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Space Activities for Sustainability and the Role of the National Space Agencies

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Abstract

The sustainability of outer space activities incorporates the Legislation, Regulatory, Policy, Safety, and Capacity building as provided in the "Guidelines for the Long-Term Sustainability of Outer Space Activities" (LTS Guidelines), scientific, international cooperation, and technical. With regard to the regulatory aspect, the national space agencies play a vital role in ensuring the sustainability of outer space. They are bestowed with the power to regulate, supervise, and implement space issues in their respective jurisdictions. This paper examined the intersection between outer space activities and sustainability and the role that national space agencies play in ensuring that outer space is a better place. The paper examines the impacts of these activities on outer space environmental conservation, resource management, and disaster response on Earth. Furthermore, it discusses how sustainable development goals can be achieved through responsible space exploration and utilization. The analysis of the role of space agencies with regard to space activities and sustainability and the role of development countries without space agencies fulfilling their international obligations with regard to space exploration and sustainability were also carefully examined. The study employed the documentary review method. The International Treaties, Conventions, United Nations Declaration, and Resolutions were critically examined to explore how they address the issue of space activities and sustainability. In doing this, the legal challenges towards space activities and sustainability were carefully examined, and better ways were proposed to enhance sustainability in outer space. The study established that, though the outer space Treaties and Conventions address the issue of space activities and sustainability, there are still some challenges to their effect. It is so because the Outer Space Treaties and Conventions provisions are not clear; as a result, a number of legal gaps emerged in addressing outer space sustainability, hence ineffective in protecting the outer space environment from the negative effects

resulting from space activities.

Keywords

Space Activities, Sustainability, Outer Space, Role of Space Agencies

1. Introduction

Activities in space have grown dramatically since the Soviet Union launched Sputnik, the first artificial satellite, in 1957. Today, Space capabilities are no longer only a luxury for states; even in developing nations, they are becoming a vital tool for national security and development. (Ferreira-Snyman, 2023: p. 2) Furthermore, unlike the early years of space flight, which were dominated by the military and political concerns of the two superpowers—the US and the Soviet Union (Ferreira-Snyman, 2023) at the time—a new era of space has emerged in which private companies, as well as states under the umbrella of national space agencies, are now major players in the space arena. They are also involved in the deployment of communication satellites, launch services, cargo and human transport to the International Space Station[1], and the development of technology for outer space settlements and space tourism[2]. Space resources on celestial planets have become particularly valuable in recent years, and this has become the driving force behind "the current space race among numerous nations and private enterprises." The number of space actors has significantly increased, making outer space a crowded and competitive environment. It goes without saying that the substantial rise in both state-sponsored and private space endeavors has consequences for the preservation and sustainability of the outer space environment (Ferreira-Snyman, 2023: p. 3). Therefore, this paper focuses on the analysis of space activities *vis a vis* outer space sustainability; in particular, the paper analyses the role of national space agencies as consumers, owners, operators, regulators, and investors towards the sustainability of outer space.

2. Design, Methodology and Approach

The paper mainly consists of data obtained through a desk review of theoretical and empirical literature. The author examined international Treaties, Conventions, United Nations Declarations, and Resolutions relevant to the outer space sector, exploring to what extent they address the issues of space activities and sus-

[1]For example, the involvement of private companies such as SpaceX in the launching of satellites and the transporting of goods and astronauts to the International Space Station. 2022. https://www.spacex.com/human

[2]See Revfine Date unknown https://www.revfine.com/space-tourism/. On the legal challenges related to space tourism, see Abul Failat and Ferreira-Snyman "Regulation of the Space Tourism Sector", pp. 301-346; Ferreira-Snyman 2014 PELJ 2-50.

tainability. International and regional legal instruments ratified by states, particularly Tanzania, were reviewed to assess the level of compliance with international obligations on the protection of the space environment from space activities. Beijing Institute of Technology's main library was utilized to access physical and e-materials in the form of textbooks, journal articles, domestic and international legal documents, national policies, guidelines, decided cases, reports, theses, papers, and other relevant material for the study. These were carefully analyzed to establish the current legal practice regarding space activities and sustainability. The paper is arranged into five parts, namely, introduction, methodology, findings or outcomes, conclusion, and recommendations.

3. General Understanding of Space Activities and Sustainability

3.1. Space Activities

The United Nations (UN) space instruments do not provide a definition of space activities (Goguichvili et al., 2021) but, in reality, in one of the fundamental monographs, the term space activities tends to be defined as the actions that pave the way for space to be accessed, explored, or used from orbit. (Space Finland, 2024) Consequently, everything done with the goal of reaching, staying in, or returning from space is considered a space activity. (Morozova & Laurenava, 2021)

Launching an item into space, operating or otherwise controlling it while in space, and returning it to Earth are all considered space operations under the Convention on International Liability for Damages Caused by Space Objects.[3] Everything that has been or will be sent into space, including components of that item, and everything that has been or will be used to launch an object into space, including components of that equipment, is collectively referred to as a space object.[4] Since the space object, its components, the launcher, or even parts of the launcher might all be the source of harm, a broad definition is used to include all of these entities. (Panakkal, 2026) Some pieces may be accidentally taken from the space object in the event of a crash or malfunction; others may be purposely removed, for instance, when the different components of the rocket vehicle break free in a controlled fashion.[5]

Due to a lack of infrastructure in some nations, such as Finland, operators must source space objects from outside Finland if they want to launch them into orbit.[6] Procuring launch services from a launch provider is considered as launching a space object and is therefore classified as a space activity according to the Con-

[3]United Nations (UN), Treaty Series, vol. 961, No. 13810.

[4]Article 1 (d) of the Convention on International Liability for damage Caused by Space Object (United Nations (UN), Treaty Series, Vol. 961, No. 13810 and Law Insider (2024), Space object Definition, on 15th October, 2024.

[5]Space Debris 101: A piece of space debris the size of a blueberry can create the impact of a falling anvil. Here's everything else you need to know about space debris.
https://aerospace.org/article/space-debris-101

[6]Finland Space Act (2024).

vention on International Liability for Damage Caused by Space Objects[7] and preliminary work on the act on Space Activities.[8] Any action pertaining to an orbital position, flight circumstances, or movement in space is considered part of the operation of a space object. (Glenn Research Center, 2024) The phrase "other control of a space object in space" refers to the ability to influence a space object in ways other than just turning it off.[9] Spacecraft that have lost all functionality or whose orbital motions are beyond human control are likewise subject to the Act on Space Activities.[10]

3.2. Sustainability and Outer Space

The term sustainable development in relation to space programme can be defined as the space exploration and peaceful use of space can only be considered sustainable if they can continue forever into the future without compromising the environment for future generations and ensuring that all people, regardless of their financial situation, have equal access to the benefits of space travel.[11] The concept sustainability contains three angles; 'economic growth', 'environmental protection,' and 'social responsibility' (Nooten, 2000). On Earth, when it comes to the environmental angle, it suggests that the emission of pollutants 'does not surpass the size of the water, soil, and air to preserve their quality, which is at least adequate for the lives of people, plants, and animals'. (Jovanović et al., 2023) In terms of economic angle needs that sustainable development permits the growth of the economy, a rise in domestic product, and creates employment opportunities. (Jovanović et al., 2023) With regard to the social angle, it suggests that sustainable development enables "social justice" with the aim of eliminating poverty and improving life quality. (Jovanović et al., 2023)

4. Active Participants in Space Activities

The Outer Space Treaty (1967),[12] the Rescue Agreement (1968),[13] the Liability Convention (1972),[14] the Registration Convention (1975),[15] and the Moon Agreement (1979)[16] are some of the treaties and agreements that have been established by the United Nations (UN). These treaties and agreements form the primary basis for the legal framework that governs activities that take place in space. (Space Foundation Editorial Team, 2023)

A recent monograph of the United Nations Office for Outer Space Affairs

[7]United Nations (UN), Treaty Series, vol. 961, No. 19810.

[8]Supra note, the Act on Space Activities (Number 63 of 2018).

[9]Section 4 (1) of the Act on Space Activities (Number 63 of 2018).

[10]Supra note, Space Finland (2024).

[11]Definition developed by the UN COPUOS Sustainability Working Group.

[12]Supra note, the Outer Space Treaty (1967).

[13]Supra note, the Rescue Agreement (1968).

[14]Supra note, the Liability Convention (1972).

[15]Supra note, the Registration Convention (1975).

[16]Supra note, the Moon Agreement (1979).

(UNOOSA) provided that Countries and corporate enterprises that are new to space operations, known as emerging space players, often have great difficulties in understanding and complying with the intricate legal structure that governs space. (United Nations Office for Outer Space Affairs, 2024a) A number of treaties and accords drafted by the UN largely codify the concepts of international law pertaining to space operations; therefore, participation in the space program enables new space actors to establish regulatory frameworks that guarantee their space activities are carried out in a responsible, sustainable, and lawful manner; this helps both the individual actors by making their operations more transparent and stable and the larger international endeavor to keep space for peaceful purposes and the benefit of all humans. (United Nations Office for Outer Space Affairs, 2024a)

Assessing the scale and activity of the many different sorts of entities active in the space economy may be somewhat complex. There are a wide variety of players in this space, including government agencies, academic institutions, major corporations, and small and medium-sized businesses. (Eenmaa, 2024) With regard to this paper, including public actors, private actors, and emerging space actors, the following is comprehensively illustrated.

4.1. Public Actors

One of the main groups involved in space exploration is the public sector. Government agencies are considered "actors" in the space economy because of their significant roles as consumers, owners, operators, regulators, and investors. (OECD, 2015) Government engagement is critical for the overall sustainability of the space economy and for addressing the strategic consequences of such intricate systems, just as it is in the case with large terrestrial infrastructure systems involving water and energy. (OECD Space Forum, 2022) Many different governmental entities, such as a space agency and a technological Centre, are involved in space research and development, and it is not always easy to tell who is doing what. There is a common practice of using the Frascati Manual, an international categorization of space research and development players, to compile comparable statistics on government-initiated research and activities. (OECD, 2010)

Those who administer the state and the community's economic and social policies are also considered government actors involved in space research and development, as stated in the Frascati Manual (OECD, 2002). (a) This includes all departments, offices, and other bodies that provide common services other than higher education to the community without selling them. (b) Organizations that are not for profit and receive the majority of their funding from the government are not a part of the higher education system. (c) The commercial enterprise categories include public or partly public firms, which are often highly involved in the space industry. (OECD, 2002)

Regardless of their funding or legal standing, all post-secondary educational institutions, such as universities and schools of technology, are considered higher

education actors under the Frascati Manual's criteria.[17] It also encompasses all medical centers, research facilities, and experimental stations that are directly or indirectly linked to or overseen by universities.[18] When it comes to higher education, private institutions like universities that have received formal recognition from the state are considered.[19]

4.2. Private Actors and Emerging Space Actors

The term private actors in the exploration of space activities refers to the growing number of businesses and startups that are engaged in space-related endeavors such as satellite manufacturing, space exploration, space tourism, and launch services. (Ayman, 2024) The term "emerging space actors" describes state and non-state entities that have recently entered the space industry. In this regard, private space actors also include emerging space actors. As provided by Article VI of the Outer Space Treaty,[20] the state is duty-bound to supervise, monitor, and provide official approval to these non-governmental entities in outer space; otherwise, the state shall be responsible. (Schaefer, 2018)

Some examples of the players include new nations, the commercial sector, academic institutions, and even individual people who are working to improve military and security intelligence, track climate change, increase navigational capabilities, or launch space tourism ventures. (Ellison, 2023)

The following are examples of private space actors/emerging space actors: new nations (with over 70 nations now running space programs and several more doing space exploration). Rather than relying on huge government grants, smaller countries have been able to launch space projects thanks to the commercial space industry. (Secure World Foundation, 2024) Both academic institutions and individual citizens engage in space-related endeavors, including climate change monitoring, navigational improvement, and the establishment of space tourism enterprises. (Secure World Foundation, 2024)

The intricate legal structure controlling space poses a hurdle to emerging space entities. (Goessle, 2022) On the other hand, this change opens up new possibilities for collaboration and creativity, as well as expanding everyone's access to space. Latin American countries like Mexico, Argentina, and Brazil are examples of rising space-faring powers. The African and Middle Eastern countries of South Africa, Egypt, Kenya, Saudi Arabia, Iran, UAE, and Türkiye, respectively. The Asia-Pacific area includes South Korea, Vietnam, Indonesia, Australia, and New Zealand. (López, 2024)

Governments throughout the world support civil space agencies so that their citizens may develop their space capabilities. Building a space agency does not adhere to any one uniform concept. Rather, many governments have conferred upon

[17]Supra note, OECD (2004).

[18]Ibid.

[19]Supra note, OECD (20O4).

[20]Outer Space Treaty (n 44) art VI.

them a wide variety of functions and responsibilities over the years.

Here, space agencies are but one kind of participant among many in national space sectors; other players might engage in space operations independently of them. The construction of spacecraft and launch vehicles, lunar landers, and human spaceflight was once the purview of space agencies, but now both private companies and the government are becoming involved. (Royal Museums Greenwich, 2021) Regardless, there were at least 72 separate national space agencies operating in 2019. In the last six years alone, sixteen of these nations have set up space agencies, and three more have announced intentions to do the same. (Defense Intelligence Agency, 2019)

Given the proliferation of space agencies in recent years, it's safe to assume that these organizations will play a significant role in the new space age. Approximately 120 countries do not have their own national space agency. As they contemplate creating one, many of these nations may have similar dilemmas in the years to come.[21]

5. The Space Activities and Impacts

The implemented system to control space activities and their effects has been initiated through UN. (United Nations Office for Outer Space Affairs, 2024) Cooperation on a global scale to govern space activities and negotiate and approve space-related treaties and agreements is largely the purview of the United Nations (UN), although other organizations do play a role. (United Nations Office for Outer Space Affairs, 2024) From this angle, the state parties, while exploring outer space, shall be guided by the principle of cooperation and mutual assistance as provided under Article IX of the Treaty on Principles Governing the Activities in the Exploration and Use of Outer Space, Including The Moon and other Celestial Bodies[22]. This article categorically provides that the exploitation of outer space has to be conducted so as to avoid harmful contamination[23].

There are now 193 member states that make up the UN (as of 2018). UN policy and representation are primarily carried out by the United Nations General Assembly (UNGA). (UNGA, 2024) In order to facilitate the UNGA's work on global concerns, six permanent committees are in place; two of these committees play a particularly crucial role in space affairs. Special political issues, such as space, are the purview of the Fourth Committee, whereas disarmament and security are the purview of the First Committee. (Britannica, 2024) To advance and codify the international legal framework controlling outer space and to promote international cooperation in the peaceful uses of outer space, the United Nations (UN) established the Committee on the Peaceful Uses of Outer Space (COPUOS). Defense space matters are beyond the purview of COPUOS. The

[21]Supra note, Royal Museums Greenwich (2021).

[22]United Nations (UN), Treaty Series, vol. 610, No. 8843.

[23]Treaty on Principles Governing the Activities in the Exploration and Use of Outer Space, including the Moon and other Celestial Bodies.

Fourth Committee is responsible for reporting COPUOS annually to the UNGA. The secretariat for COPUOS is the United Nations Office for Outer Space Affairs (UNOOSA), which is a subset of the broader UN secretariat. (Britannica, 2024)

When it comes to the political, scientific, legal, and technological elements of space operations, the Office is in charge of a lot of things, including the United Nations Programme on Space Applications. (UNOV, 2024) The worldwide venue for disarmament efforts and subjects pertaining to space weapons and other space security concerns is the Conference on Disarmament (CD), which is not an official UN institution but operates under UN auspices. (Conference on Disarmament (CD), 2024) Through the First Committee, the CD submits its yearly report to the UNGA. (General Assembly of the United Nations, 1946) The most prominent international platform for debating matters of space governance, COPUOS is comprised of 92 member states and 37 permanent observers, one of which is the Secure World Foundation (SWF). (COPUOS, 2024a) Its Scientific and Technical Subcommittee and its Legal Subcommittee split up the workload. All matters referred to COPUOS are first discussed in working groups inside a specific subcommittee. Once a consensus is established, the topic is then brought before the whole committee as a report from the subcommittee. (COPUOS, 2024b)

Following further discussion, COPUOS will draft a report and, if necessary, a resolution to submit to the UN General Assembly for confirmation as a resolution (UNOOSA Organization Chart, 2024). When it comes to disarmament and armaments control, the world stage is the CD. The avoidance of a space arms race (PAROS) is one of its primary goals. That being the case, it covers space and security weaponry. (Federation of American Scientists, 2012) When it comes to preventing a space race, the United Nations Institute for Disarmament Research (UNIDIR) is a great resource for decision-level information that the CD may use.[24] In addition to keeping track of objects launched into space, the UNOOSA is in charge of carrying out resolutions passed by the UN General Assembly that pertain to space. (Stakeholder Study, 2023)

6. Evaluation of the Space Treaties and Standards against Space Sustainability

In this section of this paper, various space treaties and standards established by international organizations such as the United Nations (UN) and the International Telecommunication Union will be critically analyzed. The evaluation will focus on the effectiveness of these agreements in promoting peaceful cooperation, preventing conflicts, and ensuring sustainable use of outer space resources. Additionally, the implications of emerging technologies and new actors in the space industry on existing treaties will also be examined to assess their relevance and adaptability in a rapidly evolving space environment.

[24]UNIDIR's work focuses on: UNIDIR's Programmes and Projects. https://unidir.org

6.1. Analysis of the Applicability of Space Treaties against Sustainability

The five treaties pertaining to space operations were all drafted by COPUOS. The Outer Space Treaty (OST) of 1967 lays the groundwork for the space law that the subsequent four accords build upon.[25] Concerning orbital debris reduction, cooperation arrangements for exchanging remote sensing data, and other associated subjects, COPUOS has negotiated further non-binding agreements for space. (United Nations Office for Outer Space Affairs, 2024b) With its opening to signatures in 1967, the Outer Space Treaty came into effect in the same year.[26]

International space law is based on the treaty, which has been ratified by more than 100 governments.[27] Some important principles include the right of all states, regardless of their level of development, to peacefully explore and use space for the benefit of all humans; the prohibition of any nation's claim to control over space or celestial objects; the prohibition of nuclear, chemical, or biological weapons in orbit or on space; the duty and obligation of each state to oversee its own space programs; the liability of each state for damages caused by its spacecraft; and the proclamation that each state must refrain from polluting space and other celestial bodies. (United Nations Office for Outer Space Affairs, 2024d)

The Rescue Agreement (1968): The purpose of the Rescue Agreement (1968) is to ensure that states respond to astronauts in distress and bring them back to the state from where they were launched.[28] It also aims to help the states that launched the spacecraft recover any objects that fall to Earth from beyond their territory.[29] Defining the procedures for the settlement of claims for damages, the Liability Convention (1972) lays out the responsibility of launching states for any harm caused on Earth or in space by their space objects.[30] The launching states are obligated to keep track of their space objects in a registry and to furnish the United Nations (UN) with details regarding these objects according to the Registration Convention (1976).[31]

The 1984 Moon Agreement Declares and expands upon the provisions of the OST that pertain to lunar exploration and the use of lunar resources. This treaty is in effect, although few nations have signed it, and even fewer actually follow its provisions.[32]Efforts to address space weapons and space security at the UN Conference on Disarmament, efforts to establish a plan to mitigate the threat of potentially hazardous asteroids, discussions between public and private en-

[25]Supra note, Outer Space Treaty (OST) of 1967.

[26]Supra note, Outer Space Treaty (OST) of 1967.

[27]Laws of the Final Frontier: What is Space Law (2024).
https://onlinelearning.csuohio.edu/blog/jd/laws-final-frontier-what-space-law

[28]Supra note, the purpose of the Rescue Agreement (1968).

[29]Ibid.

[30]Supra note, the Liability Convention (1972).

[31]Supra note, the Registration Convention (1976).

[32]Supra note, the 1984 Moon Agreement.

tities on international civil space situational awareness, and other initiatives are all components of space governance.[33] COPUOS has also endorsed voluntary guidelines for orbital debris mitigation.[34] The fundamental principles of international space policy may be transformed into workable, coordinated, and interconnected legal frameworks by laying the groundwork for space governance systems.[35]

6.2. Analysis of the Applicability of Space Standards against Sustainability

It became apparent in the 1960s that a global system agreed upon by participating states was necessary to control the commercial and public use of geosynchronous orbit for communications and other services. (Secure World Foundation, 2013) The United Nations (UN) charged the International Telecommunication Union (ITU) with overseeing the 35,786 km high Geosynchronous Earth Orbit (GEO) belt in 1963 to prevent electromagnetic and physical interference. (The UN Agency for Digital Technology, 2023) The ITU was founded in 1865 to establish global radiocommunication standards. Assigning GEO-(Geostationary Earth Orbit) spaces to states is the responsibility of the International Telecommunication Union's radiocommunication sector.[36] The Constitution of ITU bans "harmful interference" in the context of telecommunication service; "*All stations, whatever their purpose, must be established and operated in such a manner as not to cause harmful interference to the radio services or communications of other Member States…*"[37] However, article IX OST uses the term 'Harmful interference' in a broader concept. It encompasses all possible kinds or forms of interference and is not limited to radio electricity, which can cause substantial harm to the peaceful space activity of another state. (Keeping the Night Sky Clear, 2023)

When allocating GEO slots to Member States, the International Telecommunication Union takes three things into account: orbital parameters (the number of degrees longitude to the west or east), the frequencies used, and the areas covered by each state (or footprint).[38] Government space agencies from across the world get together in the Inter-Agency Space Debris Coordination Committee (IADC) to discuss and work on solutions to the problems caused by both natural and man-made space debris. (Inter-Agency Space Debris Coordination Committee, 2024) The main goals of the International Astronomical Debris Coordinating Commit-

[33]Supra note, UN Conference on Disarmament.

[34]Ibid.

[35]Ibid.

[36]Supra note, Secure World Foundation (2013), International Governance of Space Activities.

[37]91 Article 45 of the ITU Constitution. Also in the ITU Radio Regulations, ITU RR 1.169: "Harmful interference—interference which endangers the functioning of radio navigation service or of other safety services or seriously degrades, obstructs, or repeatedly interrupts a radio communication service operating in accordance with Radio Regulations".
https://search.itu.int/history/HistoryDigitalCollectionDocLibrary/1.43.48.en.101.pdf

[38]https://www.swfound.org/

tee (IADC) are the following: to share data on space debris; to collaborate on research among member space agencies; to review the status of current cooperative efforts; to find ways to reduce the amount of debris in space; and to facilitate opportunities for cooperation in this area of study. (Inter-Agency Space Debris Coordination Committee, 2024)

A set of voluntary recommendations aimed at reducing the generation of orbital debris has been released by the IADC. (Inter-Agency Space Debris Coordination Committee, 2024) The UN General Assembly adopted a resolution in 2008 that included the majority of these rules, which were submitted by COPUOS. (Inter-Agency Space Debris Coordination Committee, 2024) The new guidelines were again implemented to cover operational issues related to the new space activities. These are the 2021 IADC Space Debris Mitigation Guidelines, the 2007 UN COPUOS Space Debris Mitigation Guidelines, and the ISO-24113:2019 "Space Systems—Space Debris Mitigation" standard[39]. The following are some of the guidelines: reduce the amount of trash produced during normal operations; dispose of spacecraft when the mission is over; avoid collisions while in orbit; and ban the deliberate destruction of satellites. (Inter-Agency Space Debris Coordination Committee, 2024)

Article IX OST is, however, not free from encumbrances. The article uses the phrase 'other state parties'. This could mean that there is no obligation in whatever form to take into consideration the interest of other states that are not state parties to the OST. Luckily, this encumbrance is remedied by the fourth sentence of the same article, which extends to cover all states, be they state parties or not, to the Treaty.[40]

7. Sustainable Development In-Relation to Space Activities

This section delves into the various international initiatives and collaborations aimed at promoting sustainable development in the context of space activities. It explores how different countries and organizations are working together to ensure that space exploration and utilization are conducted in a manner that is environmentally responsible and beneficial for all stakeholders involved. Additionally, it examines the challenges and opportunities that arise from these efforts, shedding light on the complexities of balancing technological advancement with sustainability goals in outer space.

7.1. International Initiatives towards Space Programme

More and more, governments throughout the world are acting in response to the growing concerns about the future of space. (Emerging Technologies, 2024) A number of global efforts have been launched in the last ten years to address some of the issues related to space sustainability. (Fogo, 2018) Many of these projects

[39]"Best Practices for the Sustainability of Space Operations" Version: 2.38 Date: May 2024.

[40]Outer Space Treaty article IX.

are different from their predecessors because they are bottom-up efforts that aim to create voluntary standards of conduct and, in some instances, include participation from non-state actors.[41] Although these efforts are not legally enforceable and are entirely voluntary, they are widely acknowledged as a significant first step towards establishing agreement on critical matters among several nations and space players.[42]

Three global projects were established to tackle issues related to space sustainability and security between 2008 and 2010. (United National Office for Outer Space Affairs, 2016) Among them are the following: a UNGA Group of Governmental Experts (GGE) discussing potential space transparency and confidence-building measures (TCBMs), an European Union (EU) effort to draft an international code of conduct for space activities for global consideration, and a UN COPUOS Working Group on the Long-Term Sustainability (LTS) of space activities.[43] The LTS Working Group outperformed the other two projects to assist in guaranteeing the sustainable use of space for the long term and the responsibility of creating a set of voluntary guidelines for all space players.[44]

June 2018 marked the conclusion of the Working Group's term of office. As part of its duties, the United Nations COPUOS ratified a preliminary document that provided background information and twenty-one recommendations. (Secure World Foundation, 2018) The States have also decided to keep talking about space sustainability in the Scientific and Technical Subcommittee of COPUOS, which has its own agenda item.[45] There have been recent initiatives to tackle space security head-on. In February 2018, the CD decided to establish four separate entities to handle certain agenda items as there was no overarching strategy. (Sebban, 2018) Examining PAROS was the responsibility of the third subsidiary body. It convened six times in 2018 and sent a report to the CD plenary after reaching a consensus. A procedural report, including the report of the subsidiary body, enables the public to examine the concepts included inside; nevertheless, the CD was unable to approve a final report to pass on to the UNGA. (Sebban, 2018)

A GGE on further practical steps on PAROS was requested by the UNGA to be formed by the Secretary-General in December 2017. The first gathering took place in August of 2018, the second one was in 2019, and the others in 2023. While the Russian-Chinese proposal for the Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force against Outer Space Objects (PPWT) served as a starting point for discussions, delegates also looked at what other TCBM elements could be added to make a PAROS agreement work, with

[41]Supra note, Emerging Technologies (2024).

[42]Ibid.

[43]Supra note, United National Office for Outer Space Affairs (2016), Long-term Sustainability of Outer Space Activities.

[44]Ibid.

[45]Supra note, the Scientific and Technical Subcommittee of COPUOS.

the goal of examining the elements of a legally binding treaty. (Bowman, 2021) Working group II was formed to investigate potential solutions to the problems raised by the 2013 GGE's recommendations regarding space TCBMs, and space security was included in the 2018-2020 work program of the UN Disarmament Commission, which is a subcommittee of the UN General Assembly.

7.2. International Collaborations towards Space Exploration

When the UN Committee on the Peaceful Uses of Outer Space (UN COPUOS) formed the Working Group on the Long-Term Sustainability (LTS) of Outer Space Activities in 2010, they began the process that would eventually lead to the UN COPUOS Long-Term Sustainability Guidelines.[46] To assist in guaranteeing the sustainable use of space for the long term, the Working Group was given the responsibility of creating a set of voluntary guidelines for all space players.[47] The Working Group gathered input from national delegations, international organizations, and four expert groups that were formed to assist with the formulation of the guidelines. Based on this information, the Working Group settled on 21 recommendations that are optional and not legally obligatory.[48]This entails how many international organizations and professional bodies concerned with space and related industries provided input to the Working Group and its subgroups, and these organization members have substantial backgrounds in space operations.[49]

In one of the scholarly monographs, Kendall, as the former chair of UN COPUOS, provided that to make space operations safer and more sustainable in the long run, 21 countries have come together to establish a set of standards for how to do things in space. (Longueuil, 2016) They are applicable to both governmental and non-governmental organizations, and they include topics such as space policy and regulation, operations and safety, science and technology, international collaboration, and capacity-building. (Longueuil, 2016) Their applicability extends to all space-related endeavors, both current and future, as far as is practically possible, and to the whole space mission life-cycle, from launch to operation to final disposal. (Longueuil, 2016)

While allowing for some leeway to tailor these standards to each country's needs, the principles are meant to bolster the establishment of global and national safety frameworks and practices for space operations. (Longueuil, 2016) In addition to ensuring the safety of space activities and the preservation of the space environment, they are designed to assist nations and international intergovernmental organizations in building their space capabilities. (News Space Economy, 2023) According to international law, the rules are just advisory. Nevertheless, regardless of this, the rules may still have legal character since governments might choose to

[46]Supra note, UN COPUOS Long-Term Sustainability Guidelines.

[47]Supra note, A. Henriksen, (2019).

[48]Ibid.

[49]Ibid.

include parts of the guidelines in their national laws, as the COPUOS guidelines for space debris mitigation have done. (News Space Economy, 2023) The following are examples: the 'US national space law comprises the National Environmental Policy Act (United States, 1970)', which must be observed by space missions at the time of their launch and re-entry phases. Another example is the 'Russian 1993 Law on Space Activity (Russian Federation, 1993)', which appeals to all members in space activities to take any crucial measures in order to evade any threat to the environment. Environmental criteria are part of the licensing procedures inter alia the '1986 UK Act on Outer Space Activities (United Kingdom, 1986)', 'the 1998 Australian Space Activities Act (Commonwealth of Australia, 1998, 2019)', 'the 2005 Belgian Law on the Activities of Launching, Flight Operation or Guidance of Space Objects (Belgium, 2014)', 'the 2006 Space Activities Act of The Netherlands (The Netherlands, 2006),' 'the French Law on Space Activities (Article 4) of 2008 (France, 2008)', to mention a few. (Hofmann & Bergamasco, 2020) It is highly recommended that states and international intergovernmental organizations adhere to these standards as much as is practically possible, taking into consideration their specific circumstances, resources, and current legal responsibilities. (News Space Economy, 2023)

8. Improving Space Situational Awareness

This section brings about how the national space agencies, spacecraft operators, governments, and commercial SSA providers may all benefit from sharing data in order to enhance forecasts and eliminate contradicting information. (World Economic Forum, 2024) This is just one of many ways that the idea of space situational awareness (SSA) can be enhanced. Information about impending manoeuvre, satellite movements, and conjunction warnings are all part of this. Adopting space-based systems is another approach. Tracking and avoiding space hazards may be made more accurate, efficient, and stable by moving technologies from the ground to space. (Lafleur, 2024) Moreover, early warning capabilities rely on investments in object identification via a reliable and accurate object identification system. As a substitute for laser radars, machine vision and ANN are being investigated. (Geospatial Intelligence for Defence and Security, 2024)

The concept of space situational awareness established for safety purposes while exploring outer space. (U.S. Federal Geographic Data Committee, 2005) Space activities of one state may cause 'harmful interference' with the activities of other states. In this case, the duty to international consultation comes in (SSA). Therefore, the state, through the National Space Agency, has to undertake appropriate international consultation prior to initiating such space activity as provided under Article IX OST. This, when adhered to, guarantees international cooperation with regard to the peaceful use of outer space. However, the weakness of this article is that, the duty to consult comes in only when the state party has reason to believe the activity or experiment planned would cause harmful interference to another. If there is no such belief, it is implied that this duty is not there.

Coming back to the issue of space situational awareness includes acquiring, analyzing, and regularly exercising space situational awareness (SSA). It entails keeping tabs on space objects and the operating environment in which they operate. (Space Safety Institute, 2024) Predicting when objects will come together and alerting space operators of potentially hazardous near approaches are both made possible by SSA data, which allows for collision avoidance actions. (Space Safety Institute, 2024) Natural disaster debris, meteor storm debris, or debris from fragmentation events might potentially impact space activities. Therefore, space situational awareness observed by space actors, including national space agencies, may reduce the threat in outer space when space is explored by space actors.

Right here are a few instances: The Centre for Orbital and Reentry Debris Studies (CORDS) at Aerospace has spent decades perfecting models of the environment of untraceable debris in order to measure future and present threats that cannot be seen. (The Center for Orbital and Reentry Debris Studies (CORDS), 2024) To better understand how different actions and regulations may influence debris production, collision rates, and satellite operating circumstances in the future, the Aerospace Debris Environment Projection Tool (ADEPT) studies the environment under several scenarios. Policies and standards of conduct can be better crafted with the use of ADEPT results. (The Center for Orbital and Reentry Debris Studies (CORDS), 2024)

While addressing the aspect of SSA, when it comes to processing SSN data, the United States Space Force has its own criteria for astrodynamic algorithms. In order to make the government's SGP4 orbit model more accurate and useful in more contexts, Aerospace recently modified it. (a.i. Solution, 2023) In order to include this new model, Aerospace collaborated with the US government to establish modifications to the two-line element (TLE). (Kelso, 2020) The TLE is used to specify satellite orbits in the US Air Force SSN catalogue. Globally, SGP4 is the most used propagator, while among orbit data formats, TLEs are by far the most utilised. As part of the new astrodynamics standard, the new propagator will be incorporated.[50]

Launches with many payloads make it particularly challenging to uniquely identify and determine orbits, particularly in the early stages of deployment. After a breakup incident, Aerospace tweaked the government's breakup processor so it could pinpoint the orbits of certain pieces. The goal of this program is to efficiently sort and catalogue the satellites that are launched in several payloads. (Bright Ascension, 2022) Hundreds or thousands of traceable pieces and tens of thousands (or more) of untraceable fragments that terminate a mission may be created by a fragmentation event in space. It might take days or weeks to catalogue even traceable bits, at that moment, they pose an unseen threat to satellites. (Fiveable, 2024)

Gathering and analyzing data is the backbone of space situational awareness.

[50]Supra note, a.i. Solution (2023).

Data collection from the many accessible sources, such as government, commercial, and international sensors, presents a variety of challenges. (Fiveable, 2024) It is essential to establish and agree upon standard formats and procedures for data transport. It follows that organizations like the SSI are contributing to the development of the shared vocabulary and comprehension essential to efficient space situational awareness. (Spatial Awareness, 2024)

9. Strategic Stability and Outer Space

The space program and its associated technologies are widely acknowledged to have several non-military uses and to be playing an ever-growing role in ensuring the safety of the world at large. (Vergun, 2023) Spacecraft like global positioning, navigation, and timing (PNT) systems, communications, intelligence, reconnaissance, and surveillance satellites are all part of the military's utilization of space. (Amir & Rehman, 2023) Nevertheless, the likelihood of any interference, real or perceived, with satellites could initiate or intensify tensions and conflicts in space or on Earth is growing as more nations incorporate space into their national military capabilities and depend on space-based information for national security. (Office of the Director of the National Intelligence, 2011) This is complicated further since it is not always easy to establish what caused a satellite to malfunction, whether it was an attack, space debris, unintended interference, or space weather. (Space Environment, 2024)

Certain nations are working on or have already created a variety of counter-space capabilities, including ground and space-based weaponry, that might be used to manipulate, obstruct, reject, diminish, or eliminate components of space systems. The development and testing of anti-satellite (ASAT) weapons would seriously jeopardize politics and strategy, particularly in the absence of clear intentions. (Starling-Daniels & Massa, 2024) In addition, the use or testing of weapons that generate debris has the potential to pollute the orbital environment for a lengthy period of time, impacting all space actors and making space operations unsustainable in the long run. (Union of Concerned Scientists, 2007) Although many technologies have both peaceful and violent applications, a trait known as "dual-use," it is exceedingly difficult to outright prohibit them. Also, it's not easy to confirm if ASAT capabilities exist or to identify which space players have used them. (Blatt, 2020) The establishment of behavioral standards that distinguish between acceptable and irresponsible space operations is, hence, a critical first step in meeting these issues. (Roberts & Bullock, 2020) Enabling the identification and attribution of irresponsible activity also requires improved SSA for all parties. Clarifying current international legislation pertaining to space and satellites is one example of a transparency and confidence-building measure (TCBM) that might improve strategic stability and security. (Robinson, 2010)

An unhealthy national security satellite named USA 193 was definitively destroyed in February 2008 by the United States. (Day, 2021) The satellite was

carrying large quantities of very hazardous hydrazine fuel and was due to re-enter Earth's atmosphere in a few months. (BBC, 2008) Officials chose to shoot it down with a modified Aegis SM-3 missile fired from the USS Lake Erie. This was done to guarantee that the hydrazine would scatter harmlessly during re-entry. In this instance, the US government gave advance notice of the event and intentionally hit the sick satellite while it was in a very low orbit, causing most of the debris to re-enter the atmosphere rapidly. (Zander, 2020) In this case, the US abides by Article IX of the Outer Space Treaty, which provides for the obligation to avoid harmful interference and undertake consultation. (de Zwart, Henderson, & Neumann, 2023)

In keeping with international accords, the US briefed other countries on the operation and made sure the intercept would produce little debris. Several hundred fragments of the resulting debris were back in the environment within eighteen months. (Kebschull, 2024) U.S. officials have repeatedly stated that the intercept was meant to lower the danger to public safety, but many still saw it as a demonstration of how an American anti-ballistic missile defence system can be converted into an ASAT weapon. This worry grows in light of the Aegis interceptor's upcoming improvements, which will enhance its power and enable it to access higher orbits. (Aegis Ballistic Missile Defense, 2023)

10. An Analysis of the Benefits of Stable Space Agency to Space Activities and Sustainability

This section covers an analysis of the benefits of a stable space agency for space activities, with subsections. The section on legal values for sustainable development narrates how the creation of a robust legal framework for national space agencies is vital for efficient governance and coordination of space activities. The section on economic values for sustainable development explores how a stable space agency can drive economic growth through investments in space technology and infrastructure. It also delves into the potential job creation and revenue generation that can result from a thriving space industry. Additionally, the paper examines how a stable space agency can contribute to environmental sustainability by monitoring climate change, managing natural resources, and conducting research on sustainable energy sources. The section on Political and National Security Advancement discusses how a stable space agency can enhance national security through satellite surveillance, communication systems, and international collaboration. It also explores the diplomatic benefits of participating in global space initiatives and promoting peaceful cooperation in outer space.

10.1. legal Values for Sustainable Development

Space agencies play a vital role in space activities and sustainability. They monitor space activities and assess their impact on the sustainability of the space environment. They are not doing this from thin air but backed with the legal framework available. When it comes to legal values for sustainable development in space ac-

tivities, the current legal, regulatory environmental framework for the exploitation of space resources is based on the 1967 Outer Space Treaty and the 1979 Moon Agreement. The exploitation of the radio spectrum is distinctly administered by the International 'Telecommunication Union's legal regime'.[51] These tools are supplemented by a number of soft law documents, such as the 'UN General Assembly's 1996 Space Benefits Declaration'[52] and 'UN COPUOS' 2019 Long-term Sustainability Guidelines'. The credentials fashioned by the UN COPUOS, particularly by its Working Group on Legal Aspects of Space Resource Activities, although in deficit of any normative character, also offer some guidance.[53] Other miscellaneous non-binding documents with relevance include but are not limited to; for example, 'the 2019 Hague Building Blocks for the Development of an International Framework on Space Resource Activities',[54] 'the 2020 Artemis Accords', (National Aeronautics and Space Administration, 2020), 'the 2021 International Lunar Research Station's Memorandum of Understanding'[55] and associated documents, and 'COSPAR's Planetary Protection Policy',[56] updated and amended from time to time.

Therefore, national Space Agencies can use these available legal resources to make sure the space activities within their jurisdiction are conducted within the ambit of national and international law and regulations. This comprises making sure the state and other actors are free to access, explore, and use outer space, which also includes other celestial bodies, without discrimination, as provided under Article I.[57] National Space Agencies are bestowed with the power of overseeing the activities of private companies and other non-governmental entities involved in space activities, such as the launching of objects as provided under Articles I and VI[58]. In other words, states, through their national space agencies, must give approval or permission to non-governmental entities, so they also monitor their private entities in outer space just to make sure they comply with conditions stipulated in the Outer Space Treaty. (Schaefer, 2018) Since 'state authorization 'is the core rule of Article VI of OST, it is now high time to address the duties of national space agencies under this article. First, it is the duty of 'authorization' and second, the duty of 'supervision'. In this case, the non-governmental entities have to be authorized by the suitable State Party through the national space agency to conduct commercial space

[51]Constitution and Convention of the International Telecommunication Union (adopted 22 December 1992, entered into force 1 July 1994) 1825-1826 UNTS 3, and Radio Regulations, as regularly updated.

[52]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, UNGA Res 51/122 (1996), GAOR 51st Session Supp 49, 114.

[53]COPUOS Working Group on Legal Aspects of Space Resource Activities, link 8.

[54]Building Blocks for the Development of an International Framework on Space Resource Activities. The Hague International Space Resources Governance Working Group, November 2019.

[55]Memorandum of Understanding between the Government of the People's Republic of China and the Government of the Russian Federation Regarding Cooperation for the Construction of the International Lunar Research Station, 9 March 2021.

[56]Committee on Space Research, Policy on Planetary Protection, 3 June 2021.

[57]Outer Space Treaty.

[58]Ibid.

activities, which subsequently must be supervised by that same State through its national space agency. To conform with this primary rule, States must, through their national parliament, enact domestic legislation containing all the necessities to be fulfilled so as to ensure that outer space is exploited peacefully and without any harm. This domestic legislation has to bestow this duty to their national space agencies. (Keeping the Night Sky Clear, 2023)

However, today's international legal regulation framework of space activities is often branded as outdated, underdeveloped, and/or ineffective. The Outer Space Treaty does not precisely talk about space activities, but it does encompass some provisions and formulas having a direct or indirect influence on those activities. These provisions provide, among others, that space activities must be performed in conformity with international law, in harmony with the principle of mutual assistance and cooperation, taking onboard the conforming interests of all other States and avoiding harmful contamination, 'adverse environmental changes and harmful interference'. The proper States are internationally accountable for their national space activities, and liability for damage caused by their space objects shall lie to the launching state[59].

The Moon Agreement explains and further advances these basic principles and contains a more thorough and rather liberal regulation of space activities. The agreement necessitates that states abstain from upsetting the existing 'balance of the lunar environment', make available notification of the placement of radioactive materials, and consider the special protection of international scientific preserves. (Bartóki-Gönczy et al., 2024)

10.2. Economic Values for Sustainable Development

The concept of economic values while exploiting space for sustainability encompasses a wide range of activities, including mining asteroids and the moon for their mineral content, as well as products and services created in space for use in space, also known as the space economy. (Weinzierl & Sarang, 2021) Anything having to do with exploring, researching, understanding, managing, and utilizing space is what the OECD calls it. (ESA Space Economy Portal, 2019) The space industry was valued at $469 billion in 2021, up 9% from the previous year, according to the Space Report 2022, published by the Space Foundation. (Space Foundation Editorial Team, 2022) According to the study, more spacecraft were launched in the first half of this year (2022) than in the first fifty-two years of space exploration, and more than 1,000 were placed into orbit (1957-2009). (Space Foundation Editorial Team, 2022)

More than $224 billion was brought in by space companies' goods and services, with the bulk of this sum coming from the private sector, as stated in the report. (The U.S. Bureau of Economic Analysis (BEA), 2024) Worldwide, state-backed investments in space programs have been on the rise, as reported by the Space Foundation. Government expenditure on space programs, both military and ci-

[59]Outer Space Treaty, Articles VI-VII, IX.

vilian, increased by 19% in the previous year. Investments in space exploration increased by 36% in India, 23% in China, and 18% in the United States.[60]

Since new technology is driving the space economy, the National Space Agencies are blessed with the power to exercise 'freedom of scientific investigation in outer space' among the actors. In doing so, the National Space Agency, as part of the national government, is duty-bound to make sure it facilitates and encourages international cooperation as provided under Article I.[61] In other words, one may say that space Agencies play a vital role in ensuring the fair, ration, and efficient use of limited space resources. For example, with the help of Space Agencies, the space renaissance has been coined to characterize the current state of affairs, in which technological advancements are drastically cutting prices while simultaneously producing new capabilities. (World Economic Forum, 2022a) With the help of Space Agencies, Rocket costs have decreased fourfold in the last decade, according to Planet Labs CEO Will Marshall, who shared this information at the World Economic Forum's Annual Meeting in Davos. Due to the availability of cheaper components, companies that would have previously spent hundreds of thousands of dollars to launch a satellite into orbit may now accomplish it for a fraction of that. (World Economic Forum, 2022a)

Again, with the help of Space Agencies, there has been a tenfold increase in the bandwidth of communications transported throughout the world and a tenfold increase in the creation of Earth imaging by area in the last five years. Improved imaging is leading to more responsibility. World Economic Forum (2022b) For instance, the Ukrainian war is being seen and documented around the globe thanks to commercial satellite data, which gives a bird' s-eye perspective of the ground situation. (Burns, 2022) Not only that, but also governments, through their national Space Agencies, can keep tabs on carbon dioxide emissions, businesses can monitor their environmental, social, and economic performance, and farmers can keep an eye on their crops using satellite imagery. (Mapbox, 2024)

Despite astronauts' best efforts to address the issue of space garbage, the over nine thousand metric tonnes of technology already in orbit are causing new complications, according to a scientific monograph published by NASA in 2022. (NASA Science Editorial Team, 2022) Orbiting the Earth are almost a hundred million bits of space junk, each one millimetre in size or bigger. (NASA Orbital Debris Program Office, 2024) Discarded spacecraft, broken machinery, and other objects from previous missions are all examples of this kind of trash. A small piece of debris, traveling at speeds of up to 28,160 kilometers per hour (17,500 miles per hour), may destroy a spacecraft or satellite. (NASA Orbital Debris Program Office, 2024) To address this problem, Space agencies are actively involved in efforts to reduce and manage space debris. They develop and implement guidelines and technologies to ensure that satellites and other space objects are disposed of responsibly at the end of their missions. For example, the Inter-Agency Space Debris Coordination Com-

[60]Supra note, Space Foundation Editorial Team (2022).

[61]Outer Space Treaty.

mittee (IADC) is composed of over a dozen national space agencies that work together to develop technical standards for space debris mitigation.

10.3. Environmental Values for Sustainability

The climate is in danger from galactic mega-constellations, the current rate of expansion cannot be maintained, and roughly 7,000 of the 11,000 satellites deployed in the previous 60 years are still orbiting the Earth. (Gutterman, 2024) As commercial entities like Starlink, Elon Musk's spacecraft, and Amazon joint public entities like China and other nation-states in constructing mega-constellations in Low Earth Orbit (LEO), however, by the decade's end, that figure might increase to the hundreds of thousands. (Pultarova & Howell, 2024) With hundreds upon thousands of satellites, some of these new constellations will soar into space. With a lifespan of five to ten years, each one will produce an enormous quantity of space debris, which would clog its own orbit and pose a threat to everything traveling through it.[62]

To this end, national Space Agencies strive day and night to get rid of this problem or to reduce it simply because space may improve Earth life if used wisely. Space Agencies conduct research and develop technologies to minimize the environmental impact of space activities, both in space and on Earth. In doing this, Space Agencies are in line with Article I[63], which emphasize the freedom of scientific investigation in outer space. The Article provides: "*There shall be freedom of scientific investigation in outer space, including the Moon and other celestial bodies, and States shall facilitate and encourage international cooperation in such investigation.*" This includes studying the effects of rocket launches on the atmosphere and developing more environmentally friendly propellants. On the other hand, Space Agencies, through space technology, enable more precise measurement of global carbon emissions and help farmers increase yields in a more sustainable way, allowing them to feed the world's expanding population.[64] The approximately three billion individuals who do not yet have access to the internet can only be connected via satellites. Countless businesses rely on satellite communications for their daily operations. This includes mining, retail, and more.[65]

To substantiate this, there are already several provisions of the UN space treaties that are relevant for the protection of the environment of outer space, which are used by national Space Agencies. Space Agencies, for example, are duty-bound to adhere to the principle of "*Preventing Transboundary Harm*" as provided under the International Law Commission (ILC) Draft Article on the Prevention of Transboundary Harm from Hazardous Activities. Therefore, the governments, through Space Agencies, should take all necessary measures to mitigate or prevent

[62]Ibid.

[63]Outer Space Treaty.

[64]Ibid.

[65]Ibid.

damage.[66] Another principle that must be adhered to by the state through Space Agencies in dealing with space activities is the 'Polluter Pays Principle.' The principle states that the 'polluter' must pay compensation for the damage produced. Distinct from the '1972 Convention on International Liability for Damage Caused by Space Objects (the "Liability Convention")', this one categorically talks about the environmental harm caused by activities.

With regards to OST, although it does not directly speak about sustainability, it, however, creates an obligation for the states through their national Space agencies to avoid 'harmful contamination', which is directly connected to the environmental and sustainability issues in wider terms. (de Zwart, Henderson, & Neumann, 2023) Article IX OST, for example, requires that States, through their national space agencies, pursue studies of outer space, including the Moon and other celestial bodies, and conduct exploration of them with the very aim of avoiding their '*harmful contamination*'. In a very same sense, it requires spacefaring nations to avoid adverse changes in the environment of the Earth resulting from the introduction of extra-terrestrial matter and, when necessary, to adopt appropriate preventative measures (de Zwart, Henderson, & Neumann, 2023). The very aim of Article IX is to limit the freedom of exploitation and use of outer space as provided under Article I, paragraph 2 of the OST. The key term under this article is relevant to this discussion is 'space activity'. With regard to this article, all state parties are duty bound to avoid harmful contamination of outer space and, therefore, through state and national space agencies, adopt necessary measures to get rid of those harmful. (Keeping the Night Sky Clear, 2023)

To this end, the application of the principle of sustainable use to outer space by space agencies is of paramount importance from a number of angles, including in space activities. In doing this, the national space agencies will be adhered to the Inter-Agency Space Coordination Committee approach (IADC)

Critics established through this legal study draw the conclusion that the laws used to control this valuable asset are now inadequate. The second paragraph of Article IX of OST, when interpreted literally, provides the limits with regard to the duty of the state parties to avoid harmful contamination only when conducting 'studies of outer space' and 'space exploration.' A literal interpretation of the second paragraph of Article IX OST limits the duty of States Parties to avoid harmful contamination only in the pursuance of "studies of outer space" and "space exploration." Again, the foundational element of the 2nd paragraph is the idea of "harmful contamination" and the associated obligation upon States Parties to avoid it. However, it does not specifically address which exact type of degradation of the outer space environment is forbidden and at what level (Kramer, 2014). When observed between the lines, one will conclude that the term 'harmful' in the first place attracts the idea that contamination is not *per se* prohibited, and therefore, the degree of contamination is lawful when exploration activities are conducted. (Lyall, 2010)

[66]Article 3 ILC PTH.

These problems are partially cured by the 1979 Moon Agreement, whose Article 7 (1) concerns the protection of the environment. It broadens the room of Article IX OST by explicitly including the 'exploitation' phase of space activities and by asserting the duty of States Parties to 'prevent the disruption of the existing balance' of the environment of celestial bodies. Although the idea of the 'harmful contamination' of celestial bodies is still not defined to date, it is without a single shadow of a doubt that these conditions give a more significant meaning to the provision. It is unfortunate that the Moon Agreement has a very minimal number of States Parties. The satisfactory details as to the implementation of Article IX OST and Article VII of the Moon Agreement are present in the 'Planetary Protection Policy formulated by the Committee on Space Research (COSPAR)'. This is a Scientific Committee of the International Council for Science (ICSU) which came into existence in 1958. The current updated policy version (COSPAR, 2005) approves the adoption of specific measures that should be observed before and after space missions.

Inmarsat laid out five principles in their recent Space Sustainability Report that governments, regulators (Space Agencies), and industry leaders in the space sector should use to find a solution and prevent a disaster. (World Economic Forum, 2022b)

The parties to space exploration, under the supervision of national Space Agencies, must ensure that operators throughout the world are on an equal footing first. Second, there has to be strong enforcement of the regulations, including penalties for rule-breakers, under the new regulatory structure. (World Economic Forum, 2022b) The third thing we need to do is put more money into data and analytics so we can learn more about the science behind it. Fourth, we must separate environmental protection from security concerns; nations should be free to exchange satellite tracking data without disclosing the missions they are carrying out. Lastly, since new technology is coming out at a lightning pace, rules need to be established and refined quickly.[67]

10.4. Political and National Security Advancement

On a more positive note, space exploration research studies through national space agencies will keep yielding discoveries that benefit mankind as a whole. (Government of Canada, 2020) The world witnessed several instances when collaboration had favourable results. For example, the handshake in space that brought Russian and American astronauts together helped ease tensions during the Cold War. (Uri, 2020) The world benefits from many of the space-related technologies that are now in development, particularly in the fields of medical and renewable energy. (Tavernier, 2022) There is no more common property than the fact that several nations are attempting to find methods to divert massive asteroids off a crash track that might wipe humanity off the face of the earth. (Royal Museums Greenwich, 2024) This is possible only if national space agencies continue to honor collaboration with one another.

[67]Supra note.

One such example of the power of collaboration in space is the International Space System; therefore, good relations and scientific progress were aided by the collaborations that took place. (National Aeronautics and Space Administration, 2024).

Unfortunately, Russia's invasion of Ukraine has shattered that particular cooperation, and the tense relationship between the US and China is one reason why rival power blocs will most likely control human space exploration in the near future. (Royal Museums Greenwich, 2024) Enacting legislation to promote collaboration among the leading space-faring countries, especially China and the United States, would facilitate the resolution of such issues. It is unrealistic to expect the two most powerful countries in the world to set aside their differences and work together. However, if they can overcome their suspicions and accept each other's differences, they will both profit much from sharing scientific knowledge, and the world will also reap the benefits. (Royal Museums Greenwich, 2024).

When it comes to keeping tabs on military and geopolitical developments, as well as verifying treaties and weapons control, space systems are indispensable. (Space System, 2024) The capacity of a nation to react to both natural and man-made catastrophes as well as to track environmental trends over the long term, depends on its space systems through its national government space agencies. (Underwood, 2024) According to a recent monograph by the Director of National Intelligence (2024), the worldwide economy, national security, international relations, scientific discovery, and our way of life have all been improved by the United States' leadership in space activities over the last half-century.

11. The Role of Developing Countries without Space Agencies in Outer Space Sustainability

Developing countries without space agencies also have a crucial role to play in the protection of outer space and sustainability. These countries, even without space agencies, participate fully in international organizations like the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS) and other space-related forums, where they can voice their interests and contribute to the development of international space law and norms especially in space sustainability. They are also the signatories to a number of outer space International Treaties to which they are bound. Take, for example, a country like Tanzania. Though a national space agency has yet to be established, the country is a signatory to the Convention on International Liability for Damage Caused by Space Objects (Liability Convention). (4 United Nations Office of Outer Space Affairs, 2024) Tanzania has also signed and ratified five other space-related treaties: Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and under Water of 1963 (Space Nuclear Ban Treaty); and Agreement Relating to the International Telecommunications Satellite Organization (ITSO Treaty) to mention a few.

When it comes to the declaration, Tanzania has also supported the following notable space-related UN declarations/principles and resolutions: Principles Gov-

erning Use by States of Artificial Earth Satellites for International Direct Television Broadcasting; The Principles Relating to Remote Sensing of the Earth from Outer Space; The Principles Relevant to the Use of Nuclear Power Sources in Outer Space Nuclear Power Sources Principles; and The Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interests of All States, taking into Particular Account the Needs of Developing Countries. (Floehlich, 2019)

To guarantee truthfully global and equitable space governance, these countries ought to be enthusiastically involved through increased capacity building, technical assistance, and attention to equitable distribution of benefits from space exploration and resource utilization.

12. Conclusion and Recommendations

12.1. Conclusion

In conclusion, the paper titled "Space Activities for Sustainability and the Role of the National Space Agencies" offers an in-depth examination of a variety of subjects. Sustainability incorporates a diverse array of subjects, such as legal development, economic development, social equity, and environmental conservation. It entails the identification of methods to satisfy the demands of the present without compromising the capacity of future generations to satisfy their own requirements.

As the space environment becomes increasingly complex and crowded, space agencies are at the forefront of efforts to ensure space activities are conducted in a way that ensures the space remains a viable and beneficial domain for future generations. Through the development and implementation of comprehensive strategies, such as NASA's Space Sustainability Strategy, agencies are identifying cost-effective ways to meet sustainability targets and incentivizing the adoption of sustainable practices through technology and policy development.

The establishment of guidelines and norms of behavior, such as those promoted by the UNOOSA, further underscores the commitment of the global space community space agencies to responsible space operations. Additionally, the involvement of emerging space nations without space agencies and their contributions to the development of national space policies and domestic legislation highlights the collective effort required to address the challenges of space activities and sustainability. By fostering international cooperation, promoting the responsible use of space resources, and advancing research and development in sustainable space technologies, national space agencies are not only safeguarding the space environment but also paving the way for a sustainable and prosperous future in outer space exploration and utilization.

However, national security considerations affect the sustainability of outer space in practice. For example, the States are motivated to conduct the DA-ASAT test as the key means of maintaining space dominance. The destruction caused by it pro-

duces an unprecedented number of debris[68] and remains in orbit for some time, subject to the altitude at which the strike strikes and the size of the target. In other words, one may say the DA-ASAT test is harmful to outer space environment. However, in the context of globalization, space has become a new frontier for countries to compete for strategic advantage. For example, just after its successful ASAT test in 2019, India's Prime Minister Narendra Modi tweeted that "*India stood tall as a space power*" and added that the country would be stronger and more secure.[69] This reference to security suggests that India's destructive ASAT test aimed at deterring China and the world at large by showing that it possessed the same capability.

12.2. Recommendations

Currently, the international space legal system with regard to space activities and sustainability is faced with a number of challenges, *inter alia*: First, the ambiguities brought in by the development of the system of global governance have increased tremendously, and the quest of states interest towards space has made it tougher to reach consensus. (Lamy, 2006) Second, old-fashioned space legal rules are evident to be static and fail to incorporate the needs of new actors in space commercialization activities, especially in the fields of 'satellite Internet and deep space exploration', where a bulky of legal gaps have materialized. (Cai & Chen, 2022) In addition, with the growth of companies owned privately, the existing legal framework founded on intergovernmental agreements is inadequate, and there is a crucial necessity to form a more flexible and effective regulatory machinery.

In view of the above problems, the following measures can be taken to stimulate the improvement of the rule of law in international space activities: First, reinforce the very aim of the United Nations (UN), shape consensus among all state parties through a systematic high-level meeting, and progressively revise, amend and develop the Outer Space Treaty and other relevant documents. (Lamy, 2006) Second, there is a need to create a 'multi-level dialogue platform' to inspire governments, enterprises, and private organizations to contribute to the making of rules to govern space activities, with the aim of creating an inclusive institutional arrangement. (Cai & Chen, 2022) Thirdly, it is to inaugurate and advance the environmental impact assessment system, demanding all entities to fully take into account the ecological effects when conducting space projects.

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[68]Space Debris Mitigation Guidelines of the Committee of the Peaceful Uses of Outer Space. This document define "Debris" to mean 'all man-made objects, including fragments and element thereof, in Earth orbit or re-entering the atmosphere, that are nonfunctional'.

[69]Narendra Modi. "#Mission Shakti is special for 2 reasons: (1) India is only the 4th country to acquire such a specialized & modern capability. (2) Entire effort is indigenous. India stands tall as a space power! It will make India stronger, even more secure and will further peace and harmony." Twitter, March 27, 2019.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Appendix

Treaties and Acts

1. The Outer Space Treaty (1967)
2. The Rescue Agreement (1968)
3. The Liability Convention (1972)
4. The Registration Convention (1975)
5. The Moon Agreement (1979)
6. The Australia Act on Space Activities (Number 63 of 2018)