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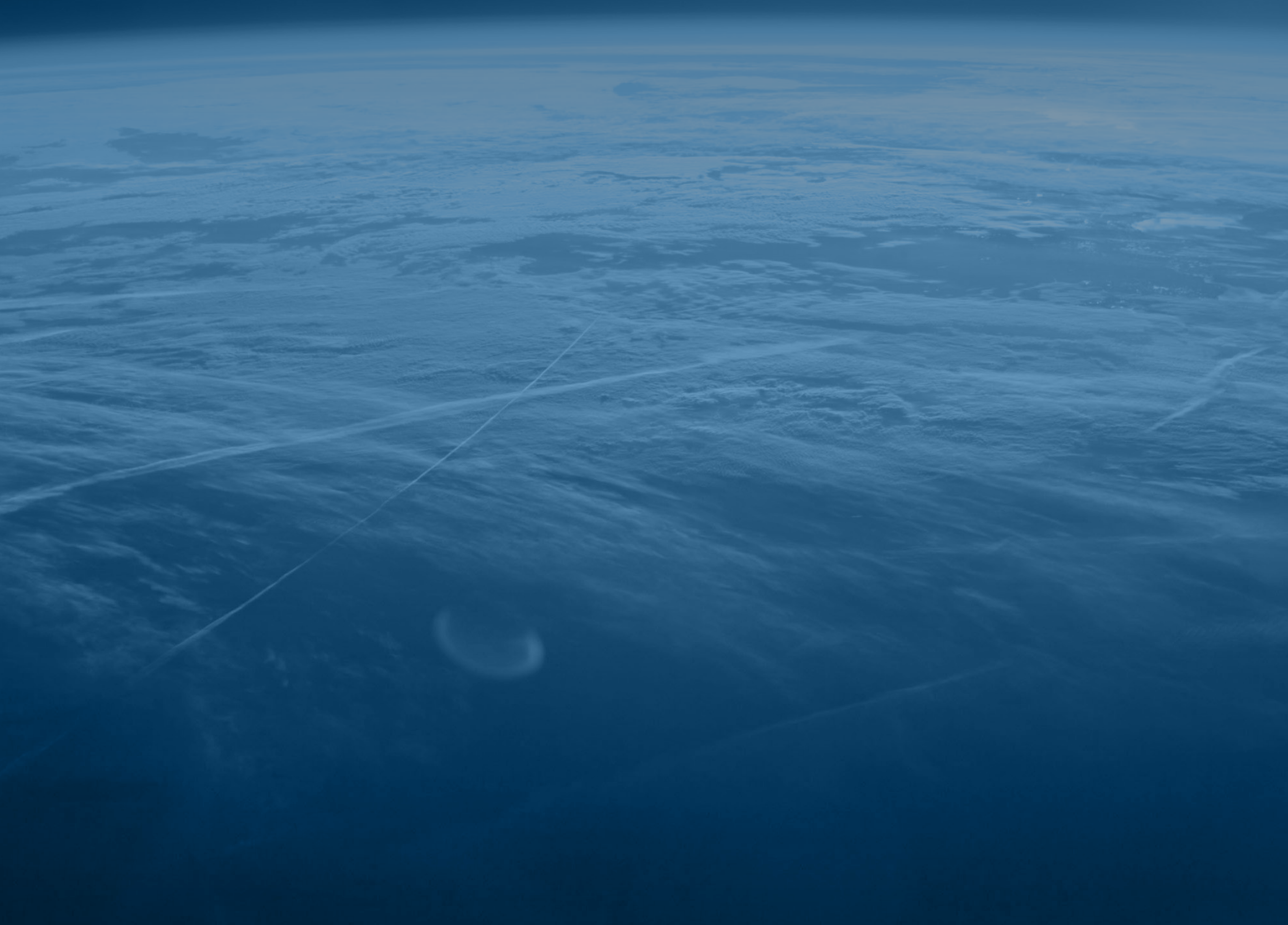
Space Sustainability

Peter Martinez



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About Secure World Foundation

The Secure World Foundation strives to be a trusted and objective source of leadership and information on space security, sustainability, and the use of space for the benefit of Earth. We use a global and pragmatic lens to study and evaluate proposed solutions to improve the governance of outer space. While recognizing the complexities of the international political environment, SWF works to encourage and build relationships with all willing stakeholders in space activities, including government, commercial, military, civil society, and academic actors. Central to this approach is increasing knowledge about the space environment and the need to maintain its stability, promoting international cooperation and dialogue, and helping all space actors realize the benefits that space technologies and capabilities can provide.

About Dr. Peter Martinez

Peter Martinez is the Executive Director of the Secure World Foundation. He has extensive experience in multilateral space diplomacy, space policy formulation, and space regulation, as well as capacity building in space science, technology, and workforce development. Before joining the Secure World Foundation, he chaired the UN COPUOS Working Group on the Long-Term Sustainability of Outer Space Activities and the South African Council for Space Affairs.

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Space Sustainability

Peter Martinez*
* Executive Director, Secure World Foundation
Former Chair, Working Group on the Long-Term Sustainability of Outer Space Activities of the United Nations Committee on the Peaceful Uses of Outer Space

Abstract (148 words)

The Earth's limited orbital environment is becoming increasingly congested with active satellites, contaminated with orbital debris, and contested by a growing number of governmental, military, and commercial space actors. This has raised concerns about the long-term sustainability of outer space activities that parallels the way in which concerns over environmental degradation later gave rise to the broader concept of sustainable development on Earth. This article traces the development of the concept of space sustainability from the early 2000s and its connection with terrestrial sustainability. The article unpacks space sustainability into its constituent and inter-related dimensions of space governance, orbital congestion, space security, and international cooperation and competition. It then reviews the role of the United Nations in elaborating the concept of space sustainability and describes a set of 21 international guidelines ('LTS Guidelines') adopted by the United Nations in 2019 to promote the sustainable use of outer space.

Keywords: space sustainability, space security, sustainable development

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Main entry text (2495 words, including all headings, table text and references)

I Introduction

The English word *sustainability* is derived from the Latin verb *sustinere* (*tenere*, 'to hold'; *sus*, 'up') and refers to the ability to maintain an activity at a certain rate or level. Since the 1970s, the concept of sustainability has been applied to human development and the equitable utilisation of the Earth's ecosystems and its natural resources. This has given rise to the widely used term *sustainable development*, which was defined in the 1987 report of the United Nations' World

Commission on Environment and Development titled *Our Common Future*, as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs'. The association of the concept of *sustainability* with *outer space activities* is much more recent and dates from the mid-2000s with the growing realization that the Earth's orbital environment and the electromagnetic spectrum are limited natural resources that are under increasing pressure from a steady increase in the number of commercial space actors, the rapid (and accelerating) increase in the number of space objects in orbit, and the emergence of new types of space activities in orbit. This realization has brought about a paradigm shift in the way that the Earth's space environment is now seen as a shared domain that must be used with due regard for other users, both currently as well as in the future. Simply put, *space sustainability* is about ensuring that humanity can continue to use space for peaceful purposes and socioeconomic benefits in the long term.

II Sustainability in the Context of Space Activities

In the early days of the Space Age, the main space actors were the United States and the former Soviet Union. In the 1970s and 1980s, more countries became space-faring nations, but the pace of development was gradual, with only a dozen or so satellites being launched each year. Most space activities were still carried out by governments. By the 1990s, the commercial sector began to emerge as a significant group of space actors, although this was limited to a small number of companies. Then, in the early 2000s, academic institutions started to develop CubeSats, very small satellites based on multiples of a standardized unit of mass and volume of 10x10x10 cm^3 that was later to become widely adopted as a de facto standard for very small satellites. Since the mid-2000s, the advent of commercially available, mass-produced space technologies has lowered the financial and technological entry barriers to space activities, allowing many more non-State entities to become space actors. This has led to tremendous growth of the commercial space industry, especially from 2010 onwards.

All these satellites launched into space have provided many undeniable benefits to humanity, to the extent that most nations are now critically reliant on space systems for their national prosperity and security. Space systems are also critical enablers for monitoring and mitigating the effects of climate change and for achieving the UN Sustainable Development Goals. However, the growing reliance on space systems has led to a proliferation of satellites. As of December 2022, there were some 6800 active satellites in Earth orbit and a much larger number of non-functional space objects such as defunct satellites and spent rocket upper stages, as well as countless fragments of these legacy space objects, which are collectively referred to as *space debris*. Space objects in orbit are tracked by several countries using optical telescopes and radars. According to the European Space Agency, as of December 2022, there were approximately 32,500 of these debris objects that were catalogued and tracked, and a much larger estimated number of uncatalogued fragments (perhaps as many as 1 million) ranging in size between 1-10 cm that are too small to track. Fragments smaller than 1 cm may number in the tens of millions. Because orbital velocities can be as high as nearly 8 km per second, these debris objects pose a collision hazard to active satellites and human spaceflight. Collisions in orbit can generate thousands of additional debris fragments, thus raising the risk of collisions even further.

On 10 February 2009, an inactive Russian communications satellite, Cosmos 2251, collided with an active US commercial communications satellite, Iridium 33. The collision occurred at an altitude of 781 km producing a cloud of debris with over 1800 fragments 10cm or larger, and many thousands of smaller pieces. As of December 2022, there were still nearly 800 pieces of trackable debris from that collision in orbit that pose a collision risk to other space objects.

Atmospheric drag causes debris fragments to re-enter over time, but this is a slow process that can take years to decades, or longer, depending on the orbital altitude. Unchecked debris growth could eventually lead to a cascade of debris-on-debris collisions that would generate new debris at a rate faster than atmospheric drag could remove these objects. This collisional cascading effect is known as the Kessler Syndrome and the avoidance of such a scenario is one of the objectives of efforts to promote sustainable space activities.

III The Dimensions of Space Sustainability

Space sustainability dialogues started with concerns posed by orbital debris for the safety of spaceflight in the same way that the early sustainable development dialogue in the 1960s and 70s was shaped by environmentalists' concerns about the Earth's ability to absorb the impact of human activities and to sustain life. However, just as sustainable development is now understood to be much broader in scope than the physical environment, so too is space sustainability broader in scope than the space debris issue. Space sustainability comprises the following inter-connected dimensions:

Space governance – Space is a shared domain that must be used responsibly and with due regard for other users. According to international space law, States bear international responsibility for the space activities of entities under their jurisdiction. States have a custodial duty to implement and enforce national regulatory frameworks to ensure that the space activities of their national governmental and commercial entities comply with their obligations under international law to ensure the maintenance of a rules-based order in outer space.

Orbital Congestion - The space in Earth's orbits is limited. Satellite constellations (large networks of satellites surrounding the Earth) are becoming more common. The growing congestion in outer space demands new approaches to the management of space traffic, technical standards, norms of responsible behaviour, and "rules of the road" for different kinds of space activities. This will necessitate the development of new systems for sharing information among spacecraft in real time to avoid collisions and implementing operational best practices to preserve space as a safe and stable operating domain.

Space Security – Militaries are developing capabilities to disrupt, degrade or destroy satellites for national security reasons. Such actions could have unforeseen and long-lasting consequences for many other space users. Since 1959, the USA, the former Soviet Union, Russia, China and India have carried out more than 70 debris-generating anti-satellite tests. Debris from these past tests will continue to pose a threat to space users for many years to come. Such deliberate debris creation is entirely avoidable and unnecessary and is being condemned as an irresponsible behaviour by a growing number of countries.

International Cooperation and Competition – Space sustainability is an intrinsically international challenge. No single actor or group of actors can ensure the safety and security of their space activities entirely through their own actions. The irresponsible or misguided actions of one actor can have negative and long-lasting repercussions for many other actors. Moreover, different actors have their own, often competing, visions for space activities, which could potentially give rise to conflict when activities carried out under these competing visions intersect in space. For these reasons, strong international cooperation and capacity-building are vital to maintaining space sustainability.

IV The UN, Space and Sustainable Development

Since the earliest days of the Space Age, the United Nations has been at the forefront of utilizing space for development. In 1958, just one year after the launching of the first artificial satellite, the United Nations General Assembly established an ad hoc Committee on the Peaceful Uses of Outer Space (COPUOS) to consider questions related to the peaceful uses of outer space, organizational arrangements to facilitate international cooperation in this field within the framework of the United Nations, and legal questions arising in the exploration and use of outer space. To this day, COPUOS continues to be the preeminent international body for dealing with questions of international cooperation in the exploration and peaceful uses of outer space and the governance of space activities.

Recognizing the immense potential of space technology for socioeconomic development, the United Nations organized three global conferences, the so-called UNISPACE conferences, to promote cooperation among States and international organizations in the peaceful uses of outer space. UNISPACE I, held in 1968, focused on raising awareness of the vast potential of space benefits for all humankind. UNISPACE II, held in 1982, focused on strengthening the United Nations' commitment to promoting international cooperation to enable developing countries to benefit from the peaceful uses of space technology. UNISPACE III, held in 1999, built on the theme of using space to support human development, security, and welfare.

The first stirrings of the space sustainability dialogue in the UN system can be traced back to UNISPACE III, which took place in Vienna in 1999. The resulting *Vienna Declaration on Space and Human Development* contained, for the first time in a high-level UN Summit output, an explicit reference to the importance of protecting the space environment. Following UNISPACE III, COPUOS convened several Action Teams to follow up on the recommendations of UNISPACE

III and this work contributed to wider awareness in the international community that the preservation of the space environment is a multilateral policy issue.

From the early 2000's, COPUOS started to deal with the various issues relating to the space environment under different items of its agenda, but these topics were still not seen in the broader context of sustainability. By the mid-2000's, a number of leading spacefaring States had started raising this issue in COPUOS but failed to reach the critical mass needed to make this a priority because at that time the idea of sustainability applying to space had not yet taken root widely in COPUOS. The 2009 Cosmos-Iridium collision was a proverbial 'wake-up call' in terms of raising awareness among policymakers and diplomats that the growing congestion in orbit was a matter that needed urgent attention at national and international level. In 2010, COPUOS established a Working Group to discuss matters related to the long-term sustainability of outer space activities and to propose a series of best-practice guidelines for States to implement in the governance of their space activities.

V The UN Space Sustainability Guidelines

In 2019, following an eight-year process, COPUOS adopted a set of 21 guidelines for the long-term sustainability of outer space activities, the so-called 'COPUOS LTS Guidelines'. These guidelines comprise a collection of internationally recognized measures that are intended to support States in the development of their national space capabilities in a manner that avoids causing harm to the outer space environment and the safety of space operations. They address the policy, regulatory, operational and safety aspects of space activities, and they are relevant to all kinds of space activities, whether civil, commercial, or military, and to all mission phases, from design, to launch and operations in orbit, to post-mission disposal.

The guidelines are grouped into four categories: (A) Policy and regulatory; (B) Safety of space operations; (C) International cooperation and capacity-building; and (D) Scientific and technical aspects. Each of the 21 LTS Guidelines takes the form of a short action-oriented title text that summarizes the main intent of that guideline, followed by several paragraphs of more detailed recommendatory text to support the implementation of the guideline. Table 1 contains the titles of the guidelines. The full text of the guidelines is available in UN document A/74/20, Annex II.

(United Nations, 2019) Since their adoption in 2019, many States have started to implement these guidelines at the national level, and several have reported their implementation experiences in COPUOS.

VI Conclusion

Space holds vast benefits for humanity that are leveraged through satellites. However, the orbits in which satellites travel are a limited natural resource because there is a finite amount of space that is being increasingly crowded with satellites and space debris. Managing this limited resource for the future requires policy, regulatory, operational, and technical measures and the mindful and persistent application of these measures by all space actors.

References

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https://www.unoosa.org/res/oosadoc/data/documents/2019/a/a7420_0_html/V1906077.pdf>
accessed 17 January 2023

Table 1: UN COPUOS Guidelines for the Long-Term Sustainability of Outer Space Activities. The full text of the guidelines appears in Annex II of UN document A/74/20. (United Nations, 2019)

A. Policy and regulatory framework for space activities	
Guideline A.1	Adopt, revise and amend, as necessary, national regulatory frameworks for outer space activities
Guideline A.2	Consider a number of elements when developing, revising or amending, as necessary, national regulatory frameworks for outer space activities
Guideline A.3	Supervise national space activities
Guideline A.4	Ensure the equitable, rational and efficient use of the radio frequency spectrum and the various orbital regions used by satellites
Guideline A.5	Enhance the practice of registering space objects
B. Safety of space operations	
Guideline B.1	Provide updated contact information and share information on space objects and orbital events
Guideline B.2	Improve accuracy of orbital data on space objects and enhance the practice and utility of sharing orbital information on space objects
Guideline B.3	Promote the collection, sharing and dissemination of space debris monitoring information
Guideline B.4	Perform conjunction assessment during all orbital phases of controlled flight
Guideline B.5	Develop practical approaches for pre-launch conjunction assessment
Guideline B.6	Share operational space weather data and forecasts
Guideline B.7	Develop space weather models and tools and collect established practices on the mitigation of space weather effects
Guideline B.8	Design and operation of space objects regardless of their physical and operational characteristics
Guideline B.9	Take measures to address risks associated with the uncontrolled re-entry of space objects
Guideline B.10	Observe measures of precaution when using sources of laser beams passing through outer space
C. International cooperation, capacity-building and awareness	
Guideline C.1	Promote and facilitate international cooperation in support of the long-term sustainability of outer space activities
Guideline C.2	Share experience related to the long-term sustainability of outer space activities and develop new procedures, as appropriate, for information exchange
Guideline C.3	Promote and support capacity-building
Guideline C.4	Raise awareness of space activities
D. Scientific and technical research and development	
Guideline D.1	Promote and support research into and the development of ways to support sustainable exploration and use of outer space
Guideline D.2	Investigate and consider new measures to manage the space debris population in the long term