Protecting the environment from nuclear weapon tests in space law

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Abstract:
Testing nuclear weapons in outer space is one of the causes of pollution in outer space and on earth. In this context, article 9 of the Outer Space Treaty (1967) prevents the pollution of the earth›s environment due to the entry of substances from outside the planet. Article 4 of the Outer Space Treaty only prohibits the use of weapons of mass destruction in space. It does not have a legal mechanism to prevent nations from testing nuclear weapons , Even with space there are texts prohibiting weapons abroad, there remains free venting and testing of some weapons in outer space. . However, nuclear weapon testing is prohibited in outer space under the Partial Nuclear Test Ban Treaty of 1963 because it lacks rules to apply in case of violation of this treaty and contains the Comprehensive Nuclear Test Ban Treaty, which also contains rules banning nuclear tests and explosions in all environments, but have not entered into force. This paper seeks to identify the obligations of countries that conduct nuclear weapons tests in outer space and note the importance of modifying existing outer space documents through the additional protocol with environmental behavioral guidelines that can be ratified and incorporated into the Outer Space Treaty.

Keywords: Pollution, International space law, Nuclear weapons, Environment.

Statement of the problem:

This research paper seeks to identify the damages that affect the environment of outer space as a result of nuclear weapons experiments

in outer space and their impact on the earth's environment. The future vision of international space law is to limit such pollution damage to the environment.

Questions:

The paper seeks to answer the following questions:

1. What are the effects of defending nuclearin outer space?
2. What is the future vision for the outer space?
3. What are the legal gaps in the Outer Space Treaty?
4. To what extent are countries responsible for the damage caused by nuclear weapons tests on the surface of the air and space?

To answer these questions, the general principles of international environmental law, the provisions of the United Nations Convention on Outer Space, the Liability Convention, and the instruments governing the ban and limitation of nuclear tests are examined.

Introduction:

As one of the new branches of international law, international space law brought much to the development of space science in the years following the second half of the twentieth century. It is worth noting that the difference between the activities in airspace and outer space is that the air is part of the territory of states and is subject to the rule of states. Thus, according to international space law insturments, no such system of sovereignty is recognized in outer space[1] In contrast, nuclear weapons have changed the concepts of war, peace, and security, as more than fifty nuclear explosions were recorded on 31 December 1953[2]. New developments in the military field and the possibility of extending nuclear weapons into space have increased the need to control weapons in space[3]. Despite adopting the freedom of exploration and exploitation of space[4], some restrictions are required to prevent pollution of space

1. Essam Mohammed Ahmed Zanati, The International law of outer space, Dar Al nahda Al Arabia, cairo, 2014, p2.
2. Hans M. Kristensen, &Robert S. Norris, A history of US nuclear weapons in South Korea, https://doi.org/10.108000963402.2017.1388656/, Volume 73, Issue 6, 2017.
3.International Committee of the Red Cross' ,ICRC Statement on Nuclear Weapons at the United Nations' (October 2015) https://www.icrc.org/en/document/weapons-icrc-statement-united-nations-2015 accessed 18 Abril 2025 .
4. Karim Muhammad Rajab Al-Sabbagh, The Legal Status of the Use and Exploitation of Outer

and earth[1]. Therefore, article 9 of the Outer Space Treaty (OST), adopted in 1967. The term "convention" may confuse with other space-related treaties calls for measures to prevent any harmful pollution of space and seek consultation before any space activity to ensure that space activity is environmentally safe.

It seems that there is no appropriate legal solution in the space and environment law to regulate and prevent these experiments, especially the protection of the space and earth environment in general. However, it must be noted that environmental pollution is by nature transboundary. Thus, according to the Charter of the United Nations and the principles of international law, governments must take care to exploit natural resources, such as space, in a way that does not cause irreparable environmental damage. On the contrary, the international responsibility of governments creates an obligation to pay full compensation, ban or discontinue any harmful activity[2].

This rsearsh, using a descriptive and analytical approach, identifies the extent of state liability for damage caused by nuclear weapons tests on the surface, in the atmosphere, and in space. It therefore examines the general principles of international environmental law, the provisions of the United Nations Outer Space Treaty, the Liability Convention, and instruments regulating the prohibition and limitation of nuclear tests.

What are the harmful effects of nuclear weapon testing in space on the environment?

Several nuclear weapon tests were conducted between 1945 and 2013, the last of which was carried out by North Korea, which led to the pollution of the environment with radioactive waste[3]. The United States conducted the largest number of nuclear weapon tests on North American soil between 1951 and 1963[4]. One of the main reasons for the rise of

Space in International Law, Journal of Law for Legal and Economic Research, 2019.

1. United Nations, Ending Nuclear Tests, International Day Against Nuclear Tests, 29 August 2021, https://www.un.org/ar/observances/end-nuclear-tests-day/history Checked 292022/1/.

2. Hanan Mohamed Abdel Rahim, Nuclear treaties and their impact on preserving the environment, Journal of Scientific Research in Arts, No. 20, Part VI, Cairo, 2019, p. 65: 66.

3. Sulgiye Park, Rodney C. Ewing, Environmental impacts of underground nuclear weapons testing, March 7, 2024, https://thebulletin.org/premium/202403-/environmental-impacts-of-underground-nuclear-weapons-testing/, procced in 19\4\2025.

4. Remus Prăvălie, Nuclear Weapons Tests and Environmental Consequences: A Global Perspective, 2014 Feb 22;43(6):729–744. doi: 10.1007/s132801-0491-014-.

thyroid cancer in the United States is radioactive nuclei[1]. It can be said that testing and expanding nuclear weapons production strengthen the regional or global power of the countries having these weapons[2].

In this context, the advisory opinion (1996) of the International Court of Justice on the legality of the threat or use of nuclear weapons defines such weapons as explosive devices that have the ability to ignite and explode by fission or fusion of a nucleus, which increases environmental concerns when testing these weapons in space, causing great devastation, lethal effects, poisoning, and widespread pollution caused by the production of large amounts of heat and energy[3].

It is worth noting that nuclear weapons have three unique characteristics: The ability to destroy, cause great pain and suffering, and harm future generations due to cancer and genetic disorders. These concerns were echoed by the World Health Organization (WHO) in its reports of 1984 and 1987[4]on the effects of nuclear war on health and health services, regarding their destructive effects on food products, plants, dairy and meat products, as well as causing climatic and environmental changes that may cause a severe food shortage[5].

International principles related to environmental protection and their impact on the protection of the space environment

The environment can be defined as the sum of living and non-living elements and their impact on human life. The environment has witnessed many harmful practices, and therefore the international legal system has established unified laws and regulations centered around a set of key

1. Remus Prăvălie, op. cit
2. Hanan Mohamed Abdel Rahim, Nuclear treaties and their impact on preserving the environment, op. cit, pg. 60.
3. ICJ, Legality of the threat or use of nuclear weapons, https://www.icj-cij.org/fr/affaire/95, procced in 19\4\2025.
Essam El-Din Muhammad Ibrahim, Commentary on the advisory opinion of the International Court of Justice and the legality of the threat to use nuclear weapons in 1996 AD, Journal of Economic, Administrative and Legal Sciences, Gaza, Vol. 4, Issue 13, 2020, p. 100: 114.
Publications of the International Committee of the Red Cross, International Humanitarian Law and the Advisory Opinion of the International Court of Justice on the Legality of the Threat or Use of Nuclear Weapons, 2016, https://www.icrc.org/ar/publication/Ihl-advisory-opinion-icj-legality-threat-or-use-nuclear-weapons Checked 012022/31/.
4. Hazem Atlam, The Legality of Nuclear Weapons in the Light of the Advisor to the International Court of Justice, Dar Al-Nahda Al-Arabiya, Cairo, 1996, p. 351
5. Hazem Atlam.

environmental legal principles derived from customary law and legal treaties, as follows:

The principle of sustainable development:

This principle was discussed for the first time in 1987 in the report of the World Commission on Environment and Development (WCED) entitled "Our Common Future"[1], stating that human activities must be conducted in a way that can be sufficient for the needs of the present generation and those of future generations to enjoy the same natural resources. Currently, most provisions of the Rio Declaration on Environment and Sustainable Development in 1992 have been incorporated and widely adopted into many international and national instruments, calling for the rational use of the environment through a public policy[2]. Thus, people can determine the harmful consequences of their activities on nature. Natural resources must be exploited according to the principle of energy conservation to allow them to renew and prevent them from being turned into waste[3].

Therefore, the possibility of conducting nuclear weapons tests in space if they can meet the current needs without compromising the requirements of the next generation. The harmful consequences of these tests on nature are already known. Thus, all measures must be taken to protect the environment from such damages.

The principle of cooperation, information, and assistance in emergencies:

The most important obligations of governments to protect the space environment are to cooperate in good faith to inform other countries of potential risks before environmental accidents and to take the necessary measures to prevent and reduce the destructive effects of nuclear weapon

1. Jeronen, E. Sustainability and Sustainable Development. In: Idowu, S.O., Capaldi, N., Zu, L., Gupta, A.D. (eds) Encyclopedia of Corporate Social Responsibility. Springer, Berlin, 2013, Heidelberg. https://doi.org/10.1007662_8-28036-642-3-978/.

2. Principles 9 and 10 of the Rio Declaration, document, A\CONF\151\26\rev.1(vol.1).

3. International Law Commission, ‹Survey of Liability Regimes Relevant to the Topic of International Liability for Injurious Consequences Arising out of Acts Not Prohibited by International Law› (2004) UN Doc A/CN.4543/.

Nasser Saleh Mahmoud Othman, The role of sustainable development in maintaining environmental balance from a theoretical concept, Al-Jadeed Journal of Agricultural Research, Issue 24, Alexandria, Egypt, 2019, p. 98: 107.

tests[1]. Countries should provide the necessary resources and technology and hold training courses to exchange information, advice, and assistance in times of environmental emergency, in accordance with articles 9 and 11 of the Outer Space Treaty, as well as the necessity to conclude bilateral or multilateral agreements for consultation, negotiation, and exchange of information on these new activities or events in space that could negatively affect the environment, especially with regard to nuclear weapons tests in space[2].

The principle of prevention and precaution:

Governments use their rights for the peaceful exploration and exploitation of outer space. Still, they must monitor and control nuclear weapons tests and ensure that they do not have harmful effects on the environment[3]. When testing nuclear weapons in space, governments should comply with the rules and standards of learning and assessing the environmental risks that may result from testing nuclear weapons[4].

Also that noted in Articles 18 and 19 of the 1992 Rio de Janeiro Declaration on Environment and Development call for environmental consultations before any economic or commercial activity. Article 15 also stipulates the need to take preventive measures in accordance with article 9 of the United Nations Convention on Outer Space, taking into account the provisions of international environmental law in accordance with article 3 of the United Nations Convention on Outer Space.

The principle of the obligation to pay compensation by the party causing the pollution:

The polluter-pays principle appeared for the first time whithin the framework of the Organization for Economic Cooperation and Development in the recommendation made on 26 May 1972[5], related

1. A\CONF\151\26\rev.1(vol.1).
2. United Nations Environment Program, Global Environment Outlook Report (4-GEO), 2007, p. 3 and beyond.
ST/SPACE/11/Rev2 - UNOOSA
3. UN, Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, Article 3, 10, https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/outerspacetreaty.html, procced in 19\4\2025.
4. Khaled Abdel Aziz, The Principle of Precaution in the Environmental Field, Master Thesis, Algeria, 2015, p. 25.
5. Muhammad Munir, History and Development of the Polluter Pays Principle, SSRN Electronic

to guidelines on the economic and political aspects of the environment at the international level. It emphasized that the establishment of the polluter-pays principle is to allocate the costs of pollution prevention and control measures while avoiding tensions in trade and financial investment. in this principle, the polluter bears the expenses related to the measures determined by the public authorities in order to preserve the environment. Accordingly, the state that caused the pollution in the space environment allocates expenses to ensure the implementation of the measures determined by the public authorities in order to keep the space and earth environments healthy[1].

In this context, the Rio de Janeiro Declaration issued by the United Nations Conference on Environment and Development of 1992 adopted the principle of polluter-pays. Article 16 of this declaration stipulates that the National authorities should endeavour to promote the internalization of environmental costs and the use of economic instruments, taking into account the approach that the polluter should, in principle, bear the cost of pollution, with due regard to the public interest and without distorting international trade and investment.

It may be argued that if it is useful to use this principle to limit states from nuclear experiments in outer space, the principle of polluter-pays has still not amounted to a real legal base. It is devoid of any mandatory force, especially since the Rio de Janeiro Declaration did not provide enforceable obligations. However, article 13 of the declaration was sufficient to stipulate the need to establish international law to determine responsibilities and compensation for environmental damages.

In contrast, the Vienna Convention for the Protection of the Ozone Layer 1985 emphasized the responsibility of countries that engage in legitimate activities in the present or future[2]. Scientific and technological developments have proven that the activities risk harming the layer of permits. Despite the legality of these activities at the time of practice, states should pay the necessary compensation on the basis of the polluter-pays principle. The pollutant-paying principle was adopted in the Convention for the Protection of the Mediterranean Sea from Pollution of 1978, amended on 10 June 1995[3]. Article 4 of this convention affirmed

Journal, 2013, DOI:10.2139/ssrn.2322485, p2.

1. CN.4543// A.

2. The Ozone Treaties AR - WEB_final.pdf, intouduction and art,,1,2,3, procced 19\4\2025.

3. Unep, Barcelona Convention and Protocols, adopted on 16 February 1976 in Barcelona and

the obligation of states to protect the environment contributing to the sustainable development of the Mediterranean region and approved the application of the principle of paying pollutant or paying pollutant based on the costs of pollution prevention and measures to combat and mitigate, borne by the polluter, with attention to the public interest[1].

Nuclear liability conventions:

The IAEA acts as the depositary for various international legal instruments concerning civil liability for nuclear damage, ensuring that compensation is available for damages resulting from nuclear incidents, including those that cross national borders. Key instruments include the Vienna Convention on Civil Liability for Nuclear Damage, which sets minimum standards for financial protection, and the Joint Protocol that facilitates treaty relations between the Vienna and Paris Conventions to prevent conflicts in their application. Additionally, the Convention on Supplementary Compensation for Nuclear Damage aims to establish a minimum compensation amount and enhance funding through public resources to address any shortfalls in national compensation for nuclear incidents[2].

Precautionary principle[3]:

The principle of precaution is considered the most appropriate legal protection for the international protection of the environment in outer space and on earth, considering that environmental damage is irretrievable, so caution is required before it occurs. Rather, human existence itself correlates, especially since the principle of precaution is a guarantee for the human being, as much as possible, to obtain the right to live in a safe and clean environment and not to harm the interests of future generations, and to take care of their future by not leaving polluted land to achieve justice between generations. Therefore, applying the precautionary principle justifies taking precautionary measures against a specific danger, which

entered into force in 1978., https://www.unep.org/unepmap/who-we-are/barcelona-convention-and-protocols?%2Far%2Fwho-we-are%2Fbarcelona-convention-and-protocols=, procced in 19\4\2025.

1. Samia Sedky, Civil Liability for Environmental Damage in International Law, op.cit.

2.. IAEA, Nuclear liability conventions, https://www.iaea.org/topics/nuclear-liability-conventions, procced in 20\4\2025.

3. Khaled Abdel Aziz, The Principle of Precaution in the Environmental Field, op.cit, p. 17 and beyond.

enables it to occupy a prominent role in international environmental law and international space law. The principle of precaution has been recognized internationally through agreements and declarations related to the environment. such as the Convention on Biological Diversity concluded on 5 June 1992 the need to anticipate and remedy the reasons for the decline in diversity even in the absence of absolute scientific certainty. In addition, article 15 of the Rio de Janeiro Declaration of 1992 emphasized the principle of precaution as a basis for international responsibility in the field of the environment. In addition, article 16 of the Cartagena Protocol on Biosafety of the Convention on the 2000 Biodiversity Precaution Principle explicitly obliges countries to adopt appropriate mechanisms, measures, and strategies to regulate and control biosafety risks when transporting, handling, and using living organisms[1]. Considering the precautionary principle is established in international environmental law, it should be reflected in the United Nations Outer Space Treaty and international space law regarding the risks that the use or testing of nuclear weapons may pose to the space environment. International space law is one of the most well-known instruments regulating the activities that must be taken into account in any space activity, including nuclear weapons testing in space. Article 9 includes obligations to take appropriate measures to avoid harmful pollution, which can be interpreted in line with this principle.

The future of international space law and the weaponization of outer space

It can be said that outer space is a very fertile military environment due to its unique features. Outer space provides critical advantages to those waging war, such as continuous coverage by space objects that move at extremely high speed due to orbital mechanics. Therefore, there is no point on the earth's surface or in the airspace that cannot be observed from outer space, including precise navigation and positioning, real-time weather data, instant global communications, espionage, and reconnaissance missions. Thus, armies with advanced space capabilities depend so heavily on space assets that most of their capabilities will

1. Article 15. Access to Genetic Resources, https://www.cbd.int/convention/articles/default.shtml?a=cbd-15, procced in 10\4\2025.

- 8. Convention on biological diversity. Rio de Janeiro, 5 June 1992, Ch_XXVII_8, VOL-2

deteriorate without reliable satellites in orbit. Therefore, civil and military satellites have become highly intertwined[1].

It has also been noted that space today, from a military perspective, is fundamental to every individual military operation on the planet. Whether humanitarian or major combat, each operation depends critically on space capabilities. That is, outer space should be a peaceful environment because there is a space tainted by harmful activities. Therefore, the Outer Space Treaty constituted an essential tool to avoid the use of weapons by states in outer space and to ensure free access to and exploration of outer space by all states. The weaponization of space is a threat to the environment of outer space and constitutes the easiest way to make outer space a battlefield and an arranged source of space debris. Then, avoiding the unrestricted armament of outer space can be considered as one of the core principles upon which the drafting of the Outer Space Treaty is based[2].

The use of these weapons and the risk of their proliferation is one of the main decisive issues concerning outer space activities, when considering the emergence of multiple space powers, such as France, the United States of America, Russia, and China, where the growing threat of space weaponization is closely related to space debris and the deterioration of the outer space environment[3]. Article IV of the Outer Space Treaty deals

1. M. N. Schmitt, 'International Law and Military Operations in Space' in A. von Bogdandy, R. Wolfrum (eds.) Max Planck Yearbook of United Nations Law, vol. 10, 2006, Brill Academic Publishers, 90–94.

- Osama Hamza Mahmoud Abdel-Fattah, The legal system for removing space debris in light of the provisions of international space law, Journal of Legal and Economic Studies, No. 1, Volume 4, 2018, pp. 70 and beyond.

2.Air Force Gen. John E. Hyten, commander of the United States Strategic Command, 'U.S. Strategic Command Perspectives on Deterrence and Assurance, Speech at the Stanford University's Center for International Security and Cooperation, California, 24 January 2017 available at: http://cisac.fsi.stanford.edu/sites/default/files/transcript_stratcom_-_hyten_160125_no_qa.pdf .

see also Michael Krepon &Christopher Clary, Space Assurance or Space Dominance? The Case Against Weaponizing Space, Henry L. Stimson Center, asserting that "Today, space assets play a much larger role in the real-time enhancement of military operations" and describing satellite's contributions to military navigation, remote sensing, communications, and weaponry, 10\2003.

3. Fabio Tronchetti, The Exploitation of Natural Resources of the Moon and Other Celestial Bodies: a proposal for a legal regime ,Martinus Nijhoff, 2009,pp 2524-.

Dunay, Pál. "The Military Use of Outer Space: Implications for International Law." Military Technology, Armaments Dynamics and Disarmament. Palgrave Macmillan, London, 1989, pp 471- 486.

SpaceSecurity.org, Space Security 2014, at 7. Available at:

directly with the issue of the militarization and weaponization of space, as it provides for the disarmament of outer space as follows:

"The States parties to the Treaty undertake not to place any objects carrying nuclear weapons or any other type of weapons of mass destruction in orbit around the earth, to install such weapons on celestial bodies, or place such weapons in outer space in any other way. All states parties to the treaty use the moon and other celestial bodies for exclusively peaceful purposes, i.e., prohibiting the establishment of military bases, installations, and fortifications, testing any kind of weapons, and conducting military maneuvers on celestial bodies. Outer space can be used in any way, but the deployment or use of anti-satellite weapons is not prohibited"[1].

Because of the importance of the "peaceful purposes" clause as a legal restriction in relation to the exploration of outer space, which was interpreted by the treaty as non-military or non-aggressive, the non-aggressive use of outer space has prevailed and supported by international practices. This ambiguity of article 4 can explain that both the United States and the Soviet Union had already launched satellites into outer space for military purposes when drafting the Outer Space Treaty. Hence, the space powers were very concerned about ensuring that no provision of the Treaty would violate their intentions to maintain peaceful military uses of outer space[2].

Conclusion:

The lack of legal clarity and goodwill for space powers places outer space increasingly in a delicate position, Especially with the difficulty of negotiating a binding treaty that might specifically address the problem of nuclear weapons in outer space, which poses a major threat to the protection of the space and terrestrial environment from nuclear contamination. After that, the paper handled environmental protection from the contamination of nuclear weapons experiments in the outer space law by researching the harmful effects of nuclear weapons experiments in space on the environment in the first topic. Then, the paper tackled

http://spacesecurityindex.org/wpcontent/uploads/201411//Space-Security-Index-2014.pdf full reference including the report's title and source, puplisher, year and page number

1.Paul G. Dembling, Daniel M. Arons 'The Evolution Of The Outer Space Treaty' (1967) 33 Journal Of Air Law And Commerce 419,433; Detlew Wolter (n.55) at 17.

Osama Hamza Mahmoud Abdel-Fattah, op.cit.

2. Paul G. Dembling, Daniel M. Arons , op.cit.

the international principles related to environmental protection and their impact on protecting the space environment in the second topic. Finaly the paper addressed the future of international space law in the face of the weaponization of outer space.

Findings:

1. Legal loopholes in Article 4 of the Outer Space Agreement contributed to the advancement of military space technology towards the era of space weaponization. At present, space assets are considered an integral part of the military equipment of major countries, which negatively affects the environment.
2. The freedom of access, use, and exploration of outer space by all nations without any discrimination and on the basis of equality stipulated in Article 1 of the Outer Space Treaty will be undermined by the deployment or use of weapons in outer space.
3. Due to the space competition between major space powers and the renewed interest in developing nuclear weapons, this poses a threat to the regulation of nuclear weapons in outer space.
4. Article 9 of the Outer Space Treaty can be considered the core of future regulation of space activities because it applies to military and non-military space activities and as an inalienable condition for exploiting outer space itself.

Recommendations:

1. measures should be adopted to avoid pollution of outer space and harmful interference with the outer space activities of other countries, which requires follow-up studies, exploration of outer space, and establishing rules limiting the use of nuclear weapons in outer space.
2. Appropriate measures should be adopted to avoid environmental pollution of outer space and interference between space activities, and mandatory international consultation in the event of potentially harmful interference with activities in the exploration and use of outer space for peaceful purposes in the light of Article IX of the Outer Space Treaty.
3. Outer space activities must be carried out in accordance with obligations to prevent nuclear contamination of outer space by nuclear damage.

4. It is important not to interfere maliciously with the outer space activities of other state, By implementing and executing the prevention of harmful interference with space activities and the environment of disputes which was approved by the Outer Space Treaty .

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