is to include justice as a parameter of space governance. Liability-sharing mechanisms ought to be extended—not only to cover countries but also NGOs and business entities that may hold the logistics, financial assistance, etc., thus, distributing the costs fairly. One model that could be considered is 'cross-waiver agreements' which may protect the debris removal activities of good faith from hard sanctions, thus increasing the number of cooperative clean-up operations. National and international bodies could also play a major role in overcoming resource constraints to include these countries in the debris monitoring networks and planning their prompt response, thus, ensuring they are not trapped in an untenable situation. Though space is everyone's, the danger is not evenly distributed. It is not only a question of rebalancing responsibility through inclusive policy and affordable cleanup tools, which would be the most logical thing to do, but also of being a moral obligation to ensure a shared future in orbit.

Space beyond the Earth might appear like an infinite empty space, but it is getting more crowded—and not in a balanced way for all. The load caused by orbital debris is not distributed in a fair way. As a result of the long history of space activities, the most powerful space-faring nations are the main culprits of space debris orbiting Earth. However, it is frequently the developing and less technologically capable countries that are the ones more affected by the aftermath of space debris. These countries are latecomers to the space race, have limited budgets, their infrastructures are not strong enough, and they have restricted access to space situational awareness resources. In case their few satellites, which are mostly vital for the realization of development goals such as weather forecasting, provision of internet in remote areas, and disaster response, become threatened by the space debris, they have very little means

of protecting themselves. The paradox is that while the Global South is the least responsible for the mess in space, it is the one that can be most affected by the mess.[20]

Imagine, for instance, a Kenyan startup or a Peruvian University that decides to send a small CubeSat to Space- such a move would be a tremendous step in their technological advancement. But what if one of these tiny satellites were to collide with a piece of an old, untraceable debris resulting from a Cold War- era mission? Not only would the accident cause the destruction of the satellite, but it would also mean that the organizations have lost their investments, research, and dreams of technological advancement, However, even in such a situation, it is not very clear who should be held responsible. International law is still somewhat ambiguous, and, among others, the Outer Space Treaty is only giving out moral obligations without specifying exact responsibilities. The problem of identification of single debris pieces and their source is still very difficult from a technical point of view, so in many cases, the affected states have no legal assistance.[21]

On the other hand, large space programs from the established spacefaring nations keep launching their mega-constellations into low Earth orbit thereby occupying more space. Their collision-avoidance systems, which are designed and even complex operations they carry out, are just some of the luxuries that these big players have and smaller ones do not have. Hence the debate on the space debris problem should not be only about science and technology but also justice. As we talk about climate change using such terms "historical responsibility" and "climate finance", similarly we need to delve into the concepts of "orbital equity" and "space accountability".[22][23]

As we proceed to a future that is reliant on space technologies, the world as a whole should inquire the following hard questions: Who decides the rules for the conduct in the orbit? Who suffers because nothing is done? And who guarantees that the aspirations of new space countries are not smothered by the leftovers of another's history? The outer space is the common heritage of mankind—although if international administration is not up to date, the

[20] Malavika S.K, *Space Junk: An Impending Danger – Who Is Responsible for it,* 7 IJLMH 400, 400-415 (2024).
[21] Edmarverson A. Santos, *International Law and the Regulation of Outer Space,* DIPLOMACY AND LAW, https://www.diplomacyandlaw.com/post/international-law-and-the-regulation-of-outer-space.
[22] Secure World Foundation, *2023 Global Counterspace Capabilities Report* (Jan.1, 2023), https://www.swfound.org/publications-and-reports/2023-global-counterspace-capabilities-report.

[23] Sibsankar Palit et al., *Rebalancing space governance: a global south perspective on outer space as a global commons,* 6 Front. Space Technol. (2025).

costs will still be distributed in an unfair manner, mostly to the areas that are less equipped to handle them.

The Consequences of Orbital Debris for Developing Nations

There are more satellites in orbit, as more countries and private companies are launching them, and the amount of space debris is growing fast. Such "orbital waste" is not only a problem of technology, but it is also becoming an issue of global fairness. The UNCTAD report emphasizes that space technologies are very important in development, especially for low-income countries, as they support areas like disaster response, agriculture and health the use of technology. Although these benefits largely depend on the availability of a safe and open space. Once debris has crowded orbital paths, the possibilities of collisions will also increase, thus both the current satellites and the future missions will be endangered. This problem is more severe in developing countries. They usually have less money to safeguard their space assets or to acquire debris avoidance systems. The report, therefore, urges the necessity of more substantial global collaboration, improved policies, and the provision of support to countries that are new to space travel to deal with the issue. By sustainable space debris management, we will be able to distribute the benefits of space fairly. That includes not only the protection of the space environment but also the rights of the people on Earth.[24]

Space Debris and the Right to Access a Sustainable Orbital Environment

Both the commercial and scientific worlds have stimulated the look of 21st-century humanity into space. However, the new era in outer space, which was previously considered boundless, is on the verge of becoming a garbage area. As Claudia Cinelli and Camilla Campodonico aptly observe, “Over the last decade the space sector has expanded with massive growth in investment activity…causing environmental hazards in space as well as pollution and degradation.”[25] Despite this clear warning, they note, “very little has been made to solve this

[24] United Nations Conference on Trade and Development, *Building Digital Competencies to Benefit from Frontier Technologies* 1–2, 14–16, 18–21 (2021), https://unctad.org/system/files/official-document/dtlstict2021d1_en.pdf.
[25] Claudia Cinelli & Camilla Campodonico, *The duty of state to protect the orbital environment,* 11 JSSE 318, 318-321 (2024).

problem."[26] In legal terms, this raises a profound question: beyond environmental pragmatism, do we have a right—a moral and legal one—to ensure outer space remains sustainable for all?

Under the Outer Space Treaty (OST), States must conduct their space activities with "due regard" for the interests of others and avoid "harmful contamination" of celestial environments.[27] Though rooted in Cold War-era language, these provisions establish a normative foundation for protecting a shared orbital domain. Legal scholars increasingly argue that space debris—even though not originally contemplated by the OST—falls squarely within what constitutes harmful contamination.[28] Indeed, the 'due regard' obligation, widely understood as demanding proportional care, becomes imperative when debris threatens "the most fundamental right in international space law: the freedom to use and explore outer space."

Moreover, the "no-harm" principle—a cornerstone of customary international environmental law—extends into space. If debris generation materially impairs other nations' satellite operations, then it could breach States' duty not to cause transboundary environmental damage.[29] Sometimes speculative legal theory becomes harsh reality: envision a deep-space collision sparking a debris cascade, depriving smaller nations of Earth observation capabilities critical for development.

One more factor is the precautionary principle: when there is no scientific certainty, the States, nevertheless, have Another factor is the precautionary principle: when there is no scientific certainty, states must nevertheless act carefully to avoid irreversible damage.[30] Experts strongly recommend that this principle be interpreted as a part of Article IX, which would then require the exercise of a more cautious foresight—also for the first debris removal missions—just because, as they can be, they can become new sources of contamination.

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[26] Ibid.

[27] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, art. IX, Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205.

[28] Tim Robinson, *Space debris: The legal issues,* ROYAL AERONAUTICAL SOCIETY (Jan.3,2014), https://www.aerosociety.com/news/space-debris-the-legal-issues/.

[29] Matthew Gillett et al., *Lex Ad Astra: Non-State Actor Accountability for Space Pollution* 386 (Brill 2025).

[30] Par Lucy Stewardson, *Space Debris: Principles of Environmental Law as Cornerstones Paving the Way for Regulation,* https://e-legal.ulb.be/volume-n05/memoires-3/space-debris-principles-of-environmental-law-as-cornerstones-paving-the-way-for-regulation.

These legal subtleties provide a powerful visual: continuing space utilization beyond Earth orbit is not only a good policy—it is a legal duty, deeply embedded in the treaty norms, environmental laws, and the general principle of intergenerational equity. The Outer Space Treaty, in its Article I, defines outer space as "the common heritage of mankind"; thus, it is part of our legal and moral obligation to keep this heritage intact - not only for those who operate the satellites now, but also for those who will be in the future.

IV.Legal and Regulatory Landscape

Existing Legal Framework of Space Debris

The legal framework for space debris dealt with at the international level is a multi-faceted structure made up of various binding treaties and non-binding 'soft law' guidelines. There is, nevertheless, not a single, all-encompassing agreement that primarily focuses on the space debris issue. The major treaties forming the basis of international space law, which were approved by the UN from 1967 to 1979, were designed before space debris was recognized as an issue, and hence, they do not explicitly manage space debris. However, some of the treaty provisions are recast in the interpretation of the governing body, which implies that they manage debris. The Outer Space Treaty (1967), while ensuring the freedom of space research for all countries, also enjoins space missions to abide by international law, which comprises environmental principles like sustainable use, the precautionary principle, and the polluter pays principle. These principles lead to the idea that the space should be cleaned of debris to be used by everyone fairly, including future generations.The most important Article in this treaty is Article IX which states, among other things, that contamination of space by harmful substances is forbidden; thus, it directly implicates space debris as a source of disaster.[31]

The Liability Convention (1972) definition of space objects is so general that it includes space debris components, moreover, it states that the states that caused the launch of the respective

[31] Outer Space Treaty, supra note 28.

object are fully liable if damage is done, either on Earth or in space.[32] On the other hand, the practical side of enforcement, which is done through a court system, is still struggling with the problem of certifying cause and fault in light of the unpredictability and the constantly changing nature. The Registration Convention (1975)urges states to compile a register of the things launched into space, but the information that is given is usually not enough for detailed tracking and collision avoidance.[33]

The international community relies on soft law since binding treaties do not fully cover space debris. Examples of soft law are rules of the Inter-Agency Space Debris Coordination Committee (IADC)[34]and the UN Committee on the Peaceful Uses of Outer Space (COPUOS). These guidelines are voluntary and they recommend the implementation of the best practices which are limiting the release of debris, post-mission disposal of space debris and the avoidance of collisions, with the main emphasis being on the sustainability of outer space activities.

The management of space debris at the national level is primarily dependent on the laws of the country. Besides, India, one of the significant space actors, does not have a single space law, but its ISRO policies and some rules that are already there govern the space activities. The draft Space Activities Bill (2017)[35] talks about limitations of pollution but there is no detailed provision related to debris. The realization of national laws that are not only compatible with international commitments but also go beyond that, such as Article VI of the Outer Space Treaty which requires state responsibility for private actors would be a significant step towards environmental justice as well as responsible space operations. Moreover, it is through strong domestic structures that India will not only be able to protect its space assets but also ensure the fair and long-term utilization of outer space by the whole human race.[36]

Legal Gaps and the Justice Vacuum in Space Governance

Almost immediately after Sputnik went into orbit around the Earth in 1957, the necessity arose for a regulatory framework in outer space. The response was the 1967 Outer Space Treaty

[32] Convention on International Liability for Damage Caused by Space Objects, arts. I-II, Mar. 29, 1972, 24 U.S.T. 2389, 961 U.N.T.S. 187.
[33] Convention on Registration of Objects Launched into Outer Space, Jan. 14, 1975, 28 U.S.T. 695, 1023 U.N.T.S. 15.
[34] Inter-Agency Space Debris Coordination Committee., IADC Space Debris Mitigation Guidelines, IADC-02-01, Rev. 1 (Sept. 2007), https://www.unoosa.org/documents/pdf/spacelaw/sd/IADC-2002-01-IADC-Space_Debris-Guidelines-Revision1.pdf.
[35] Ministry of Space, Government of India, Draft Space Activities Bill (2017), https://prsindia.org/billtrack/draft-space-activities-bill--2017.
[36] Akhil Kuppusamy K, *Space Debris Mitigation Through Domestic Legislation,* 5 IJIRL 2044, 2046-2050 (2025).

(OST) affirming that space is the common heritage of all mankind.[37] However, throughout the following years, the pace of space exploration outstripped the development of the laws regulating it. At present, the activities of private companies and the space programs of newly developed countries in Earth's orbit are hampering the application of the OST's ambiguous articles that do not offer much in the way of enforceable rights, especially regarding orbital debris and environmental sustainability.

This deficiency in law has resulted in an ever-widening justice vacuum. The Liability Convention of 1972,[38] in theory makes the state from which the satellite was launched responsible for any damage caused thereby, but less often, in practice, accountability is encountered. There is no actual global court responsible for handling cases, there is no independent force for implementing the law, and most importantly, there is no way for developing countries or non-governmental organizations to be fairly involved. Consequently, the behaviors in the orbit are mostly dictated by the powerful spacefaring states and corporations, whereas the smaller or newly entered ones get left behind in decision-making and are more vulnerable to risk.

By 2025, the imbalance will have become even clearer. The EU Space Act proposed by the European Union is a step towards one of the few obligations to control the activities of satellite operators by demanding such measures as environmental impact assessments, debris mitigation protocols, and safe disposal of satellites.[39] Nevertheless, it is applicable only within its geographical area and does not have a global mandate. Those beyond the EU who comply with different national laws or follow international guidelines voluntarily, like the Inter-Agency Space Debris Coordination Committee (IADC), which is not obligatory, nor does it have an enforcement mechanism, continue to do so.[40]

On the other hand, space traffic management (STM) is still predominantly non-proactive. Thousands of objects in orbit are tracked, AI-driven satellites are performing maneuvers at a speed that is almost impossible for humans to follow,so the lack of a binding, multilateral STM

[37] Outer Space Treaty, supra note 28, art. I.
[38] Liability Convention, supra note 33.

[39] European Commission, *EU Space Act: Strengthening Safety, Resilience and Sustainability in Space* (June 25, 2025), https://defence-industry-space.ec.europa.eu/eu-space-act_en.

[40] IADC Guidelines, supra note 35.

framework is not only inefficient but also dangerous. In this emptiness, justice is delayed: small countries become more vulnerable without the possibility of accessing the remedy or the protective infrastructure.

If there is no global legal architecture radically different from the current one—that being enforceable, inclusive, and well adapted to commercial space realities—space in orbit will still be governed by inertia and justice will be dealt with later. Laws should not only be there to maintain order but also to guarantee fairness in a space that is no longer a matter of the future but the foundation of new domains.

As the dynamics of space exploration are changing exponentially from state-led to a commercialized frontier, the lack of complete legal frameworks is engendering a justice vacuum that not only threatens the operational satellites but also the geopolitical stability. The number of space debris larger than 10 cm is currently over 26,000, and almost all of them are in orbit around the Earth, and there are millions of pieces that are too small to be tracked. Hence, the need for international norms that can be enforced is becoming more urgent.[41] Even though the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (1967) and the Convention on International Liability for Damage Caused by Space Objects (1972) may be considered as the pillars of the international space law structure, they are, however, very old and almost irrelevant when it comes to the details of the new space activities, especially those most concerned with the issue of debris responsibility and the role of the private sector.

Take the Liability Convention as an example, it only holds the party responsible for the Earth damages caused by space activities and follows a fault-based system for damages in space. Still, it does not describe in detail the concepts of "damage" or "debris," nor does it provide a straightforward way of identifying the party at fault in the case of collisions of non-functioning or untraceable space objects.

The situation is further complicated in cases such as the Iridium 33 and Cosmos 2251 collision in 2009, where the trouble with finding the responsible party was only one of the many issues

[41]See European Space Agency, Space Environment Report 2024 (July 19, 2024), https://www.esa.int/Space_Safety/Space_Debris/ESA_Space_Environment_Report_2024; NASA Orbital Debris Program Office, Frequently Asked Questions, https://orbitaldebris.jsc.nasa.gov/faq/.

surrounding the incident. And while there is a liability framework that assigns responsibility to the states for the actions of their private entities, the latter have very little enforcement, and this means they are not really compelled to follow the best debris mitigation practices.

The absence of a single global definition for "space debris" itself is another aspect that complicates the problem, as it allows different legal territories to have different understandings of the matter and there to be little agreement as to who is to blame. Laws of the nations like the U.S. Commercial Space Launch Act or the operator guidelines of the EU are examples of efforts to fill these voids, but they differ considerably in the way they go about their scope and enforcement, so the accountability across borders is still limited. Even the voluntary commitments, such as the guidelines of the Inter-Agency Space Debris Coordination Committee (IADC), are non-binding and mostly idealistic in nature.

On top of this regulatory gap, there are technological changes that have led to the development of such dual-use capabilities as anti-satellite (ASAT) weapons, which have been able to create highly risky debris clouds, e.g., the 2007 Chinese ASAT test. These sorts of actions not only underline the fears raised by the militarization of space but also leave open the question of their possible negative effect, given that no reliable legal safeguards are in place.

In the end, the existing legal framework mainly looks at how to assess the damage rather than at preserving the environment, and it gives the responsibility to the states rather than to the private entities, which means that there is a hazardous empty space. If there is no binding multilateral treaty that directly deals with the generation, removal, liability, and environmental impact of debris, we are close to making low Earth orbit a wild and unusable space.[42]

Legal Framework and Environmental Justice in India: Addressing Orbital Waste

India, an aspiring spacefaring nation, is gradually realizing the legal and environmental challenges that come with orbital waste. The Space Activities Bill, 2017, now awaiting approval, aims to control private space activities and make a space object causing debris the responsible party for damage.Apart from that, India has also signed the most important international space treaties, such as the Outer Space Treaty (1967) and the Liability Convention

[42] Rashi Sahu, *Space Debris and Legal Accountability Addressing Gaps in International Law and Liability,* 10 IJSDR 680, 681-682 (2025).

(1972), which lay down state responsibilities for space objects and call for non-aggressive use of outer space.

On the other hand, the Environmental Protection Act, 1986, passed in India, is an umbrella legislation to deal with environmental damage comprehensively, and the courts have also used the Precautionary Principle and Polluter Pays Principle in their verdicts on environmental issues which might be applicable to space debris pollution.[43] While these legal measures and the changing policy have to deal with the issues of fairness in orbital waste, the question of whether expanding space activities in India can be compatible with environmental protection as well as with global justice.

V.Corporate and Technological Responsibility

The Role of Private Corporations in Space Pollution

Private space enterprises have transformed the dynamics and road map of space exploration and operations. Government-dominated days are over since space has become a private company launcher of all sorts, from satellites to space tourism. Innovations such as reusable rockets and mass satellite deployment have allowed companies like SpaceX, Blue Origin, and OneWeb to make space more accessible, cheaper, and more frequent. The benefits that came up with these advancements in space-tech, on one hand, are great for communication and the general public, but on the other hand, they have raised a series of environmental issues.

Among the most worrying issues is the problem with space debris. The trend of launching more satellites, especially from mega-constellations such as Starlink, is driving the risk of satellites bumping into each other in orbit. A single accident can release numerous pieces of debris which can cause a phenomenon known as the Kessler Syndrome, where this debris keeps hitting each other and making the affected orbits unfit for use either for a long time or permanently.[44]

The Outer Space Treaty (1967) and other international laws were drafted with the idea of only states operating in space. Nevertheless, these laws, while carrying the countries the duty of

[43] The Environment (Protection) Act, No. 29 of 1986, Acts of Parliament, 1986 (India).
[44] Donald J. Kessler & Burton G. Cour-Palais, *Collision Frequency of Artificial Satellites: The Creation of a Debris Belt,* 83 J. Geophys. Res. 2637, 2639 (1978).

supervising the private actors, do not seem to be sufficient considering the commercial space actors of today. This legal void gets even bigger as private ventures such as the mining of asteroids, space tourism, and lunar resource extraction continue to grow.[45]

Even though several private companies are responsible for the problem, they are at the forefront of clean-up and risk reduction initiatives. Companies like Astroscale are already working on the needed space technologies to remove non-operating satellites, and orbit servicing.[46]With the support of the European Space Agency, ClearSpace is in the process of planning a dedicated mission to actively remove a fragment of junk from orbit and guide it to Earth safely - one of the earliest instances of an active debris removal program.[47]

Technological Innovations for Equity in Space Traffic Management

Advanced space traffic management (STM) tools are playing a major role in maintaining safe and fair access to space as orbital waste keeps piling up. AI and automation are being implemented by startups like Kayhan Space (USA), Dark (France) etc., to satellites to avoid that they collide. The main attention of Digantara (India) is on space situational awareness, i.e., they provide the necessary tracking data for both public and private users who need it. These types of innovations allow the new space nations to effectively manage the debris risk issue thereby lowering their dependence on the major space powers. Today, if collision prevention is more accessible, these STM solutions would be the ones to promote fairness in space operations - a way of supporting environmental justice in a space that is free for all and should be served equally.[48]

VI. Case Study and Localized Approaches

Case Study: India's Debris-Free Space Missions and Justice Goals

With the announcement of the Debris-Free Space Missions (DFSM) initiative in April 2024, India has become a key player in the world in the fight against space debris. The country plans to make sure that by 2030, no space mission from India, whether of the government or private

[45] LeoLabs, *Persistent Orbital Intelligence Propelling the Dynamic Space Era,* https://leolabs.space.
[46] Astroscale Holdings Inc., Mission Statement, Vision & Core Values (2025), https://astroscale.com/our-mission.
[47] European Space Agency, *ESA Commissions World's First Space Debris Removal Mission* (Dec. 9, 2019), https://www.esa.int/Space_Safety/Clean_Space/ESA_commissions_world_s_first_space_debris_removal.
[48] StartUs Insights, 10 *New Space Traffic Management Solutions: Innovators to Watch,* https://www.startus-insights.com/innovators-guide/new-space-traffic-management-solutions/.

organizations, will leave any debris in orbit after the end of the mission.[49] This program is about more than just technology responsibility; it is also about ethical behavior in space, seeing space as a common and vulnerable territory that must be kept for the whole of the human race. India's stance is not only about what is good for India; it is linked with the larger goals of fairness. This includes the commitment of space to be reachable, secure, and maintainable by the underprivileged countries, the future space actors, and the generations yet to come.

In context of this, India accepts the fact that the coming of numerous satellites and commercial launches has not only made several technical issues but ethical issues as well, that is - the entire gamut of space debris causing harm to the environment, and the people who live on earth and space, is the common good that is being challenged. In line with this, the space policy of India is emphasizing the necessity of post-mission disposal, collision avoidance, and design-level planning as part of a long-term orbit safety plan.It is very careful to keep the area around the 400 ±30 km band, which is the space reserved for human spaceflight, safe.[50] Besides, there is a lot of emphasis on promoting data sharing and hence the transparency both at the national as well as international levels.

Besides, India's DFSM contributions are really a part of India's commitment to 'space for all' and reflect the concept of intergenerational equity - not only are space resources saved for future space travelers, but they are also preserved in the long run. India's justice-inspired space vision is a demand for collaboration among nations worldwide. The country is using a mix of technology, policies, and morals to project itself as an accountable leader who is working to make the outer space environment safer and friendlier for all.

VII. Pathways to Justice

Education, Advocacy, and Public Participation in Space Policy

As the problem with space junk is getting worse the pace, the need for space policy to be more than just a prerogative of the governments, technocrats, and private corporations is getting more

[49] Indian Space Research Organisation (ISRO), *India's Intent on Debris-Free Space Missions- Explained,* (Apr. 19, 2024), https://www.isro.gov.in/Debris_Free_Space_Missions.html.
[50] Kumar, A. K. Anil. *India's Initiative on Debris-Free Space Missions*, ISRO, 62nd STSC, Vienna, 2025.

apparent each day. The future of human spaceflight sustainable management, just like all environmental justice movements, depends on public engagement, advocacy, and education.

Environmental justice criteria require communities severely impacted by that issue—those in underprivileged countries, dependent on natural resources regions, or unborn generations—should be allowed to know and decide how issues affecting them will be handled. Transferring this idea to the space sphere, the public needs to know that satellite malfunctions, abrupt loss of communications, and a gap in climate monitoring might be some of the consequences that space debris causes. Advocacy groups, NGOs, and academic institutions undoubtedly contribute to the democratization of this knowledge and the shaping of policy discourse.

Programs of space science can give the public a better understanding of their connection to orbital safety. Public consultations, stakeholder dialogues, and the openness in the process of granting licenses can add to the procedural justice in space law. On top of this, youth and indigenous voices, which are very weak in these matters, must be considered in the decision-making processes concerning space governance, especially as most of these communities rely on satellite-based climate forecast and disaster relief services.

Space management, therefore, should be considered as a scientific and legal process as well as a civic one where people living on Earth are not only the custodians of the planet but also the space around it.

Collaborative Governance as a Tool for Environmental Justice

Collaborative governance is a great tool that can be used to solve the complex problem of space debris through the involvement of different governments, private companies, and the communities affected by the issue. It also ensures that environmental justice is promoted because local, small, and weak groups, which are often left out of space policy discussions, get a say in managing orbital waste. By enabling open administration, shared responsibility, and just approaches, collaborative management can contribute to lessening the unequal dangers of space debris, allowing for a just and sustainable utilization of space beyond Earth.[5152]

[51] Chris Ansell & Alison Gash, *Collaborative Governance in Theory and Practice,* 18 J.Pub.Admin.Res.& Theory 543, 2008.
[52] David Schlosberg, *Defining Environmental Justice: Theories, Movements, and Nature*, 2007.

Space debris that keeps on growing is a major hurdle that is affecting our environment and stands as a big technological threat, it is even bigger than this. In a sense, it is the environmental justice challenge that requires an urgent response. The orbits around the Earth that are being broken down with the dismantled satellites and the fragments of a rocket are increasing rapidly, hence the game goes beyond the simple hardware. It is now high time that we think about the issue of risk and benefits distribution in an equitable way and come up with new ways of such governance and equally sharing our common skies.

Space, out of power and stronghold of a few, should never be that way, but rather, treated as a global commons that all existing nations, including the less developed and emerging space-faring countries, have equal access to and are responsible for it. It implies the need for a collaborative governance system that is an inclusive composition of the voices of government officials, private sector members, scientists, indigenous people, and civil society. This kind of collaboration not only guarantees that policies mirror the variety of opinions but also ensures that those who are most at risk of debris, for example, remote areas that are highly dependent on satellite data, can participate more. Additionally, we also have to address the matter using intergenerational equity as our vantage point. The choices that we make today, or that we neglect to make, are decisive, so whether our descendants will be able to visit space and draw benefit from it is entirely up to us. Intergenerational equity requires that we "provide for continuance of choices, maintain quality, and uphold access" for future generations.[53]Here, in fact, safeguarding Earth's orbits is deemed the right thing to do beyond being a technical necessity. We are the stewards, we are borrowing the space from our descendants. Littering it with debris is equivalent to depriving them of the opportunity and the joy of discovery.

As a rising space power on the fast track, India is at a pivotal point. It can chart a fair, groundbreaking route by putting in place strong domestic laws that are guided by inclusive governance and moral stewardship. By doing so, it can set an example of how to mix with collective responsibility the commercial innovations from the space industry, which is readily done by reflecting the polluter-pays and precautionary principles in the space policies besides procedural fairness for all nations that are at par with such principles.

[53] Intergenerational Equity, UNEP Law & Environment Assistance Platform, *Intergenerational equity in economic, psychological, and sociological contexts*, Rio Principle 3 (1992), http://www.informea.org/terms/intergenerational-equity.

Finally, environmental justice in space, however, would mean basing shared responsibility, long-term, and ethical governance as the foundations of policy. The values of equity, fairness, and sustainability that we practice when we meet in collaborative forums, are universal and, therefore, not only for machines and missions we defend them. In protecting space today, we are thereby both the world community and the promise of the future that we embrace.

VIII. Conclusion: Toward a Just and Sustainable Outer Space Future

The cloud of debris orbiting the Earth, which is growing continuously, is not a simple problem of engineering only but it is an environmental injustice on a global scale. The ones who have disposed of the least waste in space are usually the ones who suffer the most, and yet they have the least say in how the issue should be solved. It not only hampers the working of satellites and puts the lives of astronauts in danger but also makes it difficult to have equal access to space as a common property.

It is essential that space should be regarded as a common good of all humanity that is to be managed through cooperative and inclusive systems which, besides being fair, also satisfy sustainability and long-term care aspects. There are exemplifications of collaborative governance where the State, private entities, scientists, and citizens together make the policy framework that can overcome the crisis and take the society into the future stage.

Moreover, as climate change calls for intergenerational justice, the same applies to space debris. The orbits that are polluted today will still be there, and they will not be possible to use for the following centuries, consequently, the future generations will be deprived of the opportunity to discover, create and utilize space. The Principle of Intergenerational Equity, which means that the care of the Earth's orbits is not a luxury, but rather a moral obligation, is teaching us a lesson here.[54]

The growing Indian space program, India, must take the lead not only in the creation of laws that are binding but also in the development of legislation that is inclusive. This will not only guarantee the country’s respect for its international commitments but also establish the

[54] Rio Declaration on Environment and Development, U.N. Doc. A/CONF.151/26 (Vol. I), Annex I, princ. 3 (Aug. 12, 1992).

framework in which accountability will go together with innovation. The promotion of India's domestic codification as a precursor to greater openness, and inclusiveness can transform that subcontinent into the kind of place that marks the way for a moral and just governance of outer space.

In the end, survival in space is still not only about the preservation of equipment, but also about the protection of people, values, and the common future. An equitable way of dealing with space debris should blend changes in law, participation of citizens, moral anticipation, and international friendship. By such means alone, we can guarantee that the cosmos will still be a safe and common land for every human being.