

# International Legal Regulation and Management of Space Waste on Celestial Bodies

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## Abstract

*The present article explores the international legal regulation of space waste on celestial bodies and the ecological challenges that space missions will pose in the near future. The lack of a shared vision of whether space waste production should be minimized on celestial bodies is causing uncertainty in the planning of future space missions. Leading private space companies are proposing the transfer of dangerous space waste produced from Earth into outer space. The excessive generation of space waste would increase the risks of activities such as space tourism, and space research and will threaten scientific fields such as radio astronomy. The political alliances that exclude a priori third parties will increase the risk of a generation of unnecessary orbital space debris and space waste on celestial bodies because of the development of several space missions in the same field. The sustainability of space missions on celestial bodies and the protection of the outer space environment should become a guiding principle for both national and international legal regulation of space activities. This article argues for the urgent need to establish comprehensive international regulations and monitoring mechanisms to manage space waste on celestial bodies, emphasizing sustainability and cooperation among space-faring nations.*

**Keywords:** *Space Waste, Space Law, Space Cooperation, Exploitation of Celestial Bodies, Mitigation of Space Waste.*

## Introduction

According to NASA on March 4<sup>th</sup> 2022, an artificial manmade space object collided with the Moon and the impact caused two craters, with diameters of 18m and 16m. The collision produced thousands of debris on the surface of the Moon and the official public information about the nature of the space object or the possible risks from the produced debris is minimal and uncertain. The failure of the Russian Luna 25 Moon mission has led to the creation of space waste on the celestial body, which can increase the risk for future missions of different states.

The issue of orbital space debris has received a deserved focus of attention in the last three decades and it is becoming a priority for many space-faring nations and private space companies. The challenges from non-functional objects present are considered and debated numerous times in the United Nations Committee of Peaceful Uses of Outer Space (from now on UNCOPUOS), in other relevant international forums, such as the Inter-Agency Space Debris Committee and in academia, for example, International Law Association and the Committee on Space Research.

The space exploration era enters into a new phase with plans for robotic and crewed missions back to the Moon, particularly the Artemis program, the International Lunar Research Station (ILRS) project, and the Chandrayaan missions. These initiatives will signify the long-term presence of states on celestial bodies. The issue of preservation of celestial bodies from man-made space waste is not comprehensively regulated, and this absence of rules and guidelines creates a risk of jeopardizing future missions for space exploration and exploitation. The future space projects to the Moon, Mars and other celestial bodies could be hindered if there are poorly adopted international norms, standards and policies for the reduction of the production of space waste and minimization of the risk for activities on the celestial bodies. Research on the Moon and space tourism could be negatively affected by the production of space waste on celestial bodies.

## *Contemporary International Legal Regulation of Space Waste on Celestial Bodies*

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Nuclear contamination of the Moon is already a fact of the activities of the USA and USSR in the 1970s. Apollo missions of the USA, which carried packages of plutonium-fuelled radioisotope thermal generators, abandoned them on the Moon. Lunokhod missions also contributed to the nuclear contamination of the Moon with the usage of a polonium-fuelled radioisotope thermal generator. The vision for future missions on the Moon has to consider the risk of nuclear and other types of dangerous contaminations that carry serious risks.

The risk of polluting the Moon, Mars, and other celestial bodies in the near future increases with the advancement of space technology and the enlargement of investments from the private sector. The reason is that near-Earth celestial bodies represent significant unexploited economic resources for trillions of dollars, and the competition for the first state or group of states to reach and exploit them has already started. The economic and energy competition among states is transferred to outer space as well.

The term “space waste” is not defined in international space law and is not compared with the terms “space debris” and “space objects”. The norm in Article VIII of the Outer Space Treaty illuminates this issue. It is stipulated that the *“ownership of objects launched into outer space, and of their component parts, is not affected by their passage through outer space or by their return to the earth”*. This article contains the first international legal norm, which regulated the status of an object launched into outer space. This international legal norm elaborates on the issues of jurisdiction, control and ownership of the objects launched into outer space, and it is explicitly pointed out that celestial bodies are included in the scope of outer space. Consequently, the objects launched from Earth and which are situated on celestial bodies have to be considered space objects. From the norm in Article VIII is visible that the right of ownership of all space objects, including their component parts, stays intact, without regard to their position in space: in outer space, in the air space of Earth, or on the surface of the Earth. Since the component parts of space objects are the main type of space debris, it can be concluded that Article VIII of the Outer Space Treaty directly affects the legal status of waste in outer space. At the same time, Article VIII does not provide any obligations or recommendations to states about any regulatory aspects of ownership that should be included in the legal scope of space objects. The purpose of the article is to regulate that the right of ownership is not affected by the presence of the object in outer space.

Damages, which occur on celestial bodies, caused by foreign non-functional space objects, located on the celestial bodies are leading to international liability for the launching states. Since the damages are not occurring on the surface of Earth, the state will be *“liable only if the damage is due to its fault or to the persons for whom it is responsible”*.

The absence of a standard of care, or at least a precise common understanding of such a standard among states, is a serious challenge for the implementation of fault liability. A contrario, the development of legally binding standards will result in clarifying what behaviour will be considered faulty and will be a significant improvement of the legal regulation of activities on celestial bodies.

The criticism of the regime of international liability in Article III of the Liability Convention is well-substantiated. Christol rightly criticized Article III for the lack of definition of the fault of the state, the absence of common standards for care and also the inability to determine negligence.

The lack of a common definition of “fault” provides the opportunity for mutable interpretations on behalf of the states to avoid liability. The absence of common standards for “maintaining good care” has led to the present situation of space systems, which are not useful to be left on celestial bodies. Abandoning non-functional parts of the space systems and other space waste on celestial bodies has already happened. For example, the total amount of waste on the Moon is more than 181 tons. This fact illustrates that the need for international and national regulation of the issue is pressing.

Article IX of the Outer Space Treaty is the main international legal norm that regulates the behaviour of states on the protection of celestial bodies from harmful contamination.

When it comes to protecting the outer space environment, the rules in Article IX are unsatisfactory, as they

do not create clear legal obligations for the state parties. The lack of a clear deadline or time frame for the stipulated “consultations” means that discussion could continue indefinitely, and during that time, serious damage could take place.

What is "harmful contamination"?; What is included in the wording "due regard to the corresponding interests of all other States Parties to the Treaty"?; What changes in the Earth's environment are considered “adverse” as a result of the “introduction of extraterrestrial matter”?; What a hypothetical or real extra-terrestrial biological entity is referred in the treaty?; What should be the appropriate measures?

All of these questions have been raised in international space law forums because the exact obligations of many states and international organizations remain unclear. For this reason, several representatives of the international legal doctrine have made proposals for amendments to Article IX or further clarifying and interpreting the scope of its norms.

Robinson, for example, is concerned about the contamination of the outer space environment with microorganisms from Earth and makes recommendations to ensure the physical and biological integrity of celestial bodies. He defends his position of empowering a public organization, supported by all space-faring states. The obligations of this new international public body should include the adoption of a research protocol that sets the limits of minimal risk in the study of extraterrestrial life.

The existence of such an international organization is becoming urgent to resolve major present and future problems of international space law, including the problem of space debris.

Robinson also points out that these studies should be conducted following the international regulation of research experiments, standards of usage of equipment, and obligations to follow procedures. In his proposal to amend Article IX, he provides that the Member States of the Treaty should be represented by COSPAR (or another body) on all matters of contamination from Earth to other celestial bodies. In his view, COSPAR should determine the levels of risk that are acceptable to ensure the controlled intervention or interaction of humanity with an open extraterrestrial life form and that all Member States of the Treaty should respect these minimum standards.

In my assessment, Robinson's proposal is valuable as it finds a way to create such an authority. It emphasizes the need for highly professional expertise that protects transnational interests, including the protection of the outer space environment and, the health and life of human beings in outer space and on Earth.

Robinson's proposal focuses on outer space contamination, which is biological of nature and its source is from Earth. Adopting transparent public international rules and procedures to prevent biological contamination from Earth is not a premature action, as the existence of methane-based extraterrestrial life forms has already been recognized by some NASA scientists and by many astrobiologists.

Fernandez argues that the abandonment of objects can be interpreted as harmful contamination of outer space and a violation of Article IX of the Outer Space Treaty. He points out that space debris is not "for the benefit of mankind", is not "in the interest of all countries" and impedes free access to space. Therefore, countries that abandon any type of waste violate the treaty.

I consider this interpretation of Art. IX to be too broad and not sufficiently precise since outer space activities have always been linked to the separation of space debris. Moreover, in the sixty-year practice of states performing space activities, no country has classified abandonment of objects in outer space as a violation of the norm of Article IX. This calls for the creation of a new norm in international space law that explicitly prohibits the abandonment of non-functional objects in outer space.

The obligation which states have to cooperate and to take due regard to the corresponding interests of all other states is quite a significant legal norm of Article IX Outer Space Treaty. The importance of this legal obligation is essential as it refers to the consideration of the interests of all states, including those that are considered competitors or strategic rivals.

The obligation of the “due regard” principle should be interpreted to include avoidance of abandoning dangerous nuclear materials on the surface or below the surface of celestial bodies if those space objects constitute a danger or concern to other states. Lach rightly summarised that the purpose of the “due regard” principle is to set the limitation of the activities of states in outer space. However, such a general rule could be perceived as vague and unclear about the precise obligations of the states and where those legal boundaries are.

The present international legal regulation, specifically Article IV of the Outer Space Treaty prohibits installation of nuclear weapons or any other weapons of mass destruction on celestial bodies. Radioactive contamination, which is caused by the testing of nuclear weapons in outer space, is also prohibited by the Partial Nuclear Test Ban Treaty since 1963. This treaty partially bans nuclear testing because its scope doesn't include nuclear tests on the ground and underground in the territory of the state conducting the test. However, testing of nuclear weapons in outer space, including celestial bodies is prohibited in Article 1a of the treaty. Accidental nuclear explosions, such as nuclear-powered space object collisions with space debris, are not going to be considered a violation of the treaty.

#### *Mitigation Of Space Waste on Celestial Bodies*

After the first two decades of successful legal regulation through the adoption of the five major UN space treaties, it became a common practice for space-faring nations to adopt soft law guidelines and principles. The unique decision-making process in the COPUOS, namely the requirement of consensus, predisposed the application of the “corridor negotiation”. The result was that less developed countries received the opportunity to participate in the decision-making process after a general understanding was achieved by the leading space-faring nations.

Examples of such acts are the UN Space Debris Mitigation Guidelines and the International Code of Conduct for Outer Space Activities (ICOC). I disagree with Lim's conclusion that the ICOC represents the most promising “spiritual successor” to the OST within international soft law. The main reason for my different view is that soft law documents do not possess the same regulative value as legally binding treaties and could never be seen by states as solid regulative instruments. The Outer Space Treaty is still accepted by major space-faring nations as a cornerstone for the International Space Law. Jakhu rightly concludes that the international doctrine of the “persistent objector” would prevent soft law documents from becoming rules of customary international law. Self-interest could not be considered a sufficient driver for states to keep outer space free from debris congestion and celestial bodies clean from space waste production.

The main globally accepted but legally non-binding guidelines for space debris mitigation have been adopted by the UN COPUOS. These are the above-mentioned Space Debris Mitigation Guidelines. They are instrumental firstly in understanding the scope of the definition of space debris and secondly in interpreting the level of commitment of the members of the COPUOS to preserve the outer space environment from the risks of man-made objects. Sachdeva highlighted the importance of the guidelines, and despite their legally non-binding nature, they should be considered by states as ethically obligatory.

It is logical to raise the question of whether the guidelines include the generation of non-orbital waste on celestial bodies. The answer should be negative because the definition of space debris for the purpose of the guidelines stipulates that space debris is “non-functional manmade objects only in Earth orbit or re-entering the atmosphere”.

The guidelines provide an internationally recognized definition of space debris, which is not legally binding. The definition is explicitly limited to usage for the document.

Since the scope of the definition of space debris does not include waste on different celestial bodies, a new set of rules should be adopted by the states to properly manage and mitigate this non-functional and non-orbital space waste.

The present status quo of the legal regime and practices of waste management on celestial bodies carries the risk that the information about the released non-functional objects will not be shared publicly, accurately and timely with all stakeholders. In the incident with the Soviet satellite "Cosmos 954," Canada stated that prior notification of the imminent re-entry of the nuclear-powered satellite was not provided and that the USSR "failed to provide timely and complete answers to the Canadian questions of January 24, 1978, concerning the satellite." This example clearly illustrates that safe international traffic management on celestial bodies cannot be achieved based on the reciprocal obligations of states to share information.

NASA History Program Office provides publicly a catalogue of manmade material on the Moon, which consists of objects from every space agency, which conducted activities on the Moon. This practice is very positive and the catalogue provides information about the known location of the manmade objects. There are two major concerns for non-US space missions. However, the list has not been updated since 2012. The list is not provided due to an international legal obligation of the US government and therefore the US is not liable for any omissions, or wrong information in it. The list also does not provide information about nuclear radiation, biohazards, or other risks that could be dangerous for activities in close proximity to the objects.

#### *The Vision to Pollute the Outer Space Environment to Preserve Earth*

The attitude toward polluting outer space to preserve Earth was clearly expressed by one of the private pioneers in the space industry, the CEO of the space company Blue Origin - Jeff Bezos. This radically different vision could lead to positive environmental protection of Earth, but it has to be discussed on the highest international level – the UN General Assembly and before that in UNCOPUOS. Such a proposal holds two very dangerous patterns from an environmental perspective: 1) preserving pollutants and their dangerous debris could cause additional risk for space missions and space research; 2) using a near-Earth outer space environment as a place for waste disposal could lead to dangerous back contamination and threat to the people on Earth. Instead of transferring polluting industries into space, states and private actors could invest in transforming these industries by introducing holistic economic methods and investing in the preservation and conservation of the environment of both Earth and outer space. Such policies and legal obligations have to be adopted by all involved states that have jurisdiction over the relevant private space companies.

Private companies planning to use celestial bodies for tourism are interested in a safe ecosystem and a lack of space waste in the long term. The adoption of guidelines on sustainable management and exploration of celestial bodies, which complement the UN Space Debris Mitigation Guidelines is required before the missions on those celestial bodies are initiated.

The space companies that have commercial plans to exploit asteroids or the Moon by mining valuable resources should also be regulated by states to respect the outer space environment by producing a minimum amount of space waste and managing the dangerous waste according to high standards. These activities would cause pollution, and the produced space waste could jeopardize touristic activities or scientific projects. Presently, space activities are conducted much more by private actors than in the past and that space law development depends on the economic interests of commercial actors in outer space. The economic interests of a few private space corporations should not violate the long-term interests of all nations and the interests of humankind.

The norms of Article II of the Outer Space Treaty have been accepted as international legal custom, and they carry the obligations for non-appropriation and non-occupation of outer space to all states, private organizations and people. If private economic interests are allowed to dictate national space law regulation and encourage the non-development of international space law, this will lead to unsafe, and unsustainable utilization of the celestial bodies in the process of which unnecessary space waste will be left.

It is necessary for the comprehensive international debate to avoid and manage space waste on celestial bodies to occur before the long-term missions on the Moon and Mars are initiated in the next few years.

The mentality of cost-savings instead of applying higher standards is an additional mental obstruction of the private sector that could be overcome in outer space exploitation by introducing comprehensive legal regulation from states on a national and international level. The lack of a shared vision for outer space exploitation creates uncertainty and possible competition for the usage of territory on celestial bodies.

The current state of cooperation in outer space activities between the USA and the Russian Federation is at a historic low point after the Russian annexation of four regions of Ukraine. The guidelines for the protection of celestial bodies from space waste would not be expected to be negotiated soon between the USA and its allies on one side and China and Russia on the other side, unless a drastic shift in foreign policy occurs in the states. However, the adoption of national measures that consider those aspects of pollution of outer space could be beneficial for space activities of all states and in the interest of humankind. The efforts of the national space agencies to create national standards and guidelines to avoid the dangerous release of space waste could have a very positive effect on the planning of future space missions.

#### *Holistic Governance of Space Activities on Celestial Bodies*

To avoid the collision of national interests in the exploitation of celestial bodies, it would be beneficial and practical for the leading states to establish international mechanisms, common standards and long-term plans for the utilization of celestial bodies in advance.

UNCOPUOS with its two subcommittees remain the most authoritative international organization in the field of international space law, which is the established international forum for the negotiation of new international space norms. This is the logical choice for states to attempt to reach an agreement on the rules of management of space waste on celestial bodies. Such an issue could revitalize international space cooperation by adopting shared goals for the exploration and exploitation of celestial bodies. Different space projects should complement each other and not necessarily compete with each other. If the states develop common standards and guidelines for the management of space waste on celestial bodies, this would be a solid fundament for sustainable utilization of the resources of celestial bodies in the far future. Considering the fact that the USA and its allies on one side are competing for economic domination on the Moon against Russia and China on the other side, the most logical formats for adopting rules for waste management on celestial bodies are the Artemis Accords and respectively the Roadmap for the International Lunar Research Station.

Preventive measures and the adoption of international and national policies in advance should be a priority for the states to address the issue of harmful contamination of celestial bodies instead of relying on international liability. Viikari correctly concludes that the present liability system does not adequately address the problem of establishing a causal link between harmful activities and damage.

To mitigate the risks of damages from space waste on celestial bodies, it would be very helpful if the UN Office of Outer Space Affairs maintains a specialized register of space objects, including non-functional waste on celestial bodies. The register should include the data provided in NASA's catalogue of manmade material on the Moon and add also topographical information and discoveries on celestial bodies, which have to be taken into consideration during robotic or human activities on celestial bodies. If the register includes additional data about the possible risks from different non-functional objects, it would support better the planning of activities on the Moon and other celestial bodies.

The Inter-Agency Space Debris Coordination Committee (IADC) is another international governmental forum, which includes leading space agencies to achieve global coordination of activities related to the issues of man-made debris in outer space. The work of the organization is focused on orbital debris, but it would be beneficial if their expert knowledge and coordination were widened to include non-functional debris on celestial bodies and guidelines on how to mitigate the risks from them.

Adequate and environmentally friendly exploration and utilization of celestial bodies could be achieved if a higher perspective of governance is agreed upon and established among leading space-faring nations, developing nations and the private space industry.

Such a higher perspective of governance should be inclusive of different commercial and scientific interests because particular locations on celestial bodies have different scientific importance for various scientific fields. For example, in radio astronomy, specific craters on the far side of the Moon have been identified to become "lunar quiet zones", as defined by ITU. Other locations, such as the Daedalus crater, have been identified as suitable to become a new radio-quiet zone, and a proposal was made for receiving official status as such. Maccone also substantiated that the far side of the Moon needs to be chartered as a special zone with a diameter of 1820 km only for scientific studies. This zone is referred to as the Protected Antipode Circle. Mining activities and touristic activities on celestial bodies should not be allowed to occur without consideration of other scientific fields, such as radio astronomy. The production of waste on the Moon should also be meticulous so as not to affect radio frequencies significantly. Touristic activities in outer space should be perceived as an increased risk for the generation of space waste and a possible source of financial resources necessary to fund orbital space cleanup and celestial waste cleanup.

Controversial scientific experiments have already been conducted on the Moon, causing unpredicted effects for future scientific studies or commercial initiatives. An example of such an experiment was the NASA Lunar Crater Observation and Sensing Satellite impactor - LCROSS mission, known as the "NASA Moon bombing". The purpose of the mission was declared to be the determination of whether there is water on the Moon in the crater Cabeus. The project was conducted extremely invasively and without consideration of the negative effects on the outer space environment by crashing the satellite in the crater and performing a spectral analysis of the debris. The danger of such questionable experiments lies in two aspects. The first one is that they are conducted without prior consultations with other states, such as China, India, Japan and Russia, which were conducting or planning to conduct scientific experiments on the Moon. The intentional collision performed by NASA could be interpreted as aggressive by other nations and even a violation of Article IV of the Outer Space Treaty. The second aspect of conducting scientific experiments without prior consultations with states, the International Telecommunication Union, and other international organizations responsible for scientific studies in outer space is that activities such as intentional collisions of satellites and explosions could jeopardize further study and use of this particular area for the future generations. The knowledge of the importance of a specific location, crater, or underground resources may be discovered in the future and project activities should be planned not to harm the optimal utilization of the celestial body in the interest of humankind. If we blindly accept the purpose of this mission and the methods of this scientific experiment, it is hard to believe that a scientific team would like to discover water in a Moon crater by polluting it with space debris and destroying the frozen reservoirs for future missions. What is the purpose of discovering something if the founders are destroying it by applying aggressive scientific methods?

The conducting of scientific missions, which are destroying resources and creating a vast amount of waste, illustrates the need for a holistic approach and precise international legally binding mechanisms, which have to be adopted by the leading space-faring states and developing nations too. These rules are going to apply to all private actors as well. States and private organizations must engage in an open debate about plans for colonizing celestial bodies. Elon Musk has shared his ideas for bombing Mars and using nuclear weapons to terraform the planet publicly. International oversight of companies like SPACE-X is essential, as the owner of the private company is not serving the interests of humankind, and is probably not briefed on all classified issues concerning space exploration and discoveries on Mars. Private individuals are not focused on preserving other economic sectors or scientific projects and for this reason, they should be properly regulated.

Presently, the public and academia rely on a few space-faring nations to share their discoveries in outer space, based on their compliance with Art. XI of the Outer Space Treaty. There are no monitoring mechanisms and space assets, owned by an international organization that serves the interest of humankind and not of a specific state or group of states. International monitoring systems, space

situational awareness networks and launching capabilities are essential to avoid and control the creation of dangerous space waste on celestial bodies.

The severe impact of the manmade space object on the Moon on March 4<sup>th</sup> 2022 illustrated also that space activities on the surface of the celestial bodies could be highly risky endeavours. In order to avoid or mitigate significantly the risks of impact with a crew and robotic missions, the states need to invest in data gathering, data sharing, active debris removal projects and other systems to prevent dangerous collisions with manmade space objects and asteroids.

## Conclusion

To address the critical issue of space waste, it is imperative to establish internationally binding regulations, create an independent monitoring body, and foster cooperation among space-faring nations. Immediate action is required to ensure the sustainability of future space missions.

The planning of future missions and the adoption of comprehensive guidelines for the utilization and scientific exploration of celestial bodies should clarify what type of pollution is legally allowed because of the current development of technologies. The creation of unnecessary space waste should be qualified as prohibited pollution in national legislation and international instruments. States should apply working monitoring mechanisms conducted by an international organization, which has its own technical capabilities for independent monitoring of space objects. The time for settling the legally binding rules and measures to protect the environment of celestial bodies from space waste is before the new missions on the Moon and Mars are operational and before the bad practices of different states become the accepted way of conducting space activities on celestial bodies.

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