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The Challenges of Environmental Protection in Outer Space Following Russia's Anti-Satellite (ASAT) Weapon Test Activities

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Abstract

One of the effects of space activities is the creation of space debris that can endanger either the space environment or the Earth's environment. In response to concerns regarding a swift escalation in space debris, Russia tested its Anti-Satellite (ASAT) Weapon by deploying the PL-19 Nudol missile against its satellite, Cosmos 1408, generating space debris. This situation certainly raises the question of how to protect the environment in space and whether international environmental law that provides a legal framework for protection in the world can also be applied in outer space. This article offers a new perspective on implementing international law to protect the space environment. This study adopts normative juridical research methods by utilizing a statute and case approach to analyze the research. The analysis showed that space debris generated from ASAT Weapon testing activities by Russia is regarded as harmful contamination under Article IX of OST under the interpretation of the term through the method of interpretation regulated in the 1969 VCLT because these activities produce long-lived space debris. Further, Russia violated the principles of environmental protection in space by failing to fulfill the obligations contained in these principles, such as taking precautionary measures and international consultations before carrying out such test activities.

I. Introduction

Space debris has become a concern due to its dangerous nature that impacts the environment and other space activities. One of the activities that leaves space debris through deliberate explosion activities to destroy satellites in outer space is Anti-Satellite (ASAT) Weapon test activities (Union of Concerned Scientist USA Fact Sheet, 2008). This

activity is a test activities for using an ASAT Weapon as a weapon designed to destroy or disable a satellite in space, which may be launched in-ground or space-based, air or sea-launched (United Nations Institute for Disarmament Research Geneva, 1991). ASAT Weapon test activities have been conducted since the 1970s (during the Cold War) by the United States and the Soviet Union, which later developed this activity to strengthen the country's defence capabilities. The conduct of these test activities can be carried out through two types of weapons such as kinetic, a direct firing anti-satellite weapon to the object (e.g. ballistic missiles), and non-kinetic, a firing anti-satellite weapon using non-physical means (e.g. lasers or cyberattacks) (Daud & Harun, 2022).

On 15 November 2021, Russia conducted its ASAT Weapon test activities using Nudol PL-19, direct-ascent anti-satellite missile, to destroy its inactive satellite named Cosmos 1408, located in the Low Earth Orbit (LEO) area at 480 km (Shannon Bugos, 2021). The test activities created more than 1,500 fragments of space debris that measure 10 cm or more and hundreds of thousands of fragments of space debris that measure below 10 cm with a total mass of around 1,750 kg (ESA Space Debris Office, 2022). Furthermore, the space debris created from these activities spreads vertically and horizontally up to an orbital altitude of 1,400 km. The international community has criticised and considered this activity dangerous because the space debris generated from those activities increases the amount of space debris in Earth's orbit, which can interfere with surrounding space activities. In 2022, these activities became one of the space activities that caused conjunction events, two adjacent objects, with other active satellites in orbit (ESA Space Debris Office, 2022; Secure World Foundation, 2022). Due to these activities, some space activity executors, such as the International Space Station (ISS), Tsinghua Science Satellite of China, and Sentinel-1A of the European Space agency (ESA), reported a collision threat from those space debris (Laura Zhou, 2022; Mark Garcia, 2022a, 2022b; NASA Release, 2021; Sentinel Online News, 2022).

Despite being a major contributor to space debris and affecting other space endeavors, no official assertion has been made regarding the violation of international law by Russia's ASAT Weapon testing activities. This publication provides a new perspective on the implementation of international law, especially on protecting the space environment impacted by irresponsible activities such as ASAT Weapon test activities. It is also encouraged that there is still a debate regarding the legality of implementing ASAT Weapon test activities due to the many legal loopholes in the Outer Space Treaty 1967 (OST) (See: David A. Koplow, 2009; Jeffrey A. Murphy, 2019; Outer Space Treaty, 1967, art. IV; Taufik Rahmat Nugraha, 2019). Even now, the United Nations General Assembly has only encouraged the commitment of all states not to conduct ASAT Weapon test activities through their resolutions (Assembly, 2022). Unfortunately, no binding international law regulates the prohibition of ASAT Weapon test activities.

On the other hand, the issues regarding space debris are not regulated in international law because, at the time of drafting, those issues did not exist (Von der Dunk & Tronchetti, 2015). Article IX of the Outer Space Treaty 1967 (OST) inexplicitly regulates environmental

protection in outer space, which consists of principles of due regard, cooperation, and mutual assistance as the basis to protect the outer space environment (Froehlich, 2018). Moreover, Article IX of OST obliges the State Parties to avoid harmful contamination when conducting their activities in outer space and to conduct international consultation for activities that would cause potentially harmful interference with other space activities (Sergio Marchisio, 2017). Nevertheless, the regulation lacks specificity in its application, making it challenging to discern the criteria for categorizing whether specific space activities involve potential harmful contamination, including determining whether space debris resulting from ASAT Weapon testing qualifies as harmful contamination (Froehlich, 2018; Mineiro, 2008). Thus, this research intend to determine whether the space debris created by Russia's ASAT Weapon test activities can be considered harmful contamination as regulated in Article IX of OST.

This research also focuses on analysing whether Russia's ASAT Weapon test activities, which generated space debris, violate the principles of environmental protection under international law. The protection of the space environment is also regulated by another branch of international law, as emphasized in Article III of OST (Olivier Ribbelink, 2017). International environmental law, as a distinct branch of international law, oversees the regulations about the protection of the environment (Poorhashemi, 2020). In this regard, principles in international environmental law play an important role as the main focus of international environmental law (Viikari, 2008). The ASAT Weapon test activities should be conducted under other international rules, including environmental law. Its fundamental tenets are the precautionary principle and the duty to cooperate. However, a persistent query arises concerning the application of international environmental law in outer space due to the divergent conditions between Earth and space. Consequently, additional research is imperative to explore the application of international environmental law principles in outer space, specifically to assess whether Russia's ASAT Weapon test activities could be construed as a breach of environmental protection principles within the framework of international law.

Based on this background, this research adopts a normative juridical research method, a statutory approach and a case approach to determine the legal issues described above. This research is also divided into four parts, beginning with an introduction to the legal matters. Then, the discussion continues with a literature review on determining the meaning of harmful contamination to examine whether space debris generated by the Russian ASAT Weapon test activities can be considered harmful contamination as stipulated in Article IX of the OST. Afterwards, the discussions focus on the literature review related to the principles of environmental protection, such as the due regard principle, duty to cooperate, and precautionary principles, to find out whether the Russian ASAT Weapon test activities that generated space debris violate the principles of environmental protection under international law. Lastly, the discussion is closed with conclusions from the results of this research.

II. Harmful Contamination as a Result of Space Debris

Article IX of the OST imposes the obligation to prevent harmful contamination. However, the term "harmful contamination" lacks a clearly defined threshold in its interpretation. It makes it difficult to distinguish which activities cause harmful contamination of the space environment. In contrast, this article aims to protect the space environment and the Earth's environment from harmful contamination (Simamora, 2020).

In international law, if a term is ambiguous or unclear in a treaty, the method of treaty interpretation regulated in Article 31 of the 1969 Vienna Convention on the Law of Treaties (VCLT 1969) is applied to find out the true meaning of the terms (Dörr & Schmalenbach, 2018). This method has been recognized as customary international law that may implemented into any treaty (Dörr & Schmalenbach, 2018). Article 31 of VCLT 1969 incorporates several crucial elements, including the principle of good faith, the text of the treaty, its context, and the object and purpose of the agreement (Aust, 2007). On the other hand, a term interpretation is conducted through the ordinary meaning of its term through linguistic analysis, which refers to the common meaning of a term in a general or specific dictionary (Dörr & Schmalenbach, 2018). However, the determination of the terms cannot be conducted abstractly; instead, consider the context, object and purposes of the treaty (Aust, 2007).

The term 'harmful contamination' consists of two words: 'contamination' and 'harmful.' According to the Cambridge English Dictionary, harmful is defined as something that is causing harm (Cambridge Advance Learner's Dictionary, 2003b). In contrast, contamination is defined as the process of making something dirty or poisonous or containing unwanted or dangerous substances (Cambridge Advance Learner's Dictionary, 2003a). Interpretations of these definitions fail to yield a precise meaning for 'harmful contamination' as articulated in Article IX of OST. Determining which space activities can be classified as harmful contamination remains an unresolved challenge.

Interpretations cannot be separated from elements of context and meaning as well as purpose as a whole unit regulated in Article 31 (1) of VCLT 1969. Element of context refers to the contextual approach, where interpretations are made by paying attention to the writings of the agreement, including contents, preamble, and annexes (E. Villiger, 2009). Application of this approach is also helped by considering context and subsequent agreements, subsequent practices, and international law regulations that are relevant for interpretation (Vienna Convention on the Law of Treaties, 1969, art. 31(3)). On the other hand, the element of meaning and purpose refers to a theological approach that pays attention to the meaning and purpose of the agreement to maintain a balance of rights and obligations formed in the agreement (E. Villiger, 2009).

One of the soft laws in outer space law is the Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space (SDM Guidelines). The regulations outlined in the Space Debris Mitigation (SDM) Guidelines concentrate on the conduct and actions of those conducting space activities, specifically in outer space. The objective

is to safeguard the outer space environment from potential threats posed by space debris. The establishment of SDM Guidelines consisting of seven guidelines is done carefully by the Scientific and Technical Subcommittee of the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS) in collaboration with the Inter-Agency Space Debris Coordination Committee based on best available practices, standard, codes, and guidelines that established by several related national and international organization (United Nations Office for Outer Space Affairs, 2010).

SDM Guidelines are subsequently practiced in OST as in Article 31(3) of VCLT 1969. In this regard, the subsequent practice focuses on behavioral action that reflects the treaty interpretation that all State Parties of the treaty must accept (Dörr & Schmalenbach, 2018). The subsequent practice lacks specific forms in which formal statements pertaining to international organization resolutions can be regarded as constituting subsequent practices (Dörr & Schmalenbach, 2018). While the SDM Guidelines may not have a direct correlation with the regulations specified in the OST, their formulation took into account treaties and principles governing outer space. The regulations outlined in Article IX of the OST played a role in shaping the SDM Guidelines. In contrast, this article mandates state parties to engage in additional research to prevent harmful contamination and to take suitable measures to achieve this objective (Zannoni, 2022). SDM Guidelines were adopted in United Nations General Assembly resolutions in 2008, giving the guidelines a universal nature accepted by all States Parties (United Nations General Assembly, 2008).

In this regard, interpretation is conducted by linking the contextual application in OST in terms of 'harmful contamination,' as follows.

a) Contamination

Contamination is the state of containing unwanted or dangerous substances. However, that meaning is still too ordinary to interpret outer space activities because the term 'contamination' is also used in many fields such as environment, food, etc. The term 'contamination' contained in Article IX of OST refers to two conditions: forward contamination, in which the conditions of contamination occur in outer space, and back contamination, in which the conditions of contamination re-enter the Earth through the atmosphere (UNCOPUOS, 1962). Howard A. Baker quotes Kolossov's opinions, who interprets 'contamination' as introducing foreign substances into the space environment with the intent to cause harm (Baker, 1988; Kolossov, 1980).

Contamination and pollution in outer space are closely related in their implementation. Although not included in the OST, the term pollution is more frequently used when discussing space debris. The term pollution is defined as a modification of the environment through human actions by the introduction of undesirable elements or by the undesirable use of features where the term pollution covers bots littering and its contaminating activities (Diederiks-Verschoor & Kopal, 2008; Zhukov & Kolosov, 2014).

Numerous experts contend that space debris can be categorized as a manifestation of pollution in the outer space environment (Diederiks-Verschoor & Kopal, 2008). On the other hand, other forms of contamination may be caused by the careless use of outer space by disposing of fragments of space debris (Gorove, 1972). Nonetheless, the Intentional Instrument on the Protection of the Environment from Damage Caused by Space Debris (ILA Draft Convention) established by the International Law Association (ILA) interprets contamination and pollution as synonym (Bockstiegel, 1994; ILA Draft Intentional Instrument on the Protection of the Environment from Damage Caused by Space Debris, 1994, art. 1). Space debris causes modification of the space environment due to human activities, but the change caused by contamination of the fragments of space debris is created in outer space itself. Even though the preparatory work in Article IX of OST only focuses on biological contamination, radiation contamination, and chemical contamination in outer space (Sergio Marchisio, 2017), the term contamination was not limited. It should be extended based on the environmental conditions that exist in outer space. Therefore, space debris is one of the forms of contamination in outer space.

b) Harmful

The ordinary meaning of harmful is something that causes harm. There is no clear threshold to categorize activities that cause damage in space activities. Previously, space debris was classified as one of the forms of contamination in outer space. However, not all space debris causes harmful contamination because all space activities will create space debris alone (Stubbe, 2010). In this regard, SDM Guidelines, as a subsequent practice of OST, can be used as a standard to interpret conditions that may cause harm to the space environment because reducing the increase in space debris can be considered the same as reducing the harmful effects of such contaminations. Although not directly stated as a standard for interpreting such conditions, considering the hazardous nature of space debris to space activities due to its uncontrolled and directionless movement, it may cause the release of radioactive contamination or other waste-derived contamination (Baker, 1988; United Nations Office for Outer Space Affairs, 2021). Therefore, the SDM Guidelines are applied as a standard for assessing harmful conditions in the space environment.

One of the regulations of SDM Guidelines is to avoid intentional destruction in orbit and other harmful activities that generate long-lived space debris (United Nations Office for Outer Space Affairs, 2010). The increased risk of collisions threatening space operations was the impulse behind establishing this regulation. Despite the recommendation to avoid such actions, since the inception of the guidelines, several states have engaged in ASAT Weapon test activities aimed at destroying satellites. This, in turn, generates long-lived space debris, as the explosions propel fragments of space debris into higher-altitude orbits (Secure World Foundation, 2022).

In 2021, Russia conducted ASAT Weapon test activities with its missile named Nudol PL-19 against Cosmos 1408, which generated thousands of space debris of various sizes. As a result of this activity, the fragments of space debris spread into an altitude orbit of 1,400 km; where according to the classification of the estimated time for space debris to fall to Earth done by United Nations Office for Outer Space Affairs (UNOOSA) and ESA stipulated that above altitude orbit 1,200 km needs indefinite time to falling into Earth (Secure World Foundation, 2022; United Nations Office for Outer Space Affairs, 2021). It is also proven by ASAT Weapon test activities conducted by China in 2007, where 80% of its space debris from its test activities are still in orbit even though the actions were carried out 15 years ago (ESA Space Debris Office, 2022). Space debris generated from ASAT Weapon test activities harms the environment because it causes long-lived space debris. It also can cause risks and threats toward other satellite activities and the lives of space crews or astronauts. Therefore, as stipulated in Article IX of OST, space debris generated from Russia's ASAT Weapon test activities is considered harmful contamination.

III. ASAT Weapon Testing Activities and Violation of Environmental Protection Principles

Although OST has regulations regarding environmental protection, these regulations are still inadequate to protect outer space from its hostile environment. It's shown that the conduct of activities causing harmful contamination in outer space is not prohibited, but Member States of OST must only avoid implementing these activities. On the other hand, the development of international space law has not kept pace with the current space technology and the conditions in outer space. Until now, the development of international space law has only been indicated by the formation of soft law, which is formed as a guideline or recommendation for the States and does not have a binding nature (See: Aoki, 2012).

Howard A. Baker argues that applying the basic principles of international environmental law will provide adequate protection for the space environment (Baker, 1996). Parallel to this argument, Article III of OST affirms that space activities must be conducted in accordance with international law, which includes regulations in a source of international law. In addition, the regulation of Article IX of OST also has direct links to other branches of international law, including international environmental law (Sergio Marchisio, 2017). The application of international environmental law aims to minimise and control the harmful impact of human activities on the environment. Thus, applying the basic principle of international environmental law must be implemented in space activities to address space environmental issues (Baker, 1996).

As a result of the implementation of its ASAT Weapon test activities, Russia violates the principle of environmental protection according to international law, that is:

A. Russia Failed to Fulfill Due Regard Principle

The due regard principle is one of the principles contained in Article IX of OST, which regulates as the limitation of freedom of use in space activities as stipulated in Article I of OST (Viikari, 2008). Space activities refers to the exploration and the use of outer space (Jakhu & Freeland, 2017). Exploration activities aim to develop human knowledge related to outer space and increase human capabilities in carrying out ther activities in outer space, including activities related to the discovering resources that can be used in the future (Hobe & Chen, 2017). Meanwhile, the use of outer space focuses on human activities in outer space, wheter or not these activities are designed for profit (Hobe & Chen, 2017).

The applicability of the due regard principle in Article IX of OST is a legal obligation in implementing space activities, where failure to comply with this article in implementing activities in outer space violates the OST (Aoki, 2022). This principle limits a state's exercise of its rights and obligations in outer space to balance the exercise of other States' rights and obligation in outer space (Sergio Marchisio, 2017). However, this article's criteria for implementing the due regard principle is still unclear (Aoki, 2022).

The due regard principle is divided into two components: due and regard, where the definition of 'regard' in this case is that the State shall respect and consider other State's interests (Guobin, 2014). International law has interpreted this principle as the action of the State to consider other State's rights as required by the circumstances and nature of the rights (Hanlon, 2021). The application of these principles not only records what rights a country has, but it also depends on several conditions such as the nature of the rights and the interest of other States, the level of anticipated loss, as well as the nature and importance of the activities to be undertaken by a country, and the availability of alternative approaches (*Chagos Marine Protected Area Arbitration (Mauritius v. United Kingdom)*, 2015). To conduct its assessments, the State should, at the very least, consult with the interested government (*Chagos Marine Protected Area Arbitration (Mauritius v. United Kingdom)*, 2015).

On the other hand, international environmental law has a principle named *duty to cooperate,* whose regulations parallel the due regard principle (Craik, 2021). It is addressed in the application of duty to cooperate as an obligation of the State to consider the potential impact of its action in accordance with the perspective of the affected States or community, as well as looking out for effect based on good faith and due respect (Craik, 2021). Besides that, Neil Craik argues by relating to the case of Chagos Marine Protected Area Arbitration (Chagos Arbitration) regarding the rights of the United Kingdom, which is subject to due regard from Mauritius's rights and the scope of the nature of the obligation to give due regard (Craik, 2021). In the Chagos Arbitration case, the Court elaborated that the nature of the obligation to give due regards depends on the nature of the rights held by the affected party (Craik, 2021). In contrast, the legal obligation of the duty to cooperate arises from the

obligation in a treaty, in which the duty to cooperate has various form that depends on the words and context of the specific obligation given, as shown in the Chagos Arbitration case (Craik, 2021). Hence, the duty to cooperate principle is implemented through the *due regard* principle in Article IX of OST.

OST does not directly contain the duty to cooperate, but OST has contained some sort of 'cooperation' through various forms such as specific obligations, general obligations, or general principles (Dolzer, 1985). Article IX of OST contained cooperation in the form of general obligation implicitly through obligations to conduct international consultation towards the State's activities in space with the potential for harmful interference (Dolzer, 1985). International consultation procedures as obligation are encouraged by the different patterns of cooperation that such activities require to avoid overlap and interference (Dolzer, 1985). On the other hand, the application of the duty to cooperate is also shown in the ILA Draft Convention, which was formed by the ILA in 1994 (Viikari, 2008). It's emphasised in Article of the ILA Draft Convention, which stipulates the duty to cooperate to avoid environmental degradation. It is specified through the duty to prevent, inform, consult, and negotiate in good faith (Bockstiegel, 1994). In this regard, the implementation of consultation is a duty to cooperate, where consultation is carried out when there is potential harm from space debris to reach a solution to the problem (Viikari, 2008). Therefore, the fulfillment of the due regard principle towards ASAT Weapon test activities can be seen through the fulfillment of international consultation procedures in Article IX of OST.

There is no straightforward procedure for implementing the obligation to conduct international consultation as regulated in Article IX of OST (Froehlich, 2018). However, 3 (three) conditions must be fulfilled to enforce the obligation, such as (Mineiro, 2008):

a) The existence of planned activities in outer space;
b) There is a reason to believe refers to a proven knowledge that a firm declaration of the planned activities will cause harmful interference;
c) The potential harmful interference towards other State's activities. There are three categories of interference in space activities: observational interference, radio frequency interference, dan physical interference. In ASAT Weapon test activities, harmful interference occurs through physical interference due to interference with the freedom of physical movement or physical operation in outer space caused by space debris generated by the test activities.

Russia's ASAT Weapon test activities meet the criteria for international consultation, as evidenced by their premeditated nature, involving planning stages rather than spontaneous execution. However, these activities are not the inaugural instances demonstrating that space debris resulting from such tests creates conditions of harmful interference for other states' activities. The potential for

harmful interference arises from the physical obstructions caused by space debris generated in the process of ASAT Weapon test activities. China's ASAT Weapon test activities in 2007 became one of the test activities where its space debris still regularly had conjunction events with satellites in earth orbit despite 15 years having passed (ESA Space Debris Office, 2022). In this regard, potential harmful interference can be predicted through previous test activities. China's ASAT Weapon test caused physical interference toward surrounding satellites such as NASA's Terra satellite in 2007, Russia's BLITS nanosatellite in 2013, and ISS in 2021 (See: Blumenfeld, 2022; Kramer, 2012; Roulette, 2021; Tate, 2021). Therefore, Russia should fulfill its obligations to conduct international consultation before conducting its test activities.

Although challenging to definitively establish whether the obligation to consult has been met, the condemnation of Russia's test activities by the international community and the acknowledgment from Russia's Ministry of Foreign Affairs suggest that the obligation to engage in international consultation may not have been fulfilled (See: Council of the European Union Press Release, 2021; Shannon Bugos, 2021; UK Space Agency Blog, 2021). This failure is argued to result in interference that poses harm to other activities in outer space. This caused several satellites, the ISS and the Sentinel-1A of ESA, to perform manoeuvring movements to avoid the space debris generated by the test activities (Mark Garcia, 2022a, 2022b; Sentinel Online News, 2022). In addition, the Tsinghua Science Satellite of China also reported alert about possible collision as the fragments of space debris were 14.5 meters away from its satellite (Laura Zhou, 2022). According to an environmental report by the ESA in 2022, space debris produced from Russia's ASAT Weapon test activities frequently engages in conjunction events with other satellites (ESA Space Debris Office, 2022). In light of relevant regulations, these test activities should have been avoided as their space debris poses a long-term threat to other activities in outer space. Hence, Russia failed to fulfill the due regard principle to executing ASAT Weapon test activities.

B. Russia did not Carry Out Precautionary Measures

Principle 15 of the Rio Declaration governs that the lack of full scientific certainty shall not be used as a reason for postponing efforts to prevent environmental degradation. Scientific uncertainty is an essential element of the precautionary principle, which aims to protect the environment without waiting for the scientific certainty that often comes too late (Viikari, 2008). The fulfilment of this principle aims to support the principle of sustainable development in achieving its goals of balancing environmental protection and economic development. The precautionary principle is fulfilled by fulfilling 5 (five) elements, such as (Latifah, 2016):

a. the presence of uncertainty of risk.

This element is one of the essential elements in the precautionary principle. In terms of uncertainity of risk, precautionary measures are taken before the

cause-effect relationship of an activity or technology to its potential damage or harm is known, which arises from a lack of scientific uncertainty proof.

b. scientific assessment of risk.

Although the application of the precautionary principle focuses on the scientific uncertainty proof of the potential risks posed, to implement this principle, a complete scientific assessment must still be initiated to identify the conditions of scientific uncertainty of the potential risks that will be posed.

c. potential serious or irreversible damage.

This element refers to an activity that has the potential for serious damage or irreversible damage. Serious damage focuses on damage on life, natural resources, climate, ecosystem balance, and others. Meanwhile, irreversible damage is categorised as permanent damage involving environmental resources that are irreplaceable or reversible but require an extended period or significant cost.

d. proportionate precautionary measures.

In this element, precautionary measures must be proportionate, where it is essential to prioritise environmental protection over economic interest. This proportionality itself related to cost effectiveness.

e. reversal burden of proof.

In this principle, the reversal burden of proof is applied to activities with potetial risk that threaten the environment. The creators of technology must prove that the technology or activities they carry out are not dangerous and provide acceptable safety to the environment and related parties or community.

Although considered a fundamental principle of international environmental law, the precautionary principle has also been considered customary international law because its application has been used in various forms and fields in international treaties, court judgements, and even national laws (McIntrye & Mosedale, 1997). However, the application of this principle still needs to be determined. Some parties, such as the European Union, state prudence as a 'principle'. On the other hand, some parties, such as the United States, view prudence as an 'approach'. Both terms have different concepts of characteristics and roles in international law. Precaution as a 'principle' focuses on establishing norms of behaviour regarding potential harm in scientific uncertainity, where its role applies as general principles as stipulated in Article 38 of the Statute of the International Court of Justice (Trindade, 2015). Meanwhile, precaution as an 'approach' provides room for states' discretion to undertake precautionary measures, which is mostly applied at national level rather than the international level (Trindade, 2015). In addition, the implementation of precaution as an 'approach' is more flexible and acceptable than precaution as an 'principle'. Therefore, applicability of the precautionary principle in this research focuses on its functions as an 'approach'.

In general, the applicability of the precautionary principle has no specific limitations (Viikari, 2008). The scope can be extended to environmental threats anywhere, including risks to transboundary harm, risks on a domestic level, as well as risks to the global commons (Viikari, 2008). Outer space is a part of the global commons since its environment is beyond the jurisdictional boundaries of the states as stipulated by the non-appropriation principle in Article II of OST (Stubbe, 2010). On the other hand, the applicability of the precautionary principle in outer space parallels the scope of international environmental law, which only focuses on environmental problems that the national government cannot control because the problem does not recognise national borders (Koivurova & Timo, 2014). Therefore, implementing the precautionary principle can extend to activities in outer space.

The implementation of the precautionary principle in outer space is driven by the many uncertainties and risks that occur in the performance of space activities (Viikari, 2008). In the context of outer space, precautionary measures can be focused more on how space activities can continue while minimizing or avoiding the creation of space debris (Cinelli & Pogorzelska, 2013). Even though any kind of space activity will cause harm to the environment due to the unavoidable formation of space debris, banning space activities is also impossible because of the dependence of human daily life on the ecosystem in space (Viikari, 2008). In addition, recovering the space environment is difficult due to limited human access in outer space and the vast cost of conducting a space mission to restore the space environment. Thus, the precautionary principle is the right one to be implemented by every party to prevent or mitigate environmental damage.

Lotta Viikari stipulated that the implementation of precautionary principles referring to space debris is irrelevant since the scientific certainty that has been demonstrated between space activities and the creation of space debris is addressed and widely recognized by the international community (Viikari, 2008). However, an international law professor, Claudia Cinelli, expressed another view that the precautionary principle can be applied if it focuses on the harmful effects of space debris on the space environment because it's still full of scientific uncertainty (Cinelli & Pogorzelska, 2013). Parallel with this point, the precautionary measures shall be taken before conducting ASAT Weapon test activities since there is no scientific uncertainty about the impact of space debris caused by these activities on the space environment.

In this ASAT Weapon test activities, Russia did not take any precautionary measures when carrying out its activities because there is no information or condition evidenced by Russia that shows the test activities were not harmful. The launch of the ASAT Weapon against the satellite causes the space debris to be pushed into a higher orbital region than the satellite. It also causes space debris to take longer to fall to Earth. Russia should carefully consider the impact of its test activities. Russia should have complied with the SDM Guidelines as one of the precautionary

measures since these guidelines are still best practices for mitigating the impact of space debris. In reality, Russia implemented SDM Guidelines in 2019 by introducing a Technical Standard titled "Space Technology Items. General Requirements for Space Vehicles for Near-Earth Space Debris Mitigation" (Federation, 2019). However, this implementation is limited to technical standard regulations and does not involve legally binding arrangements (Ryzhenkov & Anisimov, 2024). Hence, the precautionary measures should be applied in carrying out these activities.

SDM Guidelines is one of the precautionary measures to mitigate space debris. Although not directly related to environmental impacts, Guidelines 4 of SDM Guidelines define avoiding intentional destruction and other harmful activities that generate long-lived space debris (United Nations Office for Outer Space Affairs, 2010). Nonetheless, in cases where intentional destruction becomes imperative, the SDM Guidelines specify that such actions should be conducted in low Earth orbits because the recovery of the space environment is contingent upon the re-entry of space debris into the Earth's atmosphere (United Nations Office for Outer Space Affairs, 2010). This limitation aims to restrict the duration of contamination resulting from space debris, considering its prolonged impact on the recovery of the space environment as the classification of predicted time of space debris re-entry into the Earth's atmosphere conducted by UNOOSA and ESA stipulated (United Nations Office for Outer Space Affairs, 2021):

a) Between an altitude of 500 kilometres above the Earth, it needs approximately 25 years to re-entry into the Earth's atmosphere;
b) Between an altitude of 500 to 800 kilometres, it needs approximately 100-150 years to re-entry into the Earth's atmosphere;
c) Between an altitude of 800 to 1,200 kilometres, it needs approximately 2,000 years to re-entry into the Earth's atmosphere;
d) Between an altitude of 1,200 to 36,000 kilometres, it needs approximately indefinitely to re-entry into the Earth's atmosphere.

Russia should also make a scientific assessment of the potential risk of the test activities through the practices of previous ASAT Weapon tests to identify the possible possibilities. There are 3 (three) practices of ASAT Weapon test activities that have been conducted over the past 2 (two) decades, such as (Secure World Foundation, 2022):

a) China's ASAT Weapon test activities, which were carried out in 2007 against its satellite at an orbital altitude of 850 km, generated 2,087 large fragments of space debris and 35,000 small fragments of space debris (less than 1 cm), and reported that the fragment of its space debris spread vertically and horizontally in the Earth's orbit up to the orbital altitude of 2,000 km, and 80% of its space debris are still in Earth's orbit until now (Kelso, 2007).

b) United States ASAT Weapon test activities carried out in 2008 against its satellite situated at an orbital altitude of 247 km, which generated 174 large fragments of space debris, where the fragments spread vertically and horizontally in Earth's orbit up to an orbital altitude of 800 km (Mineiro, 2008).

c) India's ASAT Weapon test activities were carried out in 2019 against its satellite at an orbital altitude of 282 km, which generated approximately 400 fragments of space debris and thousands of small fragments of space debris (less than 1 cm), and its debris spread vertically and horizontally in Earth orbit up to an orbital altitude of 1,200 km (Ansys Government Initiatives (AGI), 2019).

However, the facts and conditions of implementing these activities show that Russia has not fulfilled the precautionary measures or scientific assessments carried out in its ASAT Weapon test activities. This is seen from the location of the orbital altitude of the Cosmos 1408 satellite as the object of destruction of these test activities (Secure World Foundation, 2022). Even though the satellite's site is still in Low Earth Orbit, it is high enough to conduct ASAT Weapon test activities in which at least takes a long time (about less than 25 years) for the space debris to fall to Earth (United Nations Office for Outer Space Affairs, 2021). In addition, this space debris also spread vertically and horizontally up to an orbital altitude of 1,400 km (Secure World Foundation, 2022), causing the space debris to have no time limit for it to re-enter Earth.

At the very least, Russia should be able to prove the international community that its activities/technology are harmless, considering the precautionary principle has provided a reversal burden of proof as one of its elements. However, regarding this research, no information or conditions leading to reversal burden of proof have been provided by Russia to show that its test activities are not harmful. This is also supported by the statements from several countries that condemned Russia's ASAT Weapon test activities because they considered these activities harmful to space activities and the space environment (Council of the European Union Press Release, 2021; "Statement by Germany in UNCOPUOS Legal Subcommittee 61st Session 28 March – 8 April 2022," n.d.; UK Space Agency Blog, 2021). Therefore, Russia did not carry out precautionary measures when carrying out its ASAT Weapon test activities.

Based on the analysis, the implementation of Russia's ASAT Weapon test activities failed to fulfill the obligations contained in the principles of environmental protection under international law. Russia failed to fulfill the due regard principle toward the implementation of its test activities since these activities pose a long-term threat to the environment and space activities. On the other hand, Russia did not carry out precautionary measures to prevent harmful environmental damage in outer space before carrying out its activities. Whereby failure to fulfill the principles constitutes a breach of the principle. Furthermore, there is no proper reason to

justify the implementation of the test activities when looking at the environmental aspects in outer space, as well as the principle of the common heritage of mankind as regulated in Article II of OST, which should also consider the utilization of its activities for future generations. Thus, Russia's test activities, which generated space debris, violate the principles of environmental protection under international law.

IV. Conclusion

The interpretation of the basic meaning of the term 'harmful contamination' in Article IX of OST is in accordance with Article 31 of 1969 VCLT, which relates the term to the context of OST and the SDM Guidelines as a subsequent practice of Article IX of OST. According to the interpretation of the term, the space debris resulting from Russia's ASAT Weapon test activities can be categorized as 'harmful contamination,' as stipulated in Article IX of the OST. In contrast, Russia has neglected to adhere to the principles of environmental protection, specifically the principles of due regard and the precautionary principle. This failure is evident in its non-compliance with international consultation requirements and the absence of precautionary measures during the execution of its ASAT Weapon test activities.

Based on these conclusions, it is suggested that establishing rules with strict legal force for protecting the space environment can be by adjusting to technological developments. Additionally, there is a necessity for clear explanations or guidelines regarding the interpretation and implementation of Article IX of the OST to alleviate ambiguity. This involves the integration of SDM Guidelines into the national laws of each country, thereby converting them into obligatory regulations for private entities. This measure is designed to ensure that the activities of these entities are carried out in a manner that actively reduces the generation of space debris.

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