



# ASCENDANTS

22 JULY 2025 | 4:30–5:30 P.M. | FORUM 128



# Marcelo German Boldt // ARGENTINA

Polaris Spaceplanes GmbH



## Space Sustainability from a Latin American Perspective: From Exploitation to Stewardship

In the last 15 years, humanity accomplished amazing feats of engineering, like reusability –deemed impossible not so long ago – showing an underlying truth as well: we risk becoming complacent at the very moment our responsibilities expand.

At the core of this behavior lies a simple vision: humanity must shift its relationship with space from one of exploitation to one of stewardship. In this context, Latin America, often overlooked in global space discourse, provides powerful examples of how to lead that transformation – through resilience, inclusivity, and resourceful innovation [1].

In 2022, a Chinese launch's spent rocket stage reentered the Earth's atmosphere uncontrolled, scattering debris in the Indian Ocean, as reported by Deutsche Welle [2]. Last January, a similar event took place over the skies of Turks and Caicos Islands, with international coverage, including CNN. Thus, it is self-evident that this incident will not be the last one, especially with the advent of megaconstellations.

Simultaneously, in space policy circles and commercial activities alike, the conversation still revolves around the preconception of how space can serve Earth – for instance by enabling climate monitoring, powering the UN's 17 Sustainable Development Goals [3], and closing digital gaps – without conceiving that although space is infinite in its vastness, the portion that we as human beings can tap into is limited and becoming more congested with the passage of time [4,5,6]. It is of paramount importance that we tackle this latent danger actively by working toward answering the following three questions.

### 1. How Can We, as Individuals and as Society, Serve Space?

Space sustainability is not something that can be merely consigned to technical checklists or relegated to far-off timelines. Rather than inquire about how we might innovatively overcome the present crisis, perhaps it is more productive to pose other, more fundamental principles that might ultimately give rise to a genuinely sustainable space future.

We must start to measure the industry's sustainability not just by the technology we take to the market, but by how we construct and manage our institutions. This means developing internal cultures based on long-term stewardship, transparency, and resilience. We must also pledge to address today's most significant challenges with the strength and resources we currently possess – with all of them and fairly,

and without waiting for unproven technology. And we must actively work to reconstitute the governance of space by involving a wide range of diverse and underrepresented voices – such as from the newer spacefaring countries – into all tiers of decision making. This is the way that we move from rhetoric to responsibility and intention to impact.

These are not simply commitments to the future. We can already learn from places like Latin America, where resilience and lateral thinking are deeply embedded in the culture of both individuals and business organizations. Argentina and Brazil are shining success stories, having independently developed and launched GEO and LEO Earth observation satellites despite operating with space development budgets two to three orders of magnitude lower than the United States or China, as reported by NOVASPACE [7]. Furthermore, private space companies have begun to appear, already creating value across numerous domains. They are not promises of tomorrow but solutions for today. Yet this type of activity is often relegated to the fringes of global discourse, perpetuating a narrow and exclusionary understanding of progress.

### 2. Are There Sufficient Discussions Occurring on Sustainable Organizations?

Sustainability encompasses more than end-of-life disposal planning and debris mitigation; it is aligned with how we behave as individuals. Today, a significant number of space startups are locked into venture capital dynamics that value quick growth, media buzz, and short-term return over long-term value. Mining and energy are also clear examples of what happens when industries fueled by vast amounts of funding – both from private and public sources – resulted uncontrolled practices that ultimately lead to extensive environmental catastrophes and biodiversity loss, and its consequences yet to be determined.

In contrast, the World Economic Forum has already showcased that Latin American organizations – out of necessity – created substantial impact following leaner, resilient, and frugal practices [8,9]. These core values can be extrapolated for a space industry that is working more for local ecosystems and communities than shareholders. If we are to build a sustainable space economy, we must look beyond technical readiness levels alone and include durability, equity, and purpose in our organizations.

Continued on next page

### 3. Are We Fighting Today's Problems with Today's Gear?

The space industry worldwide too easily puts disproportionate reliance on future technology to address current issues. We talk of autonomous debris collectors, orbital fuel depots, and lunar infrastructure, but we avoid the actionable tools we already have. International guidelines for space traffic management do exist. Demonstrated satellite technologies for climate action are online. The issue is not invention but implementation.

There are multiple examples of space technologies used for the benefit of Earth. Argentina's SAOCOM family (an Earth observation satellite constellation), operated by the national space agency CONAE, provides vital information that can improve flood prediction and crop yields [10]. However, projects and activities that preserve the space environment are rarer and spread between one another. We must avoid waiting for the next technological revolution and tackle the problems we face today with the technology we have today. True innovation is not always a question of what's next, it's about how cleverly we leverage what's here.

#### To Be Sure: Admit the Challenges

It would be unrealistic to dismiss the resistance to more inclusion in space governance. Great space nations have vested interests, established infrastructures, and complex geopolitics. And of course, some of the challenges require cutting-edge equipment yet to be developed. But that should not be a reason for doing nothing. Space's future is everybody's responsibility, and its governance must reflect global engagement, not domination.

#### The Place of Diverse Voices in a Sustainable Space Exploration Future

Sustainability is not only a technical problem; it is also cultural and political. The composition of participants impacts cultural evolution significantly. A small group of stakeholders currently determines orbital regulations, satellite licensing, and resource allocation. Space impacts all of us, however, and the institutions we build will determine future generations' access and equity.

Latin America is not a passive receiver of international cooperation. It has to be realized as a leader in its own capacity. From running space missions on shoestring budgets to creating community-based space initiatives, it illustrates the very spirit the international industry is currently meant to admire.

Space travel in the future may not be limited by technology, but it will be bound by our choices. The question is not whether we can travel to the stars, but how wisely – and as one – we choose to build that journey.

### References

- [1] World Economic Forum (WEF) (2022). "Latin America's leaders have been tested by the global context – but their response could see better cooperation and regional integration". <https://www.weforum.org/stories/2022/05/latin-american-leadership-has-been-tested-by-the-global-context/>
- [2] Deutsche Welle (DW). (2022). "Chinese rocket makes uncontrolled return to Earth" <https://www.dw.com/en/chinese-rocket-makes-uncontrolled-return-to-earth/a-62660563>
- [3] United Nations (UN). Sustainable Development Goals (SDGs). <https://www.undp.org/sustainable-development-goals>
- [4] United Nations Office for Outer Space Affairs (UNOOSA) (2010). "Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space". [https://www.unoosa.org/pdf/publications/st\\_space\\_49E.pdf](https://www.unoosa.org/pdf/publications/st_space_49E.pdf)
- [5] European Space Agency (ESA) & United Nations Office for Outer Space Affairs (UNOOSA) (2021) "ESA and UNOOSA illustrate space debris problem". [https://www.esa.int/Space\\_Safety/Space\\_Debris/ESA\\_and\\_UNOOSA\\_illustrate\\_space\\_debris\\_problem](https://www.esa.int/Space_Safety/Space_Debris/ESA_and_UNOOSA_illustrate_space_debris_problem)
- [6] United Nations Office for Outer Space Affairs (UNOOSA) (2025). "IADC Report on the Status of the Space Debris Environment". [https://www.unoosa.org/res/oosadoc/data/documents/2025/aac\\_105c\\_12025crp/aac\\_105c\\_12025crp\\_10\\_0\\_html/AC105\\_C1\\_2025\\_CRP10E.pdf](https://www.unoosa.org/res/oosadoc/data/documents/2025/aac_105c_12025crp/aac_105c_12025crp_10_0_html/AC105_C1_2025_CRP10E.pdf)
- [7] NOVASPACE (2025). "Defense Spending Drives Government Space Budgets to Historic High". <https://nova.space/press-release/defense-spending-drives-government-space-budgets-to-historic-high/>
- [8] World Economic Forum (WEF) (2023). "Latin America is set to become a global powerhouse for innovation. Here's why". <https://www.weforum.org/stories/2023/09/see-how-latin-america-is-becoming-a-thriving-innovation-hub/>
- [9] Strategy & Business (PWC) (2013). "What the West Can Learn from Jugaad". <https://www.strategy-business.com/article/00143>
- [10] Comision Nacional de Actividades Espaciales (CONAE) & INVAP. <https://saocom.invap.com.ar/>

# Eden Abeselom Habteslasie // ETHIOPIA

Space Science and Geospatial Institute



## Space Debris as a Barrier to Sustainable Space Development in Emerging Nations

Will emerging space nations, often with the fewest resources, be permanently shut out of the cosmos they've dreamt of? Imagine the highway to the stars, once a symbol of boundless human ambition, now transformed into a treacherous, high-speed junkyard. This isn't science fiction; it's our increasingly real world.

Experts predict over 40,000 large and 1.2 million smaller pieces of debris will clutter orbits by 2025 [1]. This escalating crisis poses a stark question: Who will pay the highest price for this orbital blight? The answer, tragically, points squarely to the Global South. Emerging space nations face a risky journey with limited resources and geopolitical marginalization. Fast, fair action is vital, or their progress will stall. Inclusive solutions are a must for global space security and equal space development.

### Limited Orbit Access & Space Operation Risks

Big space powers like the United States, Russia, and China dominate far above Earth geostationary orbits [2], often leaving emerging nations in crowded, less desirable ones. Orbital satellite operation requires permission under the Outer Space Treaty for proper authorization and oversight [3]. Emerging space nations often struggle for good satellite orbits due to their limited mission design experience. In low Earth orbit (LEO), closer to Earth, the increasing number of satellites is creating so much debris that it could lead to a cascade of collisions, known as the Kessler Syndrome [4][5]. The crowded, dangerous orbital environment is a major threat to emerging nations launching their first satellites.

### Lack of Debris Removal & High Costs Complicate Space Regulation

Launching satellites requires significant investment for new space nations in technology and insurance against debris. Implementing essential debris removal and tracking is also challenging and costly due to limited resources and the need for international cooperation. The high costs associated with complying with international space guidelines and regulations (e.g., Committee on the Peaceful Uses of Outer Space (COPUOS), United Nations Office for Outer Space Affairs (UNOOSA), International Telecommunication Union (ITU)) can be prohibitive for newcomer nations, creating a significant barrier to entry in the global space sector. Is it fair to expect those who contributed least to the debris problem to pay disproportionately for its solution?

### Geopolitics & Unequal Participation in Space Treaties

The rules of space are set by early arrivals [6], leaving newcomer nations outside crucial frameworks like the Artemis Accords due to political and tech gaps. While established powers explore, emerging nations rely on space for essential needs, yet face unfair costs from others' space debris. This burden threatens their vital programs and Earth-bound applications, demanding a more equitable approach to space governance.

### Toward Equitable Solutions

1. All launching nations, big or small, must be responsible for cleaning up their space debris. Fair rules are beneficial for all, especially newcomers.

2. Share the tools, not just talk. Global partnerships need action: wealthier space nations should support emerging ones with debris tracking and cleanup tech as an investment in a safer, more inclusive space future, not charity.
3. Give every nation a real voice. Treaties like the Outer Space Treaty and Artemis Accords must evolve to include emerging nations in decisions, ensuring orbital spots aren't just for historical space powers.
4. Reward responsible space innovation. Recognize and incentivize companies that design cleaner missions and invest in sustainability to create a fairer environment where emerging nations can compete without being penalized by others' space debris.
5. Reform space liability rules. There must be real accountability when satellites cause harm in orbit or on Earth. A stronger, inclusive system ensures everyone, including private companies, follows the same rules, allowing newcomers to enter space safely without being penalized for others' risks.

Both established space powers and commercial entities have heavily invested in their space infrastructure, and their concerns about congestion and asset protection are valid, especially considering the risks and pressures they face. Nevertheless, these conditions should not prevent new countries from having a fair share in space orbits or participating in space governance.

### Conclusion

Space debris represents not only a technical hurdle but also a moral and geopolitical challenge. Without urgent, equitable action, emerging nations will bear the brunt of a crisis they did not create, stifling their potential to advance climate monitoring, connectivity, and scientific discovery.

### References

- [1] S. Lemmens and F. Letizia, "ESA's Annual Space Environment Report," no. April, p. 79, 2019.
- [2] P. Borchert and D. M. Zellmer-Bruhn, "Reproduced with permission of the copyright owner. Further reproduction prohibited without," *J. Allergy Clin. Immunol.*, vol. 130, no. 2, p. 556, 2010, [Online]. Available: <http://dx.doi.org/10.1016/j.jaci.2012.05.050>
- [3] F. G. Von Der Dunk, "The origins of authorisation: Article VI of the outer space treaty and international space law," *Stud. Sp. Law*, vol. 6, pp. 3–28, 2011, doi: 10.1163/ej.9789004204867.iii-381.9.
- [4] K. Nomura et al., "Tipping Points of Space Debris in Low Earth Orbit," *Int. J. Commons*, vol. 18, no. 1, pp. 17–31, 2024, doi: 10.5334/ijc.1275.
- [5] M. Jamro, "Kessler Syndrome and Its Implications for Satellite and Wi-Fi Communications," no. January, 2025, doi: 10.13140/RG.2.2.29449.56160.
- [6] G. Elefteriu, "The role of space power in geopolitical competition," Council on Geostrategy, Geopolitics Programme Report No. GPPR01, Jan. 2024. [Online]. Available: <https://www.geostrategy.org.uk/research/the-role-of-space-power-in-geopolitical-competition/>

# Oluwarantimi Bukola // NIGERIA

Vortyx Space



## From Riverine Dreams to Orbital Realities: Bridging Africa's Space Education and Employment Gap

My mother grew up in 1970s Imo State, Nigeria – a place where aerospace lived only in foreign textbooks, and her fascination with flight was reduced to watching planes vanish into clouds from her schoolyard. Her dream of becoming an astronaut was dismissed as fantasy, a casualty of limited infrastructure and societal norms. Today, I am living her dream. While she negotiates oil contracts now, I advocate for aerospace education and coordinate space-focused programs across Nigeria. Her story mirrors a national paradox: immense talent exists, but career pathways in space often fracture before liftoff. Nigeria's space program, though ambitious, still contends with fragmented education pipelines, underfunded innovation, and mounting pressure to participate in global space governance – often shaped by extractive models. We must redefine sustainability as intergenerational equity: not just protecting orbital environments but repairing the systemic exclusions that extinguish cosmic curiosity before it ever launches.

For Africa to claim its rightful place in the global space economy, we must tackle two intertwined challenges: reimagining education to nurture space-literate minds and building an industry that offers more than aircraft maintenance jobs. Nigeria's National Space Research and Development Agency (NASRDA) has laid some important groundwork, but its work must now connect to classrooms, startups, and future missions. Our collective future depends on it.

Before we can launch careers, we must first ignite curiosity, and across much of Sub-Saharan Africa that spark struggles to catch fire. Only 9% of young people in the region are enrolled in tertiary education as opposed to 42% globally [1]. Girls face even steeper odds, with gender norms and under-resourced schools compounding barriers to participation in STEM fields [2]. Meanwhile, the majority of schools lack labs, trained instructors, or curricula that link science to the stars. The result? Cosmic dreams fade long before they have the chance to flourish [3].

Despite these barriers, sparks of innovation are beginning to glow. The Intelsat Africa Space STEM Program provides kits and training to schools in Kenya, Nigeria, Senegal, and South Africa [4]. The Future African Space Explorer's STEM Academy (FASESA) brings hands-on exploration to classrooms, while the Pan-African Citizen Science e-Lab enables students from over 40 countries to publish real

astronomy research [5] [6]. These programs don't just educate, they awaken belief. They hint at what's possible when education, imagination, and infrastructure align in purpose.

At the national level, Nigeria's space ambitions are steered by NASRDA, created under the 2010 NASRDA Act [7]. Tasked with advancing satellite development, Earth observation, and research, the agency has overseen the launch of NigeriaSat-1, NigeriaSat-2, and NigComSat-1R [8]. It also houses a network of research centers, from the Centre for Satellite Technology Development (CSTD) to the Zonal Advanced Space Technology Application Laboratory (ZASTAL) in Kano, and the Centre for Space Transport and Propulsion (CSTP) in Epe, which focuses on indigenous rocketry and propulsion systems [9]. Yet for all its accomplishments, a disconnect remains: many students and educators are unaware of NASRDA's work, and few academic programs bridge the gap between this national infrastructure and the hands-on learning young people need.

Graduates often hit a wall: over 85% of aerospace jobs in Nigeria fall under maintenance, repair, and overhaul (MRO), with little exposure to high-impact roles in satellite engineering, orbital analytics, or mission design [10]. Across the continent, the same pattern repeats. The industry is growing – 105 satellites are in development and the market is projected to reach \$22.64 billion by 2026 [11], but workforce development hasn't caught up.

Fixing this requires more than hope. It needs targeted infrastructure and bold policy. NASRDA's budget rose dramatically from \$6.17 billion in 2021 to \$27.88 billion in 2022, a 450% leap that signals growing political will [12]. Most recently, President Tinubu approved a \$20 billion take-off fund for NASRDA's Space Regulation Project, a critical step toward licensing, compliance, and building a more vibrant private-sector space economy [13]. This move signals a welcome pivot from vision to viable ecosystem. But funding must go further: into cleanrooms, shared test labs, and capital access for satellite startups. These are the building blocks of an industry that can include and employ.

Africa is not short of ambition. The African Space Agency (AfSA), launched by the African Union, is now coordinating efforts under Agenda 2063 [14]. Its goals include building infrastructure, promoting regional integration, and prioritizing

[Continued on next page](#)



education as a strategic driver for the space economy. AfSA's success, however, will hinge on how well it partners with national agencies and private innovators to turn frameworks into flights.

Critics may ask: why space, when our roads are broken and our schools underfunded? But this is a false choice. Space isn't a distraction from development, it's a multiplier. Satellites already support African agriculture, telecommunications, and disaster relief. They monitor droughts, enable mobile banking, and track disease outbreaks. Yet beyond satellites, the space industry also includes launch vehicle and spacecraft manufacturing, sectors where Africa continues to lag due to limited infrastructure, investment, and engineering capacity. Investing in space accelerates outcomes across every sector. The real danger isn't in reaching too far but in dreaming too small. The question we must ask is not why space, but why not build a future where young Africans don't just benefit from this technology, but help create and lead it?

To do that, we must act boldly. Ministries of Education and Science must integrate space into national curricula. Governments should fund regional innovation hubs, incentivize public-private R&D, and support specialized training institutions. NASRDA's mission must align with classroom tools and internship pipelines. And gender-inclusive programs must be scaled, so the next Mae Jemison can emerge from Kampala or Kumasi.

From my mother's schoolyard sky-gazing in 1970s Imo to my own advocacy in today's evolving space sector, our stories are tethered by a shared longing: to belong in the cosmos. But longing is not enough. Dreams must be met with infrastructure, mentorship, and access. As Africa builds its space future, we must ensure that sustainability isn't reduced to technical checklists or orbital protocols but rooted in justice and inclusion. Let sustainability mean that no child, regardless of gender, geography, or income, has their cosmic curiosity dismissed as impractical. Let it mean that my children and yours inherit a sky that is not only accessible, but welcoming. That is how we lift off, together, across generations.

## References

[1] UNESCO, 2024 UNESCO Forum on Higher Education in Africa, [Online]. Available: [[https://www.unesco.org/sites/default/files/medias/fichiers/2024/12/higher-education-africa-cn-en\\_1.pdf](https://www.unesco.org/sites/default/files/medias/fichiers/2024/12/higher-education-africa-cn-en_1.pdf)]

[2] UNESCO, "What you need to know about the challenges of STEM in Africa," [Online]. Available: [<https://www.unesco.org/en/articles/what-you-need-know-about-challenges-stem-africa>]

[3] United Nations, STEM Education and Inequality in Africa, [Online]. Available: [[https://www.un.org/osaa/sites/www.un.org.osaa/files/un\\_brand\\_report\\_web\\_august\\_2020\\_v36928.pdf](https://www.un.org/osaa/sites/www.un.org.osaa/files/un_brand_report_web_august_2020_v36928.pdf)]

[4] MaxIQ, "Intelsat Africa Space STEM Program," [Online]. Available: [<https://themaxiq.com/pages/intelsat-africa-space-stem-program>]

[5] FASESA, "Future African Space Explorer's STEM Academy," [Online]. Available: [<https://fasesa.com>]

[6] arXiv, "Pan-African Citizen Science e-Lab," [Online]. Available: [<https://arxiv.org/abs/2408.11059>]

[7] NASRDA, NASRDA Act 2010, [Online]. Available: [[https://www.unoosa.org/documents/pdf/spacelaw/national/NASRDA\\_ACT\\_2010.pdf](https://www.unoosa.org/documents/pdf/spacelaw/national/NASRDA_ACT_2010.pdf)]

[8] UN-SPIDER, "NASRDA - Nigeria National Space Research and Development Agency," [Online]. Available: [<https://www.un-spider.org/nigeria-national-space-research-and-development-agency-nasrda>]

[9] NASRDA Central Portal, "Centres and Laboratories," [Online]. Available: [<https://central.nasrda.gov.ng/centers-laboratories>]

[10] CSIS Aerospace Security, "Challenges and Opportunities of Nigeria's Space Policy," [Online]. Available: [<https://aerospace.csis.org/challenges-and-opportunities-of-nigerias-space-policy>]

[11] Capmad, "Space Industry Africa: Development Opportunities," [Online]. Available: [<https://www.capmad.com/technology-en/space-industry-africa-development-opportunities>]

[12] The Guardian Nigeria, "24yrs after, Nigeria's space programme loses traction despite yearly allocations," [Online]. Available: [<https://guardian.ng/news/24yrs-after-nigerias-space-programme-loses-traction-despite-yearly-allocations>]

[13] NASRDA SpaceReg, "Tinubu Approves N20bn Take-Off Fund for NASRDA's Space Regulation Project," [Online]. Available: [<https://spacereg.nasrda.gov.ng/tinubu-approves-n20bn-take-off-fund-for-nasrdas-space-regulation-project>]

[14] African Space Agency, "Inauguration of AfSA," [Online]. Available: [<https://africanspaceagency.org/inauguration>]



## How Māori Kaupapa (Principles) Light the Path for Ethical Space Sustainability in the New Space Age

*He waka eke noa*

A canoe which we are all in with no exception  
(Māori proverb)

Earth is our shared home, a canoe in which we all journey together. We have a collective responsibility to maintain it and ensure sustainability. As we explore space, it becomes our shared reality too. Embracing this spirit makes space exploration a global endeavor, where everyone works together toward exploring and understanding the Universe and preserving it for future generations.

### Māori Perspectives and Actions for Sustainable Space Exploration

Māori have had a close relationship with space for millennia predating to their arrival to Aotearoa (New Zealand). The stars are seen as ancestors and spiritual guides, providing direction and wisdom for Pacific Ocean voyages. The Matariki star cluster marks the Māori New Year, symbolizing renewal and community gathering. Cosmology concepts like whakapapa (interconnectedness) emphasize the interdependence of all living things and are acknowledged in public science communication and curriculum development [1]. Māori Tātai Arorangi (astronomy) and spiritual connection to the cosmos reflect a holistic worldview that supports responsible and sustainable exploration and use of space, honoring both scientific advancements and cultural heritage.

Collaboration between NASA's Indigenous Peoples Initiative and Society for Māori Astronomy Research and Traditions integrates satellite data into maramataka (Māori calendar) to support Māori-led environmental monitoring. It uses advanced analytics and machine learning to align with Māori ecological priorities like kaitiakitanga (guardianship of the environment). This work promotes Māori representation in international space partnerships and ensures that space technologies are aligned with Indigenous priorities. It is also grounded in the principle of manaakitanga—which emphasizes generosity, respect, and the inclusion of diverse cultural perspectives [2].

In Aotearoa, environmental assessments for satellite launches are increasingly incorporating Māori perspectives that emphasize both spiritual and ecological impacts. Māori

view the sky as sacred, and concerns have been raised about how space debris and emissions disrupt the spiritual integrity of celestial spaces [3-4]. Ecological risk assessments and advocacy for dark sky protection by the National Institute of Water and Atmospheric Research reflect growing efforts to include Māori values like kaitiakitanga and whakapapa in space governance [5]. New Zealand's space policy now requires orbital debris mitigation plans for all launches, with Māori pushing for these plans to also consider cultural impact assessments [6]. Thus, national policy is influenced by Māori environmental stewardship on ethical use of space resources.

### Indigenous Wisdom and Worldviews in Space Strategy and Policy

As space governance frameworks evolve to address the complexities of commercial expansion and planetary protection, there is a growing call to include Indigenous wisdom and pursue ethical, sustainable, and inclusive practices. In Australia, a partnership between the Australian Space Agency and Top End Aboriginal Bush Broadcasting Association launched a radio series to amplify First Nations perspectives and improve space literacy in remote communities [7]. In Canada, a policy paper by the Centre for International Governance Innovation advocates for "Indigenous cosmic caretaking," urging the integration of Indigenous values like reciprocity and stewardship into international space law [8]. These efforts are actively shaping how space data is used, how policy is written, and how Indigenous leadership is embedded in the future.

### The Path Forward

As space becomes more accessible, sustainability is critical. Commercialization and global participation bring benefits but raise concerns about peaceful use and impacts on Indigenous communities [9]. For Māori, the night sky is a cultural resource at risk. By embracing kaitiakitanga and manaakitanga, space agencies and companies can prioritize long-term care, reduce harm, and ensure inclusive, respectful decision making by:

1. Advancing Indigenous Capabilities Locally and Globally: By supporting Māori-led education, research and business, and promoting equitable access and consultation, Māori heritage is honored while sustainability values and diverse innovations enrich the industry.

Continued on next page

2. Cultural Integration in Space Policies: Guided by Te Tiriti o Waitangi (Treaty of Waitangi) – which affirms Māori rights to self-determination and partnership – Māori values are incorporated in decision making in space. Māori Working Group on Aerospace emphasizes the importance of the treaty as a foundation for partnership and co-governance in space, and equitable access to space technologies.

3. Accountability and Ethical Governance in Space Activities: Treaties like the Outer Space Treaty and Liability Convention hold nations responsible for all space activities, while the UN Declaration on the Rights of Indigenous Peoples emphasizes the inclusion of Indigenous voices in policymaking [10]. To prevent cultural and spiritual violations, ethical guidelines and regulatory frameworks should mandate cultural impact assessments, particularly before launching missions or building infrastructure.

Space exploration has historically been propelled by competition between nations, and now among private companies, often overlooking long-term consequences. Māori values, though traditional, can be integrated into modern life and promote balance between growth and responsibility. Like the Māori, we all have a continual relationship with space and the environment.

*He waka eke noa.*

## References

- [1] *Māori Astronomy*. Astronz (Astronomy NZ Ltd). <https://astronz.nz/pages/maori-astronomy>
- [2] *Te ao Māori – space whakapapa* (2022). Science Learning Hub Pokapū Akoranga Pūtaiao. <https://www.sciencelearn.org.nz/resources/3155-te-ao-maori-space-whakapapa>
- [3] *Global agreement needed to curb orbital pollution* (2025). University of Auckland. <https://www.auckland.ac.nz/en/news/2025/01/15/global-agreement-needed-to-curb-orbital-pollution.html>
- [4] *Māori perspectives on New Zealand's space sector – Expert Reaction* (2022). Science Media Center, New Zealand. <https://www.sciencemediacentre.co.nz/2022/10/31/maori-perspectives-on-new-zealands-space-sector/>
- [5] *Ecological Risk Assessment of the impact of debris from space launches on the marine environment* (2017). Ministry for the Environment. <https://environment.govt.nz/assets/Publications/Files/Ecological-Risk-Assessment-of-the-impact-of-debris-from-space-launches-on-the-marine-environment.pdf>
- [6] *New Zealand, Item 10: Long-term sustainability of outer space activities* (2025). United Nations Office for Outer Space Affairs. [https://www.unoosa.org/documents/pdf/copuos/stsc/2025/Statements/10\\_New\\_Zealand.pdf](https://www.unoosa.org/documents/pdf/copuos/stsc/2025/Statements/10_New_Zealand.pdf)
- [7] *Elevating First Nations knowledge through space-themed series* (2025). Australian Space Agency. <https://www.space.gov.au/news-and-media/elevating-first-nations-knowledge-through-space-themed-series>
- [8] *Indigenous Cosmic Caretaking and the Future of Space Exploration* (2024). Centre for International Governance Innovation. [https://www.cigionline.org/static/documents/Noon-Sept2024\\_F9BMunh.pdf](https://www.cigionline.org/static/documents/Noon-Sept2024_F9BMunh.pdf)
- [9] *Sustainability is often an afterthought in space exploration – that needs to change as the industry grows* (2023). Public Policy Institute, The University of Auckland, New Zealand. <https://www.ppi.auckland.ac.nz/2023/08/28/sustainability-is-often-an-afterthought-in-space-exploration-that-needs-to-change-as-the-industry-grows/>
- [10] *UN Declaration on the Rights of Indigenous Peoples* (2007). United Nations Human Rights Office of The High Commissioner. <https://www.ohchr.org/en/indigenous-peoples/un-declaration-rights-indigenous-peoples>



# Adeife Ayomide Jide-Omole // NIGERIA

International Aviation Law



## Space Sustainability—The Right Way To Do Space Benefits Sharing

The year is 2067, and my 10-year-old grandchild, teary-eyed, approaches me with series of questions. “Grandma, did you think you did enough to protect my interests in space? Did you just stay silent while space exploiters ploughed through the resources in space? How could you turn the other eye while they tugged at the mineral resources and left debris in outer space, sometimes just to show off their capabilities? Grandma, how do I explain to my own grandchild that there is nothing left for them in space even when your generation stated plainly that space is the common heritage of mankind? Why couldn’t the world come together to establish proper guidelines to enable sustainability in and through space?” I loathe the day I have to confront this matter, looking at my 10-year-old grandchild with no concrete answers. Thus, it is imperative to bring this conversation to the global table. Now more than ever, to achieve space sustainability, humanity require equitable benefits sharing and intentional legal structures.

Truly, we have come so far with space exploration. Novel technological breakthroughs push the limits of human exploration even beyond what we could have dreamed of in 1969 when the first man landed on the moon. From reusable rockets that reduce the cost of space travel, to advanced space telescopes and sensors, the human race is at the forefront of cutting-edge technologies.

However, the dependency on space exploration for multiple financial, navigational, and communications activities calls for effective practices of space sustainability that will ensure all humanity can continue to use outer space for peaceful purposes and socioeconomic benefit now and in the long term, and that future generations will have the same and even better access. This is encapsulated in the UN Outer Space Treaty. It was coined as the concept of space benefits sharing, which emphasizes the principle that the exploration and use of outer space should benefit all nations, regardless of their economic or scientific development. This sharing of benefits ensures that advancements and resources derived from space exploration are accessible to everyone at all times. Currently, this is more aspirational than obtainable.

As we speak, these groundbreaking technologies from outer space are mostly being developed by the leading spacefaring nations and the lack of adequate conversation around technology and knowledge transfer has contributed immensely to an enabling environment where space exploration is achieved by the selected few. Notwithstanding what is stated in Article IX of the Outer Space Treaty that the exploration of outer space shall be guided by the principle of cooperation and mutual assistance, the international community truly has not been cooperative. This has profoundly affected international relations and the balance of power especially

in the conversations surrounding space benefits sharing and space sustainability. For instance, developing countries favor a broad obligation to share the tangible benefits derived from space exploration as a means of promoting economic development, while industrialized nations advocate minimal sharing obligations so they may retain control over their space programs and keep them economically viable.

The current space law environment does not specifically address benefit sharing, and substantial disagreement remains among nation states whose levels of economic and scientific development differ. To make true headway, we must resuscitate the conversations promoting cooperation between spacefaring nations and third-world countries particularly around knowledge and technology transfer. The purpose of which is to share information, skills, insights, or expertise and to successfully convey knowledge to improve understanding, capabilities, and performance within the space industry. Emphasis is on the transfer of awareness of facts and practical skills.

Second, sustainability in space requires proactive, deliberate actions, not passive reliance on regulations or governments. Thus, succeeding contractual obligations between countries should be practicable and encourage the tenets of mutual assistance and cooperation as stated in Article IX of the Outer Space Treaty. For instance, the relationship between the Federal Republic of Nigeria and the UK’s Surrey Satellite Technology Limited (SSTL) to support Nigeria’s satellite-building capacity highlights several issues that will prove insightful for inexperienced African countries looking to partner with more established players. The contract included inequitable terms that exploit the country’s intellectual property and ability to modify the design and software codes it was to receive from SSTL, codes that were very critical to a successful technology transfer and subsequent technology development in Nigeria, and trivialized the interests of future Nigerians.

Consequently, as we continue to use the environment of space to meet the current needs of society, we must always bear in mind not to compromise the needs of future generations. There are examples to show how bad and how quickly poor implementation of space sustainability strategies can go. The situation requires international cooperation, discussion, and agreements designed to ensure that outer space is safe, secure, and peaceful so that all humanity can continue to use outer space for peaceful purposes and socioeconomic benefit now and in the long term.

So, no, I did not stay silent, nor did I turn the other eye. Space is the common heritage of humankind, and I did my best to protect it for the benefit of your grandchildren and for future generations.

# Antonio (KangSan Kim) Stark // SOUTH KOREA

iSpace, Inc.



## Need We Reach for the Moon?

### The Harsh Mistress

“Shoot for the moon - even if you miss, you’ll end up among the stars”, and plenty did. Reaching the moon is no easy feat. Since the 1950s, nearly 150 missions targeted our nearest celestial neighbor, and barely half have succeeded [1,2]. Landing on the lunar surface is particularly difficult, with many recent missions like India’s Chandrayaan-2 (2019), Israel’s Beresheet (2019), and Russia’s Luna-25 (2023) ending up as new craters in the desolate landscape.

### Not a Piece of (Moon)Cake

Why do we go to the moon? We have enough “hard” problems to solve here on Earth. And why do we invest in it? Even without being American citizens whose taxes pay for NASA’s Artemis missions, we all purchase enough products from companies increasingly looking to invest those profits in space. To many, the moon seems distant and irrelevant to daily life. Should we care - and does it even matter?

I say our voices do matter - the moon is just too visible. Two billion muslims pray and celebrate alongside the moon, where Ramadan and Eid festivals rely on lunar sightings [3,4]. Over 1.5 billion people celebrate the lunar new year, whether in the Chinese spring festival, Vietnamese Tet, or the Buddhist Songkran across Thailand, Cambodia, and Myanmar [5]. It even influences military operations - in my three years as a Marine officer, I’ve seen plans get rewritten to minimize moonlight. But the moon’s importance extends beyond strategic calculations - it has become a stage for international cooperation and competition. Sputnik set off the first Space Race out of fear of space-borne surveillance, and a crewed base on the moon becomes a nightly reminder of what we - or “they” - are capable of. Whether out of fear or reverence, too many of us care about the moon for presidents and billionaires to ignore when planning to plant new footsteps on the moon.

### Mayflowers to the Moon

These plans used to be called “colonies” or “settlements” - borrowing terms from when people would migrate to new lands with new machinery to set up old flags. While the terms have fallen out of favor, the upcoming missions still carry equipment to mine local resources and set up permanent habitats. As lawyers scramble over treaties written 50 years ago, engineers design landers that can carry 300kg (iSpace APEX 1.0), 2,000kg (ESA Argonaut), 20,000kg (Blue Origin Mk2), and 100 tons (SpaceX Starship HLS) of seeds and flags to the lunar surface [6,7,8,9].

The prima space power - the United States - is building a

coalition of governments through the Artemis Program. The Lunar Gateway space station will have modules contributed from ESA (ESPRIT), the UAE (Crew and Science Airlock), and Japan (I-HAB, in collaboration with ESA), as well as a robotic arm from Canada (Canadarm-3) [10,11,12,13]. The homonymous Artemis Accords represent 50+ signatory nations, being a platform to rapidly expand future agreements on hardware standards, regulations on resource ownership and commercialization, and guidelines for crewed activities on and around the moon [14]. The secundo powers of China and Russia are advancing the Chang’e and Luna programs and the International Lunar Research Station (ILRS) coalition based on institutional partnerships [15].

Then there are the companies. These can be billionaire-fueled SpaceX and Blue Origin, or traditional aerospace giants like Thales Alenia and Lockheed Martin signing up to build lunar architecture [16,17, 18, 19]. Startups are entering the lunar ecosystem as a prime focus (Lunar Outpost, Starpath Robotics) or as the next market segment [20,21]. Normal citizens with an investing hobby might see their portfolio contributing to these companies, or their pension funds re-pooled into space companies [22]. As the appetite for private capital grows, investors become increasingly attracted to space companies that offer high visibility.

### To Lune or Not to Lune

There is an illusion of choice about being involved in this gold rush for the moon: nonparticipation itself becomes a statement. We have long regarded space as a global commons - a heritage for every individual present and future. Muting our voices now becomes an endorsement of the loudest speaker in the room. If time won’t stop the arrow of lunar development, we must at least guide its direction.

Activism is daunting, especially in a world with more immediate challenges like ours. Even within the space community, the moon represents a fraction of its budget, workforce, and needs. However, as the world becomes more uncertain and multipolar, the brave new world of the moon can become the platform for global consensus. The symbolic value of the moon will play an outsized role for those who walk and cultivate the grey soils of our night sky. Before a call to action, I present a call to thought - what values do we want represented among the stars?

Critics argue that pouring resources into lunar missions diverts attention and funds from urgent Earthly issues like climate change and poverty. Yet, many space innovations spin off

[Continued on next page](#)

technologies that aid sustainability, while the international frameworks developed for lunar governance can model peaceful cooperation on our planet. Hence, when those among us criticize our attention skyward, we can recognize both the immediate need to better our world based on our current values and the impending need to identify such values for future generations.

### And the Stars Echoed

However, a vote can only be exercised by those who have one - many from the Global South or the financially disadvantaged lack the knowledge or tools to shape what the moon becomes. For those fortunate enough to engage in these conversations, the responsibility is clear: to advocate for inclusive, equitable participation and to champion a vision of space that reflects our shared humanity. Otherwise, we risk waking up to a future where we look up to an alien civilization among the stars that neither looks, thinks, nor believes like we do. The choices we make now, here on Earth, will echo across the stars, especially for those who never had the option to shoot for the moon. It's time to ensure those echoes carry the voices of all.

### References

- [1] Elizabeth Howell, "Missions to the Moon: Past, Present and Future," *Space.com*, July 15, 2023, <https://www.space.com/all-moon-missions>.
- [2] Gail Iles, "Almost Half of Moon Missions Fail—Why Is Space Still So Hard?," *The Conversation*, August 15, 2023, <https://theconversation.com/almost-half-of-moon-missions-fail-why-is-space-still-so-hard-211914>.
- [3] TimesPrayer.com, "Global Muslim Population," <https://timesprayer.com/en/muslim-population/>.
- [4] Yaseen Rashed. "Why Is the Moon So Important in Arab Culture?" *Arab America*, November 6, 2019. <https://www.arabamerica.com/why-is-the-moon-so-important-in-arab-culture/>.
- [5] "Buddhist New Year Celebrations." *Tricycle: The Buddhist Review*. <https://tricycle.org/beginners/buddhism/buddhist-new-year/>.
- [6] United Nations Office for Outer Space Affairs (UNOOSA). "The Outer Space Treaty." <https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/introouterspacetreaty.html>.
- [7] ispace U.S. "APEX 1.0 Lunar Lander." <https://ispace-us.com/apex-1-0-lunar-lander/>.
- [8] Jason Rainbow. "Europe Awards \$900 Million Contract for Argonaut Lunar Lander Development." *SpaceNews*, January 30, 2025. <https://spacenews.com/europe-awards-900-million-contract-for-argonaut-lunar-lander-development/>.
- [9] Jack Kuhr. "Blue Origin's 2025 Lunar Landing Goal." *Payload Space*, March 6, 2024. <https://payloadspace.com/blue-origins-2025-lunar-landing-goal/>.
- [10] Thales Alenia Space. "ESPRIT Module for Lunar Gateway Orbital Outpost Set for a Significant Upgrade." Press release, October 14, 2024. <https://www.thalesaleniaspace.com/en/press-releases/esprit-module-lunar-gateway-orbital-outpost-set-significant-upgrade>.
- [11] Mohammed Bin Rashid Space Centre. "Lunar Gateway." Mohammed Bin Rashid Space Centre. <https://www.mbrsc.ae/lunar-gateway/>.
- [12] European Space Agency (ESA). "Gateway: Lunar I-Hab." European Space Agency, [https://www.esa.int/Science\\_Exploration/Human\\_and\\_Robotic\\_Exploration/Gateway\\_Lunar\\_I-Hab](https://www.esa.int/Science_Exploration/Human_and_Robotic_Exploration/Gateway_Lunar_I-Hab).
- [13] Canadian Space Agency. "Canada Begins Detailed Design, Construction and Testing of Canadarm3 for Gateway." Government of Canada, June 27, 2024. <https://www.canada.ca/en/space-agency/news/2024/06/canada-begins-detailed-design-construction-and-testing-of-canadarm3-for-gateway.html>.
- [14] NASA, "Artemis Accords," <https://www.nasa.gov/artemis-accords/>.
- [15] China National Space Administration. "China and Russia sign a Memorandum of Understanding Regarding Cooperation for the Construction of the International Lunar Research Station." <https://www.cnsa.gov.cn/english/n6465652/n6465653/c6811380/content.html>.
- [16] Christian Davenport. "NASA Selects SpaceX to Build Lunar Lander." *The Washington Post*, April 16, 2021. <https://www.washingtonpost.com/technology/2021/04/16/nasa-lunar-lander-contract-spacex/>.
- [17] GeekWire. "Blue Origin's Blue Moon lunar lander is on deck to deliver NASA payload to the moon." March 11, 2025. <https://www.geekwire.com/2025/blue-origin-blue-moon-lunar-lander-nasa/>.
- [18] Thales Group. "Thales Alenia Space Partners in NextSTEP-2 Adventure to Support Human Spaceflight in the Vicinity of the Moon." December 14, 2017. <https://www.thalesgroup.com/en/worldwide/space/press-release/thales-alenia-space-partners-nextstep-2-adventure-support-human>.
- [19] Lockheed Martin. "Lockheed Martin Completes Orion Development for Artemis II Mission to the Moon." News release, May 1, 2025. <https://news.lockheedmartin.com/2025-05-01-Lockheed-Martin-Completes-Orion-Development-for-Artemis-II-Mission-to-the-Moon>.
- [20] Business Wire. "Lunar Outpost Announces \$12 Million Seed Investment to Scale Mobility Technology Enabling Commercial Lunar Advancement." *Business Wire*, May 24, 2022. <https://www.businesswire.com/news/home/20220524005399/en/Lunar-Outpost-Announces-%2412-Million-Seed-Investment-to-Scale-Mobility-Technology-Enabling-Commercial-Lunar-Advancement>.
- [21] Tim Fernholz. "Starpark Raises \$12M for Lunar Ice Mining." *Payload Space*, August 20, 2024. <https://payloadspace.com/starpark-raises-12m-for-lunar-ice-mining/>.
- [22] "11 Best Space Stocks To Invest In According To Hedge Funds." *Yahoo Finance*, November 4, 2022. <https://finance.yahoo.com/news/11-best-space-stocks-invest-164356086.html>.



# Hohmann Kline // UNITED STATES

Virgin Galactic



## Long-Term Impacts Require Sustainable Teams

*The views expressed in this article are solely those of the author and do not represent the views of their employer or other entities.*

As an aerospace engineer I have spent my career working on efficient access to space through highly technical topics [1,2] – in other words, trying to get satellites and people to space with a lower environmental impact. However, taking a step back, no technical or regulatory solution can impact the far future state of low Earth orbit (LEO), or other resources, without continuous, sustained effort from teams that span generations. For that reason, I will focus on three key elements of sustainable teams: building trust with new contributors, shared joy, and crew resource management.

Trust and connection are essential for any team's long-term success. For hard evidence, and an example of maintaining a shared resource, we can look to data available on open-source software development. Many people do not know that technology including the internet and satellite navigation rely on tools that are maintained by volunteer developers. In a study of the open-source ecosystem that drew from more than 45,000 projects [3], most share a common structure of a core team of trusted developers making high impact decisions, connections with other projects, and a regular influx of new members from a larger group of volunteer contributors. Interestingly, university rather than corporate sponsorship was correlated with long-term success – despite the associated high turnover. To move from a community contributor whose code changes are heavily vetted, to being part of the core group responsible for decision making, you must develop trust not only through consistently making high quality contributions, but also through socializing with that team.

Why do volunteers take part in these activities, despite no direct profit? I see answers in the similar way that trust and collaboration are built in wilderness rescue and in aviation. As with open-source development, even though sometimes money is involved, we do it for the joy that it brings us and the community we find. That joyful sense of connection is a powerful force also demonstrated by the overview effect [4] reported by astronauts returning newly motivated to take care of Earth after seeing it from space. I have seen the impact of joy everywhere, from the resilience of LGBTQ communities, to the volunteer teams that provide a safety net in remote wilderness, to the flying clubs where both hobbyists and future commercial pilots mix.

In addition to aviation providing examples of joy as a powerful motivator, collision avoidance in aviation is critically important and analogous to collision avoidance in LEO. The human factors best practices that have been shown through hard-earned data to reduce aircraft collisions are known as crew resource management

(CRM) [5]. Everyone available shares the workload and responsibility, leveling traditional power gradients in the cockpit and control room – contrary to the strict hierarchy that many might expect. This requires a deep trust in all members of your team and to honestly talk about and correct mistakes. These sorts of practices are sometimes missing from new space startups trying to reach LEO as quickly as possible and focusing more on competition than collaboration. Crew resource management, which relies heavily on open communication, leveled power gradients, mutual trust, and methodical decision making, should be considered in how we collaborate to reduce satellite collisions. This “slow is fast” approach might seem counterintuitive for scrappy startups. However, keep in mind that CRM was specifically developed for situations that require rapid reactions in competitive environments.

In conclusion, to keep the shared resource of LEO equitably accessible far into the future, we need more than just high competency and good decisions. We need communities that develop mutual trust and offer a path for new and unconventional contributors to join and sustain the joy in solving hard problems. I encourage those at a senior level in your career, or from a country with an established space program, to take the time to connect and socialize with those who are different from you, and look at them as the people who could take up the torch of the project that you are passionate about. For both those more established and those fighting for a place at the table, remember also that trust does not just happen from socializing and demonstrating competency, but also from being honest about who you really are and finding a common joy even when we are otherwise different from each other.

### References

1. Kline, H. L. The continuous adjoint method for multi-fidelity hypersonic inlet design. Diss. Stanford University, 2017.
2. Chang, Chau-Lyan, H.L. Kline, and Fei Li. “Wall cooling effect on high-enthalpy supersonic modes over a cone.” *AIAA Journal* 59.10 (2021): 3831-3844.
3. Valiev, Marat, Bogdan Vasilescu, and James Herbsleb. “Ecosystem-level determinants of sustained activity in open-source projects: A case study of the PyPI ecosystem.” Proceedings of the 2018 26th ACM Joint Meeting on European Software Engineering Conference and Symposium on the Foundations of Software Engineering. 2018.
4. Yaden, David B., et al. “The overview effect: Awe and self-transcendent experience in space flight.” *Psychology of Consciousness: Theory, Research, and Practice* 3.1 (2016)
5. Kanki, Barbara G., José Anca, and Thomas R. Chidester, eds. *Crew resource management*. Academic Press, 2019.

# Charles-Aime Nzeussi Mbouendeu // CAMEROON

SES Satellites



## Space Sustainability and Inequality

Throughout human history, inequality has been a defining challenge; its persistence rooted not only in economic systems but also in access to resources, opportunity, and resilience. Now, as humanity reaches beyond Earth, we must ask: Are we repeating the same patterns of exclusion in space?

*Let's step back a little bit! In the village of Bafoussam, west of Cameroon, I remember a mother named Clarisse wept as she recounted how a landslide buried her home in the night; taking with it her three children, their laughter, and the only future she had ever known.*

The Global South has long borne the brunt of crises it did not create. From colonial exploitation to the disproportionate impacts of climate change, countries with the least historical responsibility have faced the most severe consequences. This same dynamic is now at risk of unfolding in space. As nations and private companies race to occupy orbits and exploit space-based resources, developing countries could again find themselves sidelined.

Space sustainability, the practice of using space in a way that preserves its long-term usability, is quickly becoming a critical global concern. Without inclusive governance, mounting space debris, unequal access to orbital slots and frequencies, and the unchecked commercialization of space resources could render key orbits unusable, limit future innovation, and deepen global inequality in access to space.

There is a stark lesson to be learned from how the world has handled climate change. According to the United Nations Framework Convention on Climate Change, the world's poorest and least industrialized nations are the most vulnerable to climate impacts, despite having contributed the least to greenhouse gas emissions.

Consider these examples:

- In 2023, Storm Daniel killed over 11,000 people in Libya following catastrophic dam failures ([The Guardian, 2023](#)).
- Cyclone Nargis in Myanmar (2008) caused over 22,500 deaths, one of the deadliest tropical cyclones ever recorded ([UN OCHA, 2008](#)).
- The 2010–2012 famine in Somalia killed an estimated 258,000 people, half of them children under five, due to drought exacerbated by climate change ([FAO, 2013](#)).

In contrast, the entire African continent accounts for less than 4% of global carbon emissions, while housing almost 20% of the world's population ([IEA, 2023](#)). Meanwhile, China and the United States alone contribute over 44% of total emissions combined ([Global Carbon Project, 2022](#)).

This imbalance is not just unjust, it is dangerous. And if left unaddressed, space sustainability could become the next chapter of this same inequality.

Space technology is increasingly essential for addressing global challenges. Earth observation satellites provide critical data for:

- Disaster monitoring and response
- Precision agriculture and food security
- Water resource management
- Climate modeling and mitigation planning

For many developing countries, space is not about prestige; it is about survival and resilience. Yet most nations lack the infrastructure, funding, and regulatory leverage to access space-based solutions or participate in international policy discussions.

A recent report by the World Economic Forum highlights how fewer than 20 countries have full launch capabilities, and space traffic governance is still largely dominated by powerful spacefaring states ([WEF, 2025](#)).

To be fair, spacefaring nations have legitimate concerns about protecting intellectual property and ensuring returns on costly missions. Without safeguards, they risk losing competitive advantages. But overly strict protections can hinder collaboration and slow progress. A balanced approach, like shared research frameworks or limited IP pools, can protect innovation while promoting global cooperation.

As the world looks upward, we must ensure that the benefits of space are shared equitably, not hoarded by a handful of powerful actors. True space sustainability demands:

- Open access to data and technology for all nations.
- Inclusive policymaking, involving the Global South in regulatory discussions.
- South-South and North-South cooperation, enabling mutual benefit and knowledge exchange.
- Public-private partnerships that center ethics, sustainability, and accessibility.

[Continued on next page](#)

International cooperation mechanisms such as UNOOSA, ITU, and COPUOS should be strengthened and expanded to include greater representation from emerging space nations. The Artemis Accords, while a step toward transparency, must be balanced with inclusive governance under the Outer Space Treaty of 1967, which declares space the “province of all mankind.”

We need a multidisciplinary, international, and intercultural approach to space. Whether managing debris in low Earth orbit, assigning satellite frequencies, or addressing the reentry impact of small satellites, every decision must account for the long-term equity and accessibility of space.

The space economy is projected to reach \$1 trillion by 2040 ([Morgan Stanley, 2022](#)), but without inclusive frameworks, its wealth and benefits may bypass those who need them most.

The stakes are clear: if we fail to act, we risk repeating Earth’s mistakes; this time in orbit.

Space is more than a domain of exploration; it is a mirror of our values. In its vastness lies a test of our collective will to act justly, inclusively, and wisely.

If space becomes another realm where inequality thrives, then we will have failed not only the future, but also the present.

To harness space science for the public good, coordinated action is vital. Governments should promote open data policies and international collaboration through platforms like COPUOS or the Group on Earth Observations. Research institutions can lead interdisciplinary projects that apply satellite data to climate resilience, disaster response, and sustainable development.

Industry can prioritize technologies with broad societal impact, from precision agriculture to environmental monitoring. And citizens can support science-based policymaking and engage through educational and citizen science platforms. Space must serve people, especially in the face of global challenges.

Let us instead choose a path of solidarity, vision, and shared stewardship.

Let us ensure that space remains a resource for all humanity, not just the few. And let us take the next step, through inclusive dialogue, equitable investment, and meaningful global cooperation, to make that vision real.

Because only together can we build a truly sustainable future, on Earth and beyond.





## Not Debris, But Dormant: Reimagining Zombie Satellites at Sustainable Assets

In the traditional “build-use-discard” model of space operations, satellites are built, launched, and ultimately discarded once their primary missions end. As of late 2024, over 3000 satellites are defunct, unresponsive, and labelled as “zombie satellites” [1] [2]. They are tracked, often dismissed as hazardous debris to be avoided or deorbited. But this narrative is deeply flawed. These satellites are not junk – they are dormant assets, built with immense human effort, invaluable materials from Earth and enormous cost, many of which still hold structural integrity, operational subsystems, and untapped potential. What we now dismiss as orbital waste can and must be reimagined as infrastructure waiting for a second life. As a systems engineer, I’ve come to see satellites not just as machines, but as the outcome of years of human effort, collaboration, and precision – abandoning them at end-of-life feels like walking away from unfinished potential. Embracing this perspective is not just a technical adjustment; it marks a strategic shift toward a sustainable, circular space economy.

Circular space economy represents a paradigm shift for sustainable space development, drawing on the same “reduce-reuse-recycle” principles gaining traction on Earth. This model emphasizes that waste is designed out of the system – satellites are built from the start with the end of their life in mind, ready to be refuelled, repaired, or even cannibalized for parts instead of simply abandoned. “Circularity” in this context means planning a satellite’s entire lifecycle so that its components can be reused or recycled when its initial job is done. This stands in stark contrast to the status quo, where virtually every satellite becomes debris once its mission concludes. Today, when a mission ends, we treat the satellite itself as expendable – new satellites are built from scratch with new materials, and the old hardware is often consigned to a graveyard orbit or left to burn up in the atmosphere. It’s a tremendous waste, akin to junking an entire car just because the road trip is over. By rethinking satellites as infrastructure rather than one-off consumables, the space industry can extend the utility of orbital assets and drastically cut down on waste.

The benefits of extending or repurposing zombie satellites go far beyond the spacecraft themselves. Squeezing more out of what’s already in orbit means we don’t have to keep launching replacements, and that eases the environmental toll of space activity. In recent years, with advancements in reusable launch vehicle technology, the launch cost has

been drastically reduced. But does that justify rushing into frenzy of launching thousands of spacecrafts without being conscious about the materials we extract from Earth and the impact on Earth environment? Each rocket launch emits a cocktail of greenhouse gases and particulates, such as carbon dioxide, soot, and alumina, that have damaging effects on our atmosphere and climate [3]. And deliberately deorbiting satellites at end-of-life (or allowing uncontrolled reentries) can release harmful materials into the air that pose risks to people on the ground. Reusing what we already have in orbit helps mitigate these impacts. If an aging satellite can be revived, we avoid the need to build and launch a brand-new replacement, preventing the additional rocket emission and resource consumption that a new mission would entail. Repurposing zombie satellite is not just a engineering strategy. It is a necessary act of stewardship.

Critics will argue that repurposing satellites is prohibitively complex. Yes, it is complex, so was launching humans to the moon. Yet we accomplished that with grace and determination. Salvaging a zombie satellite requires coordination, autonomy, precision rendezvous (precise orbital meeting of two spacecraft) and software archaeology, critics are not wrong. But skeptics who doubted reusability of rocket boosters or the repair a telescope in space have been proven wrong. The Hubble Space Telescope, which celebrated its 35th anniversary in April 2025, was repaired and upgraded five times by astronauts, not just surviving but thriving beyond its expected lifespan, which no one anticipated in 1990s. More recently, the private sector has shown the potential of on-orbit life extension for satellites that were never intended to be serviced. In 2020, Northrop Grumman’s Mission Extension Vehicle (MEV-1) autonomously rendezvoused with an almost-expired communications satellite, Intelsat-901, and docked to it. The MEV then assumed control of orientation and propulsion for the client satellite, effectively giving an otherwise derelict spacecraft five additional years of functional life [4]. These legacy systems with extended life prove that aging satellites can be transformed from liabilities back into working assets.

Today, repurposing zombie satellites isn’t a standard practice – it is still an exception. This calls for changes in design philosophy, business models, and policy. Government, agencies, and private industries must reward reuse, mandate end-of-life options, and invest in infrastructure circularity:

Continued on next page

autonomous servicing vehicles, swapping batteries, refuel tanks, and software versioning standards. There are encouraging signs – the European Space Agency has declared a goal of achieving zero debris in orbit by 2030 and is actively championing in-orbit servicing as main pillar of future circular space ecosystem [5]. With all the support from stakeholders we can build a robust space economy that treats obsolete satellites as an opportunity rather than a nuisance.

Reimagining aging satellites as valuable assets aligns perfectly with the broader pursuit of sustainable development on Earth and beyond. The space sector can no longer afford the “build-use-discard” mindset, especially as it becomes increasingly intertwined with environmental accountability. Embracing satellite repurposing and life extension is an enlightened form of environmental stewardship, one that reduces waste, conserves resources, and protects the orbital commons for future generations. If we change the frame, we change the future. We must begin to see zombie satellites not as relics, but as anchors of a new kind of thinking – one that prizes resilience over replacement, adaptability over abandonment. Their very name is misleading. A zombie is lifeless. But these satellites are not dead – they are dormant, waiting for us to wake them with ingenuity, policy, and purpose.

## References

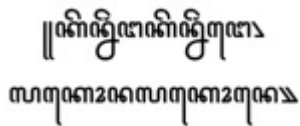
- [1] Kat Bauman, “So This Is a Thing: Zombie Satellites”, in Tech, June 30, 2014, <https://www.core77.com/posts/27196/So-This-Is-a-Thing-Zombie-Satellites>
- [2] García, M. (2024, December 23). “Space debris: A growing challenge from old satellites. Global Society Earth”. <https://www.globalsociety.earth/post/space-debris-a-growing-challenge-from-old-satellites>
- [3] Weiss, B. M. (2025). “Toward a Circular Economy in Space: The Role of Satellite Reuse”, Luleå University of Technology. DiVA Portal. <https://ltu.divaportal.org/smash/get/diva2:1921157/FULLTEXT01.pdf>
- [4] Intelsat, “Intelsat Completes Satellite Life-Extension Mission, Makes Space History”, Press Release, 9 April 2025.
- [5] European Space Agency – Clean Space Initiative, “Recycling in space: wannabe or reality?”, ESA Clean Space Blog, 10 January 2022. (ESA’s plans for debris-neutral orbits and in-orbit reuse by 2050)

# Farah Diya Yasmine // INDONESIA

Secretariat General for the House of Representative of the Republic of Indonesia



## Environmental Interpretation from an Indigenous Madurese: A Proposal to Implement Long-Term Sustainability as a Legal Principle in Responsible Space Activities



"Kennengnga kennengngè, lakona lakonè"

"In every corner, in every responsibility".

-Famous Madurese proverbs-

While it is traditional and general, the aforementioned proverb reaffirms that when space belongs to everyone, regardless of their coordinate points and capabilities, responsibilities are attached to those who own it. Both leading and emerging space nations are entitled to utilize space and take responsibility for it. The establishment of the Guidelines for the Long-Term Sustainability of Outer Space Activities of the Committee on the Peaceful Uses of Outer Space (hereinafter the LTS Guidelines) serves to accommodate those efforts as a voluntary implementation and as a premise to safeguard the space environment, ensuring equitable access for present and future generations [1].

Although the LTS Guidelines address the harmonization of long-term sustainability in outer space activities with national regulatory frameworks, they serve as a non-binding instrument [2]. In this context, a legal approach could help facilitate the activities of countries by incorporating long-term sustainability as a legal principle to establish a legal foundation in their law-making processes and the enforcement of countries' responsibilities (and liability).

Therefore, this proposal advocates for implementing long-term sustainability as a legal principle to benefit global communities. It requires adopting diverse perspectives from various communities, including indigenous ones, to achieve equal and mutual understanding during the implementation. The author presents an interpretation based on her identity as an Indigenous Madurese, highlighting the potential for implementing long-term sustainability as a principle. Hence, to initiate the discussions, it is essential to understand the Madurese values regarding the environment.

### A Glimpse at the Madurese and Their Environmental Values

In English, the word "Madurese" has two definitions. First, it portrays Oréng Mâdhurâ, the third-largest ethnicity in Indonesia, which inhabits Madura Island in Jawa Timur province, spreading

into four regencies: Bangkalan, Sampang, Pamekasan, and Sumenep [3]. Second, it refers to Bhâsa Madhurâ, the Indigenous language of the people [4].

Oréng Mâdhurâ loves to explore other islands [5], encompassing overseas countries. The proverb, "Kennengnga kennengngè, lakona lakonè," becomes a reminder for the Madurese to always do their best in fulfilling their responsibility wherever they belong, as part of Allah's creation, as part of humanity, and as part of the community.

In environmental aspects, the Indigenous Madurese prioritize natural tools for producing and presenting traditional foods. For example, sellers use banana leaves for both the plate and the spoon in Tajin Sobih (a sweet porridge from Bangkalan) [6] or Rojha' Mâdhurâ (a salad) [7].

According to historical and cultural records, most local activities are linked to the natural environment, especially water and astronomy. Sailors and fishermen are among the most common occupations\* [8] [9], utilizing celestial bodies for navigation, weather, and tide time prediction that proves the people have strong ethnoastronomy lore for daily practices, and even the celestial objects have their own Madurese names [10]. More than just a money machine, Oréng Mâdhurâ once used environmentally friendly traditional boats, called parao or janggolan and lis-alis, for daily transportation when numerous canals functioned back then [11].

The Madurese environmental preservation effort covers cultural performances, such as Nyello' Aeng, a dance from Bangkalan by Raden Usmajanti [12]. The movement demonstrates proper water fetching by the female Madurese to achieve a clean and clear water source [13].

As shown above, the Indigenous Madurese possess strong local wisdom and values of environmental preservation by absorbing those into culture, habits, and daily activities. How can these practices support the implementation of long-term sustainability as a principle in responsible space exploration?

### A Proposal: Understanding Long-Term Sustainability as a Legal Principle in Responsible Space Exploration

The author's previous work, along with the Global Expert Group on Sustainable Lunar Activities, examines long-term sustainability adoption as a principle to support humankind's activities in the lunar environment [14] [15]. The adoption aims to support the existing technical practices and non-binding long-term sustainability guidelines [16], wherein the principle

Continued on next page



serves as a basis in the substance aspect for producing legally enforceable documents.

The principle refers to the 'legal principle' as the source of international law, according to Article 38 of the Statute of the International Court of Justice [17]. The currently available principle in international space law, the common heritage of humankind and/or province of all humankind, states that the exploration and use of outer space, the moon, and other celestial bodies belong to all humanity. Despite the principle leaving multiple interpretations and having a stagnant stance [18, discussed in the author's undergraduate thesis], there is a central question of when those belong to all humanity, and then who will be responsible for their actions in outer space?

Therefore, long-term sustainability will act as a complementary principle of the common heritage of humankind [19]. Besides being the foundation of all countries in the preservation and responsibility of the space environment, it applies a progressive legal development or an adaptive legal framework in responding to rapid changes as occurred in the space sector. As a legal principle, long-term sustainability will present a legal reason in the law-making process for both national and international spheres, producing more binding instruments and providing substantive implications (legal basis) in pre-, during-, and post-operation [20]. The binding effect after the law's establishment will ensure harmonization and synchronization for hierarchical and parallel regulations to guarantee responsible space activities [21].

Another consideration to transform long-term sustainability as a principle aims to acknowledge the diverse and different capabilities of each country and nation and reaffirm that space for all is not just a tagline but everyone's right, obligation, and responsibility. To achieve the goals for global yet diverse communities, mutual and equal understanding is essential to gain respect and ensure feasibility. Especially when it comes to a principle, it should be straightforward to follow without coercion, as applies in natural law, and this type of equilibrium usually happens in Indigenous communities. Accordingly, as part of the Indigenous community, how would Madurese's traditional local values support long-term sustainability as a legal principle?

### **Absorbing Indigenous Madurese Traditional Local Values in Long-Term Sustainability Principles**

In regard to involving Indigenous people's voices to boost space for all efforts, decisions, and achievements, observing local values, such as those from the Indigenous Madurese, would unlock more locally based opportunities and relevancy during the implementation. The core idea is to absorb the local values in the future long-term sustainability principle, other space law principles, and binding instruments. It posits space activities and the laws, including environmental preservation, as part of (aligning with) their custom and culture, making them easier to follow, without any feeling of compulsion, even when adapting to novel approaches. At the same time, it would expose the

Indigenous perspective on the global stage, ensuring that their voice does matter.

Absorbing local values is also a means to collaborate with the Indigenous community. When the space mission aligns with the community, it will lead to supportive "glocal" (global and local) collaboration in promoting the long-term sustainability operation through traditions, such as ceremonies (including annual space-related celebrations), dances, and songs (with native languages). The absorption includes translating international space instruments into the Indigenous language and opening more native speaker-related vacancies or contributions. It will present reciprocal benefits from preserving Indigenous identity and solving massive local challenges, including clean water and sanitation, as happens annually on Madura Island [22] by utilizing remote sensing satellites for land and water body monitoring.

In alignment with Madurese culture in using natural materials, space agencies and developers shall consider selecting natural and environmentally friendly modification materials in space missions. For example, JAXA deployed the first wooden satellite in the world, called LignoSat, utilizing the traditional Japanese wooden joining method (the blind miter dovetail join) [23]. This initiative aims to reduce space junk for the long-term period, one of the main objectives of the establishment of LTS Guidelines [24].

From this proposal, "Kennengnga kennengngè, lakona lakonè" fits everyone and every corner, including outer space. Absorbing local values will provide reciprocal benefits for implementing long-term sustainability as a legal principle, achieving responsible space activities, as expected. However, the adoption of Indigenous values should not be defined as over-formalization and as an attempt to harmonize Indigenous customs in international space law. Fortunately, the current digitalization era offers transparent progress and information that enables the public to monitor and react to the dissonance from the objectives. In addition, a well-prepared road map and facilitation are core to achieving the goals, namely, responsible space activities that reflect diversity, equality, and mutual understanding.

To accommodate the execution, as the main actor, the United Nations Committee on the Peaceful Uses of Outer Space shall: 1) leverage in-person discussion with space related-Indigenous experts and the Working Group on the Long-term Sustainability of Outer Space Activities through its Scientific and Technical Subcommittee, 2) negotiate and draft the long-term sustainability principle through its Legal Subcommittee, and 3) after the United Nations General Assembly adopts the principle, engage the United Nations Office for Outer Space Affairs to facilitate a collaborative effort among Indigenous communities by adding an exclusive platform (which should be distinct from current portals on space law and Space4Water-Indigenous Voice) in demonstrating long-term sustainability through traditional performance and glocal opportunities, such as research incentives, including providing an annual space forum for the Indigenous speakers, writers, and translators.

## References

- [1] United Nations (UN). (2021). Guidelines for the Long-term Sustainability of Outer Space Activities of the Committee on the Peaceful Uses of Outer Space (Adopted in 2019, A/74/20). [https://spacesustainability.unoosa.org/content/the\\_guidelines](https://spacesustainability.unoosa.org/content/the_guidelines).
- [2] United Nations (UN). (2021). Guidelines for the Long-term Sustainability of Outer Space Activities of the Committee on the Peaceful Uses of Outer Space (Adopted in 2019, A/74/20). [https://spacesustainability.unoosa.org/content/the\\_guidelines](https://spacesustainability.unoosa.org/content/the_guidelines).
- [3] 'MADURESE definition and meaning | Collins English Dictionary' (2025) Collins Dictionaries. <https://www.collinsdictionary.com/dictionary/english/madurese>.
- [4] 'MADURESE definition and meaning | Collins English Dictionary' (2025) Collins Dictionaries. <https://www.collinsdictionary.com/dictionary/english/madurese>.
- [5] Wekke, I.S., Ladiqi, S. and Bustami, R. (2019) 'BUGIS AND MADURA MIGRATION IN NUSANTARA: Religiosity, Harmony, and Identity from Eastern Indonesia,' *ULUL ALBAB Jurnal Studi Islam*, 20(1), pp. 1–24. <https://doi.org/10.18860/ua.v20i1.4902>.
- [6] Sajian legit Gurih Tajin Sobih - Indonesia Kaya (2025). <https://indonesiakaya.com/pustaka-indonesia/sajian-legit-gurih-tajin-sobih/>.
- [7] RUJAK MADURA DENGAN PETIS KHASNYA YANG UNIK - Sarihusada (2013). <https://www.sarihusada.co.id/Nutrisi-Untuk-Bangsa/Kesehatan/Umum/RUJAK-MADURA-DENGAN-PETIS-KHASNYA-YANG-UNIK>.
- [8] Project, J. (no date) Madura in Indonesia. [https://joshuaproject.net/people\\_groups/13199/id](https://joshuaproject.net/people_groups/13199/id).
- [9] Wekke, I.S., Ladiqi, S. and Bustami, R. (2019) 'BUGIS AND MADURA MIGRATION IN NUSANTARA: Religiosity, Harmony, and Identity from Eastern Indonesia,' *ULUL ALBAB Jurnal Studi Islam*, 20(1), pp. 1–24. <https://doi.org/10.18860/ua.v20i1.4902>.
- [10] Fatima, S., Orchiston, W. and Hidayat, T. (2021) 'Ethnoastronomy in Madura, Indonesia: Observations of the night sky and eclipses,' in *Historical & cultural astronomy*, pp. 565–587. [https://doi.org/10.1007/978-3-030-62777-5\\_19](https://doi.org/10.1007/978-3-030-62777-5_19).
- [11] Eliot, J., et al. (1993) *Indonesia, Malaysia & Singapore Handbook*. Second Edition. Trade and Travel Publications Limited: England. p. 657.
- [12] Sulalah, A., Kuswandi, I. and Ar, M.M. (2024) 'Strengthening the character of the love of the motherland through the of the Nyello 'Aeng dance at the Sanggar Bimbingan Jalan Kebun Selangor Malaysia,' *Electronic Journal of Education Social Economics and Technology*, 5(2), pp. 438–444. <https://doi.org/10.33122/ejeset.v5i2.288>.
- [13] Sulalah, A., Kuswandi, I. and Ar, M.M. (2024) 'Strengthening the character of the love of the motherland through the of the Nyello 'Aeng dance at the Sanggar Bimbingan Jalan Kebun Selangor Malaysia,' *Electronic Journal of Education Social Economics and Technology*, 5(2), pp. 438–444. <https://doi.org/10.33122/ejeset.v5i2.288>.
- [14] Carvalho, F. A. de, Yasmine, F. D., & Silva, E. (2024). Long-Term Sustainability: Lunar Environmental Protection in Renewable International Environmental Law and Space Law perspectives, International Astronautical Congress. International Astronautical Federation: Milan. <https://iafastro.directory/iaac/paper/id/85709/summary/>.
- [15] The United Nations Office for the Outer Space Affairs (2024) A/AC.105/C.1/2024/CRP.11 - Reports of the Moon Village Association. [https://www.unoosa.org/oosa/en/oosadoc/data/documents/2024/aac.105c.12024crp/aac.105c.12024crp.11\\_0.html](https://www.unoosa.org/oosa/en/oosadoc/data/documents/2024/aac.105c.12024crp/aac.105c.12024crp.11_0.html).
- [16] United Nations (UN). (2021). Guidelines for the Long-term Sustainability of Outer Space Activities of the Committee on the Peaceful Uses of Outer Space (Adopted in 2019, A/74/20). [https://spacesustainability.unoosa.org/content/the\\_guidelines](https://spacesustainability.unoosa.org/content/the_guidelines).
- [17] Statute of the Court of Justice | INTERNATIONAL COURT OF JUSTICE (no date). <https://www.icj-cij.org/statute>.
- [18] Yasmine, F.D. (2021). Pemanfaatan Sumber Daya Alam di Bulan oleh Negara-Negara (The Utilization of Natural Resources of the Moon by Countries). Thesis. Bangkalan: Fakultas Hukum Universitas Trunojoyo Madura.
- [19] Carvalho, F. A. de, Yasmine, F. D., & Silva, E. (2024). Long-Term Sustainability: Lunar Environmental Protection in Renewable International Environmental Law and Space Law perspectives, International Astronautical Congress. International Astronautical Federation: Milan. <https://iafastro.directory/iaac/paper/id/85709/summary/>.
- [20] Carvalho, F. A. de, Yasmine, F. D., & Silva, E. (2024). Long-Term Sustainability: Lunar Environmental Protection in Renewable International Environmental Law and Space Law perspectives, International Astronautical Congress. International Astronautical Federation: Milan. <https://iafastro.directory/iaac/paper/id/85709/summary/>.
- [21] Carvalho, F. A. de, Yasmine, F. D., & Silva, E. (2024). Long-Term Sustainability: Lunar Environmental Protection in Renewable International Environmental Law and Space Law perspectives, International Astronautical Congress. International Astronautical Federation: Milan. <https://iafastro.directory/iaac/paper/id/85709/summary/>.
- [22] Martha, A.W. and Zain, I. (2019) 'The clustering of households in Madura based on factors affecting their ingestion of clean water using similarity weight and filter method,' *Inferensi*, 2(1), p. 45. <https://doi.org/10.12962/j27213862.v2i1.6813>.
- [23] JAXA's First Wooden Satellite Deploys from Space Station - NASA (2025). <https://www.nasa.gov/image-article/jaxas-first-wooden-satellite-deploys-from-space-station/>.
- [24] United Nations (UN). (2021). Guidelines for the Long-term Sustainability of Outer Space Activities of the Committee on the Peaceful Uses of Outer Space (Adopted in 2019, A/74/20). [https://spacesustainability.unoosa.org/content/the\\_guidelines](https://spacesustainability.unoosa.org/content/the_guidelines).



The 2025 cohort of the Diverse Dozen are influential thinkers and emerging leaders from around the globe. Led by Moriba Jah from Privateer Space and the University of Texas at Austin, these authors are also the featured speakers in a series of rapid-fire lightning talks that highlight the most important issues surrounding space safety, security, and sustainability. What needs to happen for space to be more transparent, more predictable, and to have a globally accessible pool of evidence to help people make decisions and hold them accountable for their behaviors in this shared domain?

Find out by attending their ASCEND session.

[www.ascend.events](http://www.ascend.events)



**Moriba Jah** is the Chief Scientist and a co-founder of Privateer. Privateer is a data and intelligence platform empowering the future of space sustainability. As a renowned space environmentalist and astrodynamist, Moriba brings a wealth of knowledge and expertise in space object detection, tracking, identification, and characterization, as well as spacecraft navigation to the Privateer team, where he is developing the first highly accurate space traffic map that aggregates multi-source data on Earth orbiting space objects, as a means to power the new space economy and make space exploration safe and sustainable. He is also an associate professor of Aerospace Engineering and Engineering Mechanics at the University of Texas at Austin where he is the holder of the Mrs. Pearlie Dashiell Henderson Centennial Fellowship in Engineering. At the University of Texas at Austin, he has worked with a team to develop ASTRIAGraph, an award-winning near real-time map of where objects are predicted to be located in space.

**Marcelo German Boldt** // ARGENTINA  
Polaris Spaceplanes GmbH

**Eden Abeselom Habteslasie** // ETHIOPIA  
Space Science and Geospatial Institute

**Oluwarantimi Bukola** // NIGERIA  
Vortyx Space

**Fay Ghani** // NEW ZEALAND  
Center for Regenerative Biotherapeutics

**Adeife Ayomide Jide-Omole** // NIGERIA  
International Aviation Law

**Antonio (KangSan Kim) Stark** // SOUTH KOREA  
iSpace, Inc.

**Hohmann Kline** // UNITED STATES  
Virgin Galactic

**Charles-Aime Nzeussi Mbouendeu** // CAMEROON  
SES Satellites

**Rashika Sugganahalli Natesh Babu** // INDIA  
Stevens Institute of Technology

**Farah Diya Yasmine** // INDONESIA  
House of Representatives, Republic of Indonesia