10 May 2023

Original: English

General Assembly
Seventy-seventh session
Agenda item 126 (a)
Strengthening of the United Nations system: strengthening of the United Nations system

Our Common Agenda

Policy brief 7: for all humanity – the future of outer space governance

Summary

The challenges that we are facing can be addressed only through stronger international cooperation. The Summit of the Future, to be held in 2024, is an opportunity to agree on multilateral solutions for a better tomorrow, strengthening global governance for both present and future generations (General Assembly resolution 76/307). In my capacity as Secretary-General, I have been invited to provide inputs to the preparations for the Summit in the form of action-oriented recommendations, building on the proposals contained in my report entitled "Our Common Agenda" (A/75/982), which was itself a response to the declaration on the commemoration of the seventy-fifth anniversary of the United Nations (Assembly resolution 75/1). The present policy brief is one such input. It serves to elaborate on the ideas first proposed in Our Common Agenda, taking into account subsequent guidance from Member States and more than one year of intergovernmental and multi-stakeholder consultations, and rooted in the purposes and the principles of the Charter of the United Nations, the Universal Declaration of Human Rights and other international instruments.

The present policy brief contains an examination of the extraordinary changes under way in outer space and an assessment of the sustainability, safety and security impacts of these changes on present and future governance. The brief also contains an outline of major trends that are impacting space sustainability and the positive impact that these trends could have on achieving the Sustainable Development Goals. Also contained in the brief is an outline of major trends affecting the security of outer space activities and the risks to humanity that could materialize if these challenges are not solved. Lastly, it provides a practical set of governance recommendations for maximizing the opportunities of outer space while minimizing short-term and long-term risks.

In Our Common Agenda, I proposed to Member States that "a combination of binding and non-binding norms is needed" to address emerging risks to outer space security, safety and sustainability. Our common interest in preserving the domain of outer space, a province of humankind that benefits us all, requires agile and multi-stakeholder governance responses. Emerging risks, driven by increased congestion of the low Earth orbit and competition in space, need to be addressed in concert with the full range of actors now involved in space exploration and use, while maintaining the centrality of Member States and their leadership of intergovernmental processes.

During the informal consultations with Member States held in February 2022 on the "Frameworks for a peaceful world – promoting peace, international law and digital cooperation", Member States agreed that outer space must be explored and utilized for peaceful purposes and for the benefit of all States. Member States also recognized the need to discuss the ways and means of strengthening global governance of outer space, building on the work of the Committee on the Peaceful Uses of Outer Space and the other relevant intergovernmental bodies and in close cooperation with the Secretariat.

I. A new era in outer space

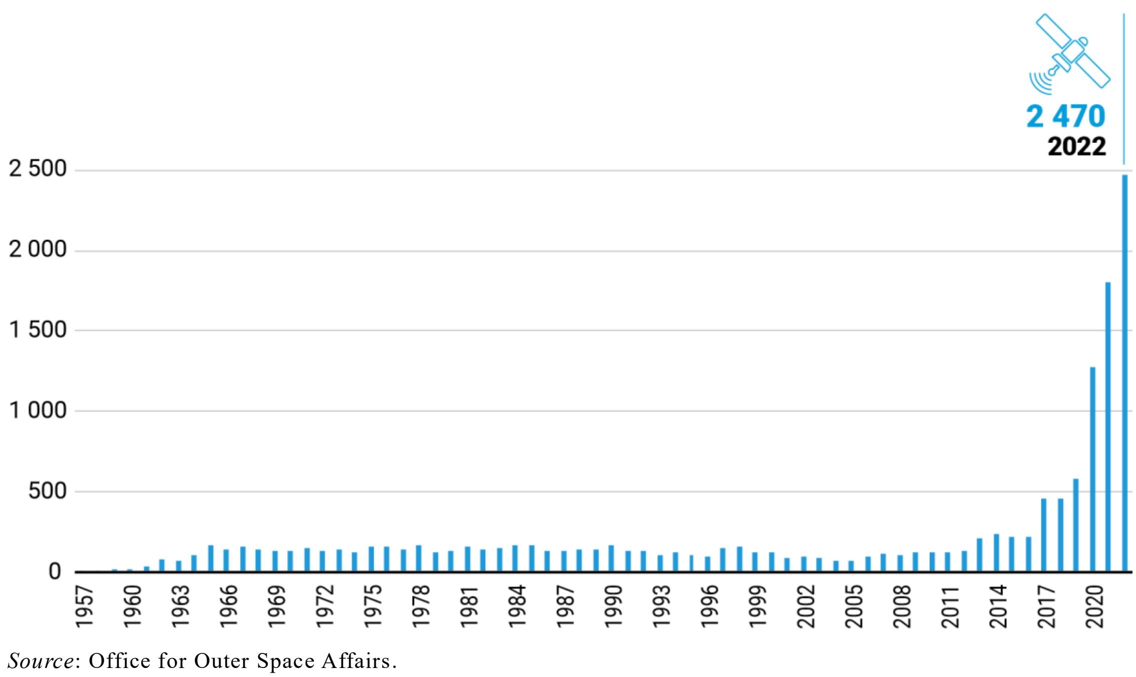
1. In the past 10 years, humanity's access to and operations in outer space have fundamentally changed and the driving factors behind these changes are likely to accelerate in the coming decades. Of the many indicators that show evidence of this unprecedented change, three stand out: the number of objects launched to orbit; the participation of the private sector; and commitments of public and private actors to return to deep space and enable the long-term presence of humanity among the celestial bodies. This revolutionary change, like other twenty-first century technology-enabled breakthroughs, presents us with both opportunities and risks, and we need to develop further the existing governance so that we can sustainably accelerate innovation and discovery with a view to achieving the Sustainable Development Goals.

A. Objects in orbit

2. From 1957 to 2012, the number of satellites launched into outer space remained remarkably consistent, at approximately 150 each year. This includes the eras of human flight to Earth orbit and to the Moon, the development of global communications satellite systems and the construction of the International Space Station. However, a decade ago, the number of satellites launched into orbit began to increase at an exponential rate, from 210 (2013), to 600 (2019), to 1,200 (2020) and, most recently, to 2,470 in 2022 (see figure I).

Figure I
Satellites launched in the past

Satellites launched to space annually



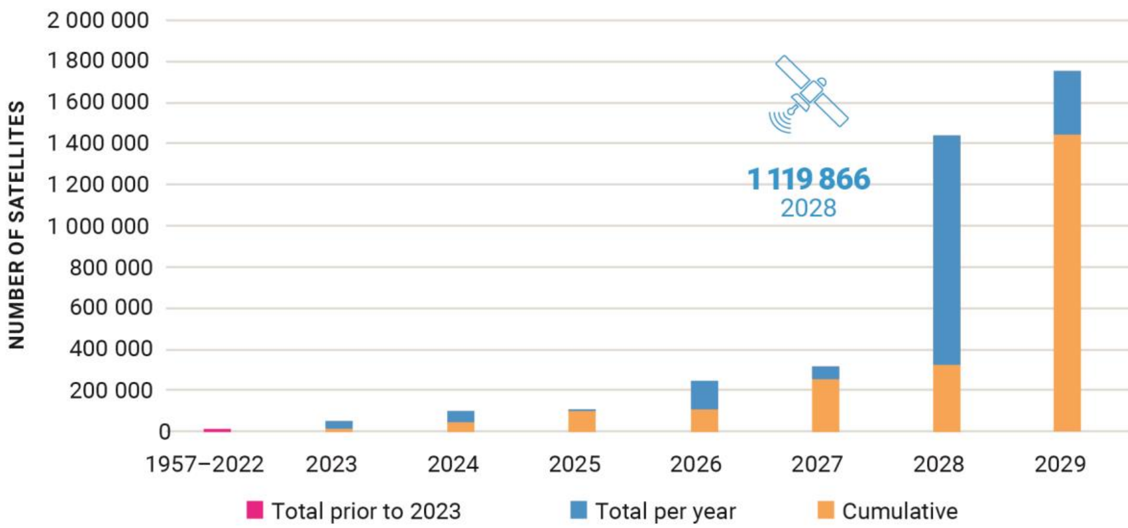
Source: Office for Outer Space Affairs.

3. This rate of increase has been driven largely by the launch of small satellite networks by private sector actors and is reflected in the tenfold increase in the number of satellites registered in the Register of Objects Launched into Outer Space of the Office for Outer Space Affairs. The satellite network filings made with the International Telecommunication Union (ITU), a specialized agency of the United Nations, and recorded in the Master International Frequency Register indicate that this trend is likely to continue in the future. To date, States have registered radio frequencies with ITU for more than 1.7 million non-geostationary satellites that may be launched into orbit by the beginning of 2030 (see figure II).

Figure II
Satellites registered to launch in the future

Number of non-geostationary satellites for which States have registered radio frequencies with the International Telecommunication Union (by year and cumulative)

For past launches, see figure I

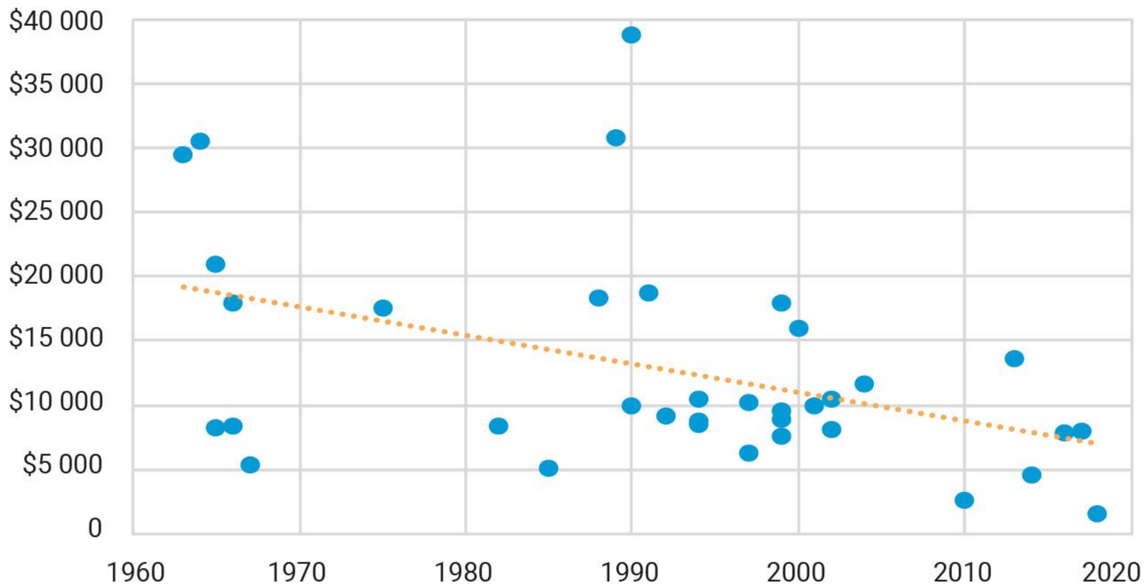


4. This rapid increase in the launch of objects into orbit is being driven by technology breakthroughs in both rockets and satellites. Rocket reusability and new manufacturing techniques have reduced launch costs (see figure III). New systems under development could reduce these costs even further.[1] For satellites, mass production and the miniaturization of electronics have resulted in a halving of their size and a cost level that is a small fraction of that of previous generations. This has led to a proliferation of new constellations of small satellites.[2]

Figure III
Cost of space launches to low Earth orbit

Mean average by decade

Cost to launch 1 kilogram of payload mass to low Earth orbit as part of a dedicated launch. The data is adjusted for inflation



Source: Center for Strategic and International Studies, Aerospace Security Project (2022).
Note: Small vehicles carry up to 2,000 kg to low Earth orbit, medium vehicles from 2,000 to 20,000 kg and heavy vehicles more than 20,000 kg. Low Earth orbit: a low Earth orbit is an orbit around Earth with a period of 128 minutes or less (making at least 11.25 orbits per day). Most of the artificial objects in outer space are in low Earth orbit, with an altitude never more than about one third of the radius of Earth.

B. Private sector activity

5. Private industry has long had a close association with the development of outer space capabilities, especially in the United States of America and Europe, where private companies have built and launched government projects for decades. The past decade has witnessed a rapid expansion in the number of private missions to space launched by private companies, including the first-ever private mission to the

[1] SpaceX has published a potential cost-to-orbit price of $10 per kilogram for its reusable heavy-lift Starship rocket system. The system is under testing currently, but if realized, this could be up to 100 times less expensive than existing systems.

[2] This includes planned and approved satellite constellations, such as: SpaceX Starlink (42,000); Government of China project “GW” (12,992); OneWeb (7,088); Amazon Kuiper (3,236); Telesat Lightspeed (298); Satellogic Aleph-1 (200) (Uruguay); SpaceBEE (327); Inmarsat Orchestra (150–175); and Low Earth Multi-Use Receiver (LEMUR) (100). These networks are all planned for launch and operation by 2030.

International Space Station[3] in 2021. Driven by significant cost decreases and launch options, the number of planned private missions for communications, resource activities, space tourism and science is rapidly rising. This rise in private launches and human missions, in conjunction with the emergence of large satellite constellations, will significantly increase space traffic in the coming decade.

6. Although private sector activity is most robust in the United States, new actors are emerging around the globe. In China, many new commercial space companies have been started and development is accelerating.[4] Similar growth has been seen in India and Japan. Industry experts note that the global space market grew by 8 per cent to $424 billion in 2022 and is expected to reach more than $737 billion by 2030.

C. Return of humans to deep space

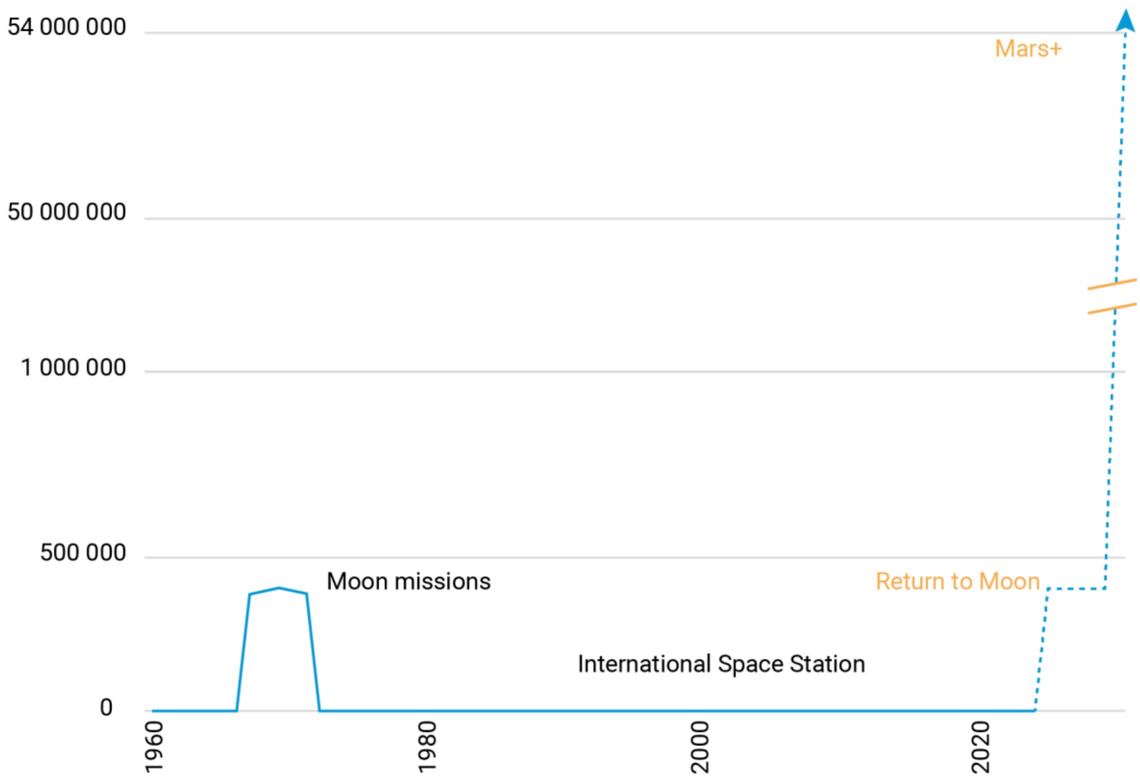
7. Humans have not been to deep space since the end of the National Aeronautics and Space Administration (NASA) Apollo programme in 1972, more than half a century ago. However, a new era is dawning with the return of deep space crewed missions. NASA plans to fly humans around the moon on its new Space Launch System rocket in 2024, while SpaceX plans to launch a crew of artists to deep space on its experimental and fully reusable rocket system, Starship. Crewed missions to deep space by the United States and its partners in the Artemis programme are expected to continue throughout the 2020s and 2030s (see figure IV). This will include the construction of an orbital Moon station called Lunar Gateway, as well as a long-term base on the surface. Beyond the Moon, both the United States and SpaceX have set out broad timelines for human missions to Mars. The sustained presence of humans on celestial bodies will necessarily be supported by in situ resource exploitation and utilization.

8. China has also begun the development of its newest heavy-lift rocket family, the Long March 8, 9 and 10, which are expected to continue to send robotic missions to the moon in the 2020s. This may be followed by human missions, probably in the 2030s, and the development of a base at the south pole of the Moon, in partnership with the Russian Federation. While no other Governments or private firms have publicly announced human deep space missions, several space programmes, including those of countries in Europe, India and Japan, are making progress on heavy rocket development and human-rated vehicles.

[3] Axiom/SpaceX mission to the International Space Station aboard a Falcon 9 rocket and a Crew Dragon capsule.

[4] Commercial operator Space Pioneer achieved orbit with its Tianlong-2 rocket on 2 April 2023, the first private sector Chinese firm to achieve orbit with a liquid-fuelled rocket.

Figure IV
Furthest human distance from Earth
(Kilometres)

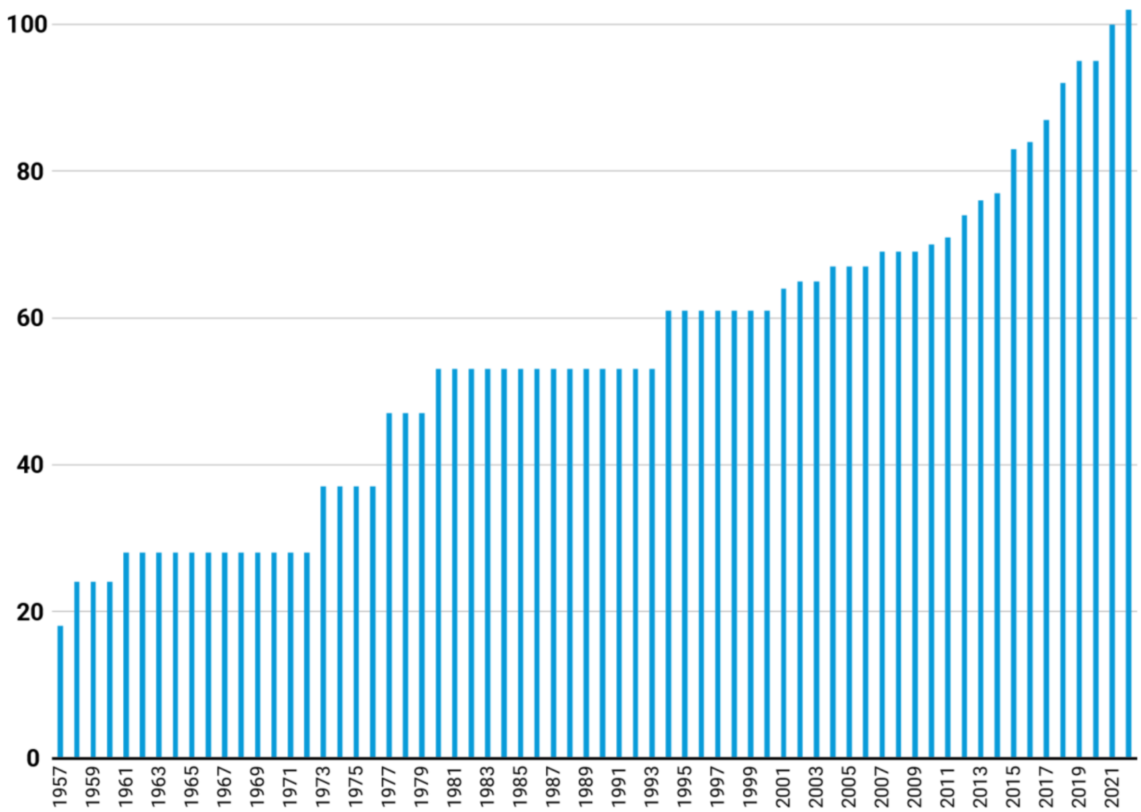


Source: Office for Outer Space Affairs.

II. Existing governance mechanisms

9. Beginning in 1959, just two years after the launch of Sputnik, the world's first satellite, the States Members of the United Nations established the Committee on the Peaceful Uses of Outer Space. Through the Committee, diplomatic and scientific experts shepherded the development of an agreement on five United Nations treaties on outer space (see annex I) negotiated between 1967 and 1979. These treaties addressed challenges and risks associated with space exploration, the rescue of astronauts, the liability for and registration of space objects and agreement for activities on the Moon and other celestial bodies.

Figure V
Evolution of membership of the Committee on the Peaceful Uses of Outer Space



Source: Office for Outer Space Affairs.

10. Another set of treaties relating to space security (see annex I) were agreed through various processes to prohibit the testing of nuclear weapons in outer space (1963) and the prohibition against the alteration of the environment as a weapon (1977). Efforts to ensure space security continue, in particular through the work of the First Committee of the General Assembly, the Conference on Disarmament and the United Nations Disarmament Commission.

11. In parallel, States Members of ITU agreed in 1963 to include provisions related to radio frequencies and associated satellite orbits in outer space in one of its treaties, the Radio Regulations (see annex I). This treaty is complemented by governance meetings (the World Radiocommunication Conferences) that update its provisions in order to keep pace with the advances in satellite technologies.

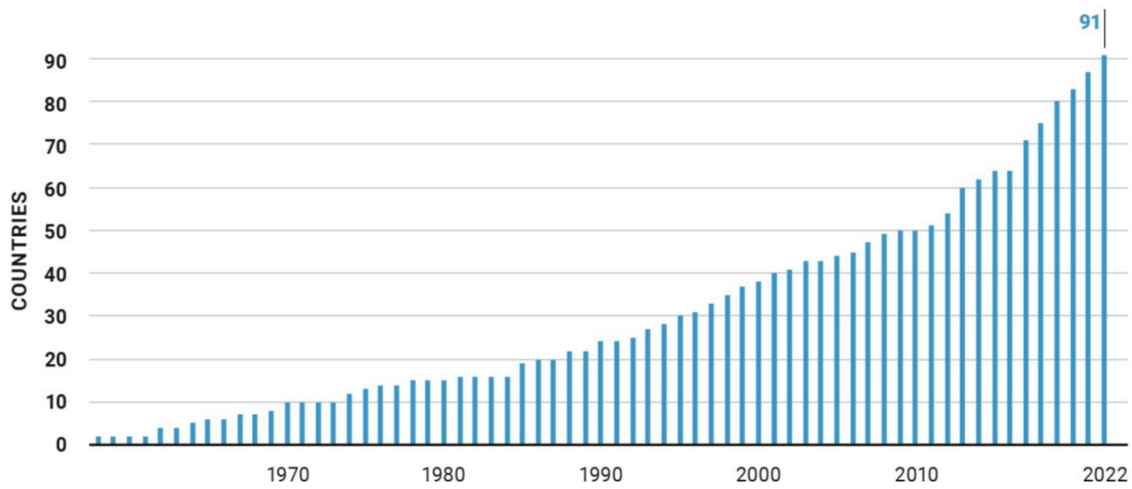
12. Advances in technology necessitated the development of a set of principles and declarations (annex II) to support the earlier treaties. These agreements, negotiated from 1982 to 1996, dealt with a disparate range of technical issues, from television broadcasting to nuclear power in space.

13. Several of these treaties are close to achieving universal participation by space-faring nations and have served the international community well, in preventing conflict in outer space and facilitating safe and sustainable space activities.

14. More recently, a series of guidelines, frameworks and recommendations (see annex III) have been agreed on issues of space debris mitigation, nuclear power source safety, the long-term sustainability of outer space activities and transparency and confidence-building measures in outer space activities. These new measures,

together with the growing number of Member States that have joined the Committee on the Peaceful Uses of Outer Space and the number of countries that have a satellite in orbit (see figure VI), demonstrate the heightened engagement on outer space issues from a diverse range of actors.

Figure VI
Countries with at least one satellite



Source: Office for Outer Space Affairs.

15. The Committee on the Peaceful Uses of Outer Space, through its Scientific and Technical and Legal Subcommittees (see annex V), has a mandate to address space situational awareness, space debris and resource activities, while processes such as the ongoing open-ended working group on reducing space threats and the forthcoming group of government experts on the prevention of an arms race in outer space can mitigate risks associated with space security. Similarly, ITU has the institutional mechanisms in place to address the communications requirements of future space missions.

16. Issues relating to security, safety and sustainability have distinct considerations and have historically been taken up in separate intergovernmental bodies, but there remains a degree of overlap between their work. Some action has been taken to address this, including the innovative practice of joint meetings of the First and Fourth Committees on outer space, which underscores the cross-cutting nature of these issues. Such practices should continue and be explored for application across relevant forums.

17. Looking towards broader governance challenges, in April 2023 the High-level Advisory Board on Effective Multilateralism released a report [5] in which it encouraged more networked, flexible and future-oriented approaches for multilateral decision-making. On outer space, the Board encouraged the Committee on the Peaceful Uses of Outer Space and other governance bodies to increase the use of procedures such as the Arria formula used at the Security Council that more effectively include external experts in Member State discussions. This recommendation speaks to the increase in private sector actors in outer space, and such a proposal could provide a platform for more inclusive and diverse voices. Increasing the contributions from external technical experts could also ensure that the Committee remains at the forefront of technology advancement and operational requirements.

[5] High-Level Advisory Board on Effective Multilateralism, *A Breakthrough for People and Planet: Effective and Inclusive Global Governance for Today and the Future* (New York, United Nations University, 2023).

III. Space-based opportunities

18. From the launch of the first communication satellites to the cutting-edge science laboratories and observatories currently in orbit, humanity has sought to apply the opportunities presented by outer space to accelerate development. So much so that today, nearly 40 per cent of the targets underpinning the Sustainable Development Goals leverage Earth observation and global navigation satellite systems. This important link between outer space and the 2030 Agenda for Sustainable Development was agreed by Member States through the General Assembly in 2021 with the adoption of the "Space2030" Agenda, as resolution 76/3, which sets out a forward-looking strategy for reaffirming and strengthening the contribution of space activities and space tools for the achievement of the Goals.

Figure VII
Application of space to the Sustainable Development Goals

1 NO POVERTY

Space applications and technology directly and indirectly prevent and reduce poverty, for example, through disaster monitoring and response – and through supporting other Sustainable Development Goals. Earth observation data is used to improve coffee quality and productivity in Timor-Leste, increasing the revenue of coffee growers.

2 ZERO HUNGER

Space increases agricultural yields through: precision and sustainable farming, optimizing crop productivity through efficient land monitoring and management (e.g., where to fertilize and irrigate) and improving livestock management. A specific example is the detection of anomalies and stress in olive groves.

3 GOOD HEALTH AND WELL-BEING

Space life sciences are an important aspect of the work done by astronauts. Microgravity research in space observes physiological changes in the human body. Space-derived data is used to monitor and map yellow fever mosquito populations (which can spread dengue fever) and cases in Argentina, Chile and Paraguay.

4 QUALITY EDUCATION

Satellite-enabled remote learning has helped reduce the disruption of education for millions of children during the COVID-19 pandemic. E-learning and related programmes, such as virtual internships, enabled through satellite technology, increase the accessibility of educational opportunities for rural communities and people from developing countries.

5 GENDER EQUALITY

Space is a motivational area for girls and women to pursue a career in science, technology, engineering and mathematics. Connecting female role models and leaders with students and graduates in mentor-mentee programmes boosts the participation of women and girls in these fields. Space technology, such as geolocation, is also an important element in eliminating gender-based violence.

6 CLEAN WATER AND SANITATION

Earth observation satellites are crucial in analysing global water cycles, mapping water courses and water pollution and monitoring and mitigating the effects of floods and droughts. Satellite data collected on total suspended (organic and inorganic) matter in water act as a proxy for water quality.

7 AFFORDABLE AND CLEAN ENERGY

Research and development into solar panels for satellites contribute to boosting the efficiency of solar cells and the development and deployment of solar panel farms on Earth. Global navigation satellite systems (e.g., GPS) provide the accurate timing that smart grids require for synchronization.

8 DECENT WORK AND ECONOMIC GROWTH

Space is a multiplying force for national and global economies. Every $1 spent on the National Aeronautics and Space Administration (NASA) creates a return or investment of $7–$14. Space data assists policymakers in crafting better economic policies: satellite data contributed to measuring the impacts of COVID-19 lockdowns and post-lockdown recoveries.

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

The space economy is booming. Opportunities to tap into the space market for developed and developing countries are at their highest point ever, and continued growth is expected. Increasing private capital and public expenditure creates jobs and boosts industrialization and innovation by supporting space start-ups and small and medium-sized enterprises.

10 REDUCED INEQUALITIES

Unlocking access to space- and Earth-based research facilities, infrastructure and information for people from developing countries can assist in bridging the equality divide. Space technologies also connect remote and isolated communities to services, education and work opportunities.

11 SUSTAINABLE CITIES AND COMMUNITIES

Space is utilized for urban planning and smart, sustainable cities, which is vital for climate action as cities are responsible for more than 70 per cent of global emissions. Identifying heat spots in cities, monitoring the cooling effect of green spaces, analysing air quality and crime trends are among other examples of how space improves life in urban areas.

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

Satellite imagery can help monitor the efficient use of natural resources in a consistent and repeatable manner across the Earth. Space assets are widely used for resource analysis towards the sustainable management of forests, open-air mines, water reservoirs, logging, fisheries, crops and many other resources.

13 CLIMATE ACTION

Space technology and applications are crucial for effective climate action, for instance, through climate change monitoring, weather forecasting, disaster management and response. More than half of the essential climate variables (characterizing Earth's climate) are monitored from space.

14 LIFE BELOW WATER

Satellite data are essential for mapping and monitoring natural and protected areas, fishing vessel tracking and navigation, monitoring illegal fishing, assessing marine and coastal health and identifying algal blooms.

15 LIFE ON LAND

Land surface monitoring, biodiversity monitoring, the monitoring of poaching and smuggling routes, deforestation, forest fire risk, vegetation health and the protection of endangered species all benefit from space-derived data.

16 PEACE, JUSTICE AND STRONG INSTITUTIONS

Satellite data have enabled real-time monitoring and response to illegal deforestation, fishing and poaching. It has also been demonstrated that Earth observation sensors and precision navigation can be combined to enable the safer identification and clearance of landmines. Space assets are also utilized for verification of treaties and international agreements.

17 PARTNERSHIPS FOR THE GOALS

The Committee on the Peaceful Uses of Outer Space has 102 members and more than 50 observer organizations. Its unique convening power benefit space and the other Sustainable Development Goals writ large: all 17 Goals are positively impacted by space; almost 40 per cent of the targets directly benefit from space-derived information and earth-observation data.

A. Earth observation

19. As at January 2022, there were more than 1,000 Earth observation satellites operated by a diverse group of Governments and private actors. Satellite data and images enable scientists to monitor weather patterns, temperature fluctuations and coastal changes, informing energy and climate policy. Satellites are also used to track deforestation, monitor protected areas for illegal poaching and fishing and assess biodiversity changes. At the local level, farmers can monitor soil changes to enhance yields and improve their products.

20. The United Nations is also an important consumer of satellite data and images. We use this information for our climate and meteorological work and to monitor and respond to natural disasters including floods, droughts and earthquakes. Earth observation satellites contribute to more than half of the 54 essential climate variables.[6]

B. Communication

21. Twenty-first century communication networks rely increasingly on access to space-based assets and have been an important enabler of global development. Communications from space-based networks offer some advantages over terrestrial counterparts, as they are better able to reach remote locations where land-based infrastructure is too costly or problematic. They are also more resilient to natural disasters that can disrupt land-based hardware and connectivity.

22. Connecting the final 2.7 billion people and achieving universal Internet connectivity, one of the goals in Our Common Agenda and my Road Map for Digital Cooperation (A/74/821), will require that we leverage both terrestrial and space-based networks.

23. Recent innovations have made Internet connectivity from low-Earth orbits increasingly viable, with the potential to connect rural schools, hospitals and communities to the Internet. This capability could be a game-changer for achieving the Sustainable Development Goals as studies show[7] that connecting villages to the Internet can increase wages, skill development, business profits and access to services. Space-based Internet also has the potential to help bridge the digital divide by opening access in developing areas and supporting students, teachers, farmers and health workers, support that is critical in public health emergencies such as coronavirus disease (COVID-19).

C. Satellite navigation

24. The use of global navigation satellite systems to support planes, ships, cars and other transportation systems is vital to our global logistics chain and economic development. This field is deeply reliant on space-based assets and serves as a model for international cooperation among satellite operators, and significant progress continues to be made through the work of the International Committee on Global Navigation Satellite Systems. The interoperability of these systems supports live positioning, navigation and other services with wider availability and improved accuracy. Prominent global navigation satellite systems are operated all over the world and include BeiDou, Galileo, the Global Positioning System (GPS) and GLONASS, together with several regional systems.

---

[6] See www.earthdata.nasa.gov/learn/backgrounders/essential-variables.

[7] World Bank, < https://blogs.worldbank.org/digital-development/can-internet-access-lead-improved-economic-outcomes. >

D. Science

25. Scientific experiments in orbit have been a major driver of national space programme missions. Active scientific work ongoing today includes experiments in biology, material science, hydrology and development of medicines. With a lowering cost to orbit, it is expected that science and experimentation will remain central to our collective efforts, including as we return to deep space.

26. Over the past 20 years, the International Space Station has hosted more than 3,000 scientific experiments, with hundreds ongoing at any given time. This orbital laboratory and its predecessors Salyut, Skylab, Mir and the recently commissioned China Space Station, Tiangong, have been sources of scientific inspiration, opportunity and discovery for decades.

27. Beyond the hard sciences, the effective governance of outer space will enable a renewed spirit of inspiration and discovery for humanity. The diverse and inclusive group of spacefarers who set out for our surrounding celestial bodies will inspire a new generation of people. This progress has a particularly important gender dimension, as women hold less than 30 per cent of jobs in science, technology, engineering and mathematics fields. The figures for the space sector are even starker, with women making up less than 20 per cent of the workforce, a figure that has hardly changed in the past three decades.

28. Our collective responsibility to effectively govern outer space is something that we owe to present and future generations. Our success can turbocharge the achievement of the Sustainable Development Goals and set out a model for effective, innovative and inclusive governance for the twenty-first century and the centuries that follow.

IV. Space-based challenges

29. Over the past decade, major new trends have impacted the outer space environment. These include the number of space objects, the increasing number of private sector actors, the decreasing costs of launching objects into orbit and planned human missions to deep space. They have the potential to unlock enormous opportunity for humanity but they also exacerbate risks. It is essential for the international community to have a thorough understanding of these risks and to mitigate them.

A. Space traffic coordination

At present, national and regional entities coordinate space traffic with different sets of standards, best practices, definitions, languages and modes of interoperability. This relative lack of coordination widens the gap for countries with less space capacity, making it harder for them to operate their limited space assets in an increasingly complex environment

30. The rapid increase in the number of objects and frequency of missions to outer space brings a corresponding increase in the risks of accident, collision and debris. This issue will become increasingly relevant as space actors conduct new and novel missions such as debris removal, in-orbit servicing and manufacturing and space tourism.

31. Experts and Governments are aware of the major risks at play and have taken some initial steps to take them into consideration, including through the consensus adoption in 2019 of the non-binding Guidelines for the Long-term Sustainability of Outer Space Activities of the Committee on the Peaceful Uses of Outer Space

(A/74/20, annex II). However, it is challenging to address this issue owing to the diversity of new actors and activities, the lack of a common shared knowledge of the positioning, trajectory and intended behaviour of outer space objects, the gaps in the capabilities of space actors to manoeuvre their satellites, and disagreement over the right of way.

32. There is also a lack of consensus on how any risks should be communicated and solved. For example, if two outer space actors become aware of a potential collision between their space assets, they are often unaware of the manoeuvring capabilities or intentions of the objects at risk. This is especially true for private actors or countries with limited space capabilities. There are no set protocols, aside from those protecting human spaceflight, that define which object should move to which orbital level.

33. Although this issue is under analysis and review through the Committee on the Peaceful Uses of Outer Space, an agreed international platform for monitoring risks and assessing the potential consequences of a collision in orbit remains elusive.

34. In addition to the notable risks to human safety and security, a collision in outer space could render orbits with high scientific and economic value completely unusable for present and future generations, thus squandering the opportunities presented by this unique domain of common interest to humankind.

B. Space debris

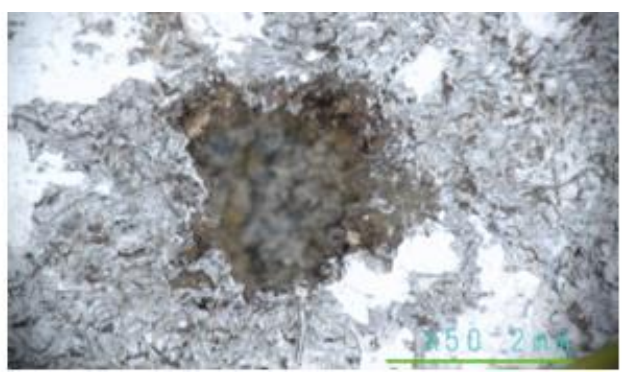
Space debris is a challenge that will be compounded by the large number of satellites being launched to low Earth orbit. There is not at present an international mechanism or body to monitor space debris or facilitate its removal

35. The rapidly increasing number of active objects in Earth orbit pales in comparison with the total number of human-made objects that are already in space and circling our planet. There are more than 24,000 objects 10 cm or larger (see figure X), 1 million smaller than 10 cm, and likely more than 130 million smaller than 1 cm. One of the main problems associated with space debris, aside from the volume of objects, is their velocity. Objects as small as a chip of paint, travelling at more than 28,000 km per hour, can cause significant damage to spacecraft.

Figure VIII

Impact observed on the reaction control system engine nozzle of a Crew-4 vehicle.
Magnification: 59.3×.
Source: Hypervelocity Impact Technology Group, NASA.

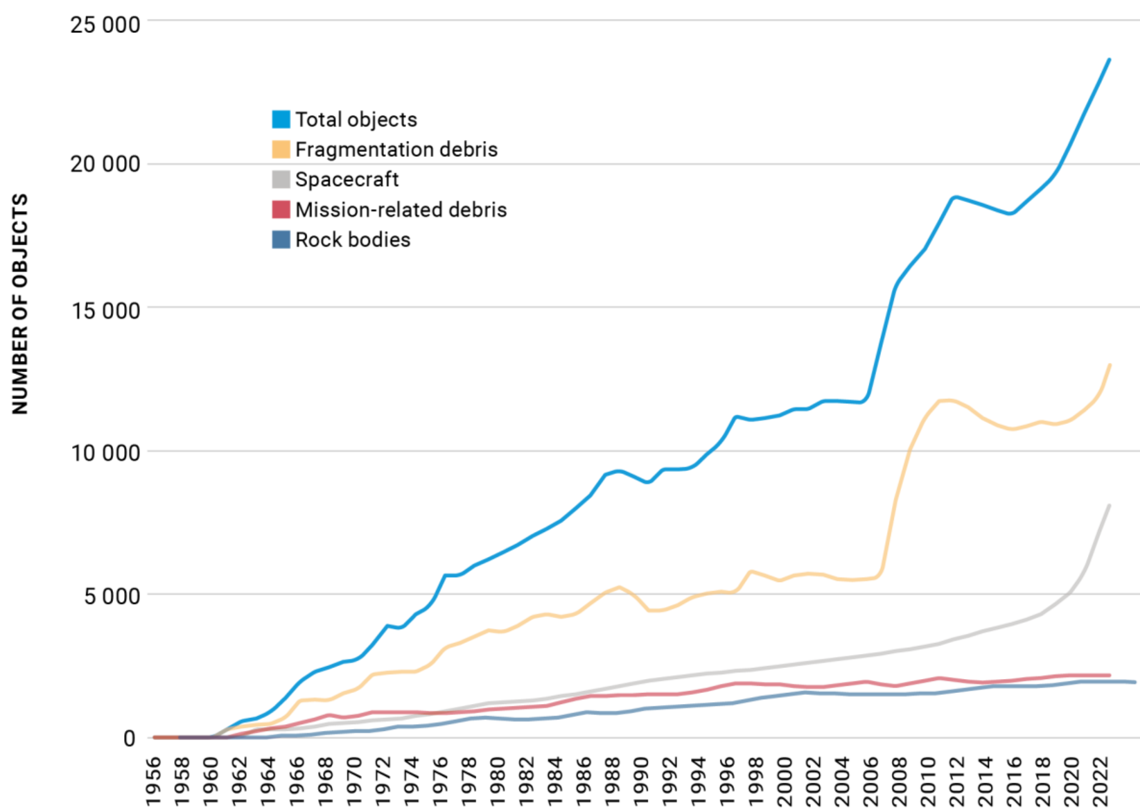
Figure IX



Impact observed on the leeward heat shield shoulder of a Crew-4 vehicle.
Source: Hypervelocity Impact Technology Group, NASA.

36. According to NASA,[8] by as early as 2005, the amount of debris in low Earth orbit had grown to the point that, even if no additional objects were launched, collisions would continue to occur, increasing the instability of the debris environment and operational risk to spacecraft. The risk from orbiting space debris is heightened by the Kessler syndrome, a potential scenario where the amount of space debris increases to such a level that collisions begin to cascade into each other, causing more debris, raising the risks of orbital pollution and rapidly reducing access to assets and orbits.

Figure X
Orbital debris by type



Source: NASA Orbital Debris Program Office.

37. The targeting and destruction of space-based satellites with ground-launched missiles also increases the risk of space debris. Tests using anti-satellite weapons (ASATs) have been carried out by a small number of States, against their own space assets. These weapons tests, although rare, can significantly increase the amount of space debris.

38. Member States have made some progress on this issue, including the development of procedures, measures and guidelines that have slowed the growth of orbital debris. These actions, however, are unlikely to prevent potential random collisions or remove the Kessler Syndrome risk. While the technology necessary for space debris removal or remediation is currently in development, there are important legal issues to consider, including jurisdiction, control, liability and responsibility for environmental pollution in space for present and future generations.

[8] See https://orbitaldebris.jsc.nasa.gov/remediation/.

39. Environmental pollution risks from rocket launch emissions also merit consideration. Combining the expected growth of the space sector in the coming years with the fact that rocket production and launches generate emissions across layers of the atmosphere, up to and including the ozone layer, this issue will require further attention at the international level on the potential impacts of space activities on the environment.

C. Resource activities

While there is ongoing review within the Committee on the Peaceful Uses of Outer Space, there is not an agreed international framework on space resource exploration, exploitation and utilization, or a mechanism to support its future implementation

40. Resources on celestial bodies such as the Moon, planets and asteroids present significant economic potential. There are minerals that are abundant on the Moon, such as helium-3, that are rare on Earth, presenting strong economic incentives for exploitation. Likewise, asteroids in our solar system contain valuable metals, including platinum, nickel and cobalt, making them attractive destinations for investment. Water is another resource that will be in significant demand for any space economy, and it can be found in frozen form on many celestial bodies.

41. Without agreed international principles on activities in the exploration, exploitation and utilization of space resources, these economic incentives carry a potential risk of conflict, environmental degradation and cultural loss. When the space treaties were negotiated, provisions were included to ensure that no nation could claim ownership of celestial bodies, recognizing the common interest of all humankind in the progress of the exploration and use of outer space for peaceful purposes. But some Governments contend that exploitation of space resources is permissible, including by private sector actors.

42. The Committee on the Peaceful Uses of Outer Space has begun research on space resources, in line with growing interest from the private sector on the compatibility of space resource exploitation with the provisions of the Outer Space Treaty. The central question is whether the exploitation and utilization of space resources, including ownership and transfer rights, is an exercise of free exploration and use of space allowed under the Outer Space Treaty, or whether such activities amount to a prohibited appropriation of the Moon and other celestial bodies.

43. The outcome of this debate is central to the future exploration of celestial bodies throughout the Solar system as access to space resources will be essential to support sustained deep-space human presence, enable construction of human and robotic settlements and develop fuel sources far from Earth.

44. As a growing number of States intend to establish and operate settlements on the Moon, the locations of and access to scarce water ice deposits in craters at the lunar poles is vital. Accelerating existing work[9] to gain consensus on governance in this area would prevent harmful interference and facilitate information-sharing and operational coordination among those States engaging in such activities.

---

[9] In 2021, the Committee on the Peaceful Uses of Outer Space began to collect information on space resource activities and study existing legal frameworks to develop a set of initial recommended principles, taking into account the need to ensure that any such activities are carried out in accordance with international law and in a safe, sustainable, rational and peaceful manner. This research is expected to be completed by 2027.

D. Prevention of conflict in outer space

Additional normative frameworks are needed to prevent any extension of armed conflict into outer space and to prevent the weaponization of outer space

45. A major risk to outer space security is its emergence as a possible domain of military confrontation between major military powers. The combination of new space actors, the proliferation of space objects, the fact that many space-based services have both civil and military users and the increasing reliance of armed forces on space systems, exacerbates this risk.

46. Given these emerging risks, a number of national security strategies, doctrines, concepts and policies describe outer space as a warfighting or operational domain. These are not just theoretical concepts, they are being backed by the development of military capabilities to deny, disrupt, degrade or destroy the space systems of adversaries. This can include direct-ascent missiles, manoeuvrable satellites, Earth or space-based laser systems, electromagnetic and cyber capabilities or even the use of nuclear weapons.

47. A major challenge in space security is the dual-use nature of many capabilities. Any satellite capable of manoeuvring to change its orbit or to avoid a collision is also capable of manoeuvring purposefully into one. Any satellite designed to service, repair or refuel another satellite could be instructed to cause damage instead.

48. An armed conflict that extends into outer space would significantly increase the potential for space debris and the compromising of critical civilian infrastructure, disrupting communications, observation and navigation capabilities that are vital to the global supply chain. These conflict risks are particularly acute for emerging space nations as they may lack sufficient space situational awareness to detect possible threats or the manoeuvring capability to respond to them.

V. Recommendations

A. Recommendations to Member States

49. To harness the potential of outer space for the achievement of the Sustainable Development Goals, and to mitigate the risks posed by a rapidly changing space environment, I present the following set of recommendations:

Sustainability of outer space

- OPTION 1. The Committee on the Peaceful Uses of Outer Space to develop a unified regime for space sustainability. Such a regime, developed in cooperation with relevant bodies of the United Nations system, would foster transparency, confidence-building and the interoperability of space operations in Earth orbit and beyond, including on the Moon and other celestial bodies. This regime should also incorporate a platform for broader operational stakeholder inclusion.

  OPTION 2. Alternatively, the Committee on the Peaceful Uses of Outer Space could consider developing new governance frameworks for various areas of space sustainability. Such frameworks, which would comprise separate, mutually reinforcing instruments, should also be developed in cooperation with relevant bodies of the United Nations system and incorporate a platform for broader operational stakeholder inclusion.

Issues to be addressed by the regime or frameworks would include:

– **Space traffic management**. Develop an effective framework for the coordination of space situational awareness, space object manoeuvres and space objects and events.

– **Space debris removal**. Develop norms and principles for space debris removal that take into account the legal and scientific aspects of space debris removal.

– **Space resource activities**. Develop an effective framework for sustainable exploration, exploitation and utilization of the Moon and other celestial bodies. This framework could include binding and non-legally binding aspects and should build upon the five United Nations treaties on outer space and other instruments for international cooperation in the peaceful uses of outer space.

• The Committee on the Peaceful Uses of Outer Space to establish an international mechanism to coordinate the implementation of the proposed regime or governance frameworks on the sustainability of outer space, taking into account the five United Nations treaties on outer space and other instruments for international cooperation in the peaceful uses of outer space. This international coordination mechanism, developed in cooperation with relevant bodies of the United Nations system, should incorporate a platform for broader operational stakeholder inclusion.

Security of outer space

• Member States to develop, with the widest possible acceptance, international norms, rules and principles to address threats to space systems and, on that basis, launch negotiations on a treaty to ensure peace, security and the prevention of an arms race in outer space. This could be done through the relevant disarmament bodies of the United Nations.

Inclusive approaches to outer space governance

• Member States to consider how to facilitate the participation of commercial actors, civil society representatives and other relevant actors in the work of outer space-related intergovernmental processes, given the increasing importance of non-governmental actors in outer space activities, including as mentioned in the report of the High-level Advisory Board on Effective Multilateralism.

• United Nations bodies dealing with issues of outer space to ensure the equal representation of women in their composition.

B. Recommendations for United Nations entities

• United Nations entities to accelerate efforts to advance the equal participation of women in the aerospace sector, including through programmes that promote science, technology, engineering and mathematics education for girls. Partnerships with commercial actors in all regions should be considered to scale up these efforts.

• United Nations entities to increase their collaboration, including through the Inter-Agency Meeting on Outer Space Activities (UN-Space), with a view to better coordinating their data-sharing, building United Nations system capacity and cooperating on the procurement of space-based information, to accelerate the application of space assets in order to achieve the Sustainable Development Goals.

VI. Conclusion

50. Over the past decade we have witnessed a fundamental change in the actors, ambitions and opportunities in outer space, and a new era of space exploration has come rapidly upon the multilateral system. It is our shared responsibility to ensure that existing international space law is fully implemented, and that effective governance is in place to propel innovation and mitigate risks.

Annex I

Treaties on outer space

Year of adoption	*Title*
1963	Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water
1963	Radio Regulations (ITU – last updated in 2019)
1967	Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies
1968	Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space
1971	Convention on International Liability for Damage Caused by Space Objects
1974	Convention on Registration of Objects Launched into Outer Space
1977	Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques
1979	Agreement Governing the Activities of States on the Moon and Other Celestial Bodies

Annex II

Outer space principles and declarations

Year	*Title*
1963	Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space
1982	Principles Governing the use by States of Artificial Earth Satellites for International Direct Television Broadcasting
1986	Principles Relating to Remote Sensing of the Earth from Outer Space
1992	Principles Relevant to the Use of Nuclear Power Sources in Outer Space
1996	Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interest of All States, Taking into Particular Account the Needs of Developing Countries

Annex III

Outer space resolutions and guidelines

Year	*Title*
1961	International cooperation in the peaceful uses of outer space (General Assembly resolution 1721 (XVI))
1993	ITU recommendation ITU-R S.1003 – Environmental protection of the geostationary-satellite orbit
2004	Application of the concept of the “launching State” (General Assembly resolution 59/115)
2007	Recommendations on enhancing the practice of States and international intergovernmental organizations in registering space objects (General Assembly resolution 62/101)
2007	Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space
2009	Safety Framework for Nuclear Power Source Applications in Outer Space
2013	Recommendations on national legislation relevant to the peaceful exploration and use of outer space (General Assembly resolution 68/74)
2013	Recommendations to promote the practical implementation of transparency and confidence-building measures in outer space activities of the Group of Governmental Experts on Transparency and Confidence-Building Measures in Outer Space Activities
2019	Guidelines for the Long-term Sustainability of Outer Space Activities of the Committee on the Peaceful Uses of Outer Space
2021	The “Space2030” Agenda: space as a driver of sustainable development (General Assembly resolution 76/3)
2022	ITU resolution 218 – ITU’s role in the implementation of the “Space2030” Agenda: space as a driver of sustainable development, and its follow-up and review process

Annex IV

Subcommittees and activities of the Committee on the Peaceful Uses of Outer Space

Current working groups of the Scientific and Technical Subcommittee	
Working Group of the Whole	The Working Group presently considers a number of issues, including the use of space technology for socioeconomic development in the context of the Sustainable Development Goals.
Working Group on the Use of Nuclear Power Sources in Outer Space	The Working Group has a long record of productive work under matters under its consideration. In 2009, the Working Group developed, jointly with the International Atomic Energy Agency (IAEA), the Safety Framework for Nuclear Power Source Applications in Outer Space.
Working Group on the Long-term Sustainability of Outer Space Activities	The Working Group is identifying and studying challenges and considering possible new guidelines; sharing experiences, practices and lessons learned from voluntary national implementation of the adopted Guidelines; and raising awareness and building capacity, in particular among emerging space nations and developing countries.
Current working groups of the Legal Subcommittee	
Working Group on the Status and Application of the Five United Nations Treaties on Outer Space	The Working Group was established under the Legal Subcommittee to review the status of the treaties, their implementation and obstacles to their universal acceptance, as well as to promote space law.
Working Group on the Definition and Delimitation of Outer Space	The Working Group considers various matters relating to the definition and delimitation of outer space.
Working Group on Legal Aspects of Space Resource Activities	The Working Group considers views on potential legal models for activities in the exploration, exploitation and utilization of space resources.