Studies on Space Law and Policy

Edited by
Balázs Bartóki-Gönczy
– Philippe Achilleas – András Edl

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Conference Paper of the 1st Space Policy Student Symposium

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Editorial Foreword

In recent years the concept of New Space is slowly getting ground even among the general public. It meant to highlight the advances and possibilities opening up to us with new technologies, novel ideas and economical possibilities. The number of satellites grew at a tremendous pace in recent years and even conservative estimates think that reaching 100,000 satellites before the decade comes to end is not a farfetched idea. But this new environment also opens up the possibilities of more accidents, more vulnerability to infrastructure on Earth and even the chance of an armed conflict in space is stepping out of the world of sci-fi and becoming a reality, as we can see in anti-satellite weapons test or the formation of new military units focusing on space. In order to secure the benefits provided by space and at the same time find a way to avoid conflicts in space is crucial to nations and humanity as a whole. Space assets can help us to tackle climate change, to increase agricultural output, to grant people access to online knowledge and education, to secure Earth from asteroids or forecast space weather. To optimise the results, keep and further develop space infrastructure we have to know what goes on in space. We need to plan based on that knowledge. We have to find answers to difficult questions and solve challenging problems. Innovation, research, new perspectives are the key to discover the best path forward.

The present book is a collection of essays, based on the presentations of researchers held at the Space Policy Student Symposium in 2022 at the Ludovika University of Public Service, following an international conference on the New Space Era. The speakers of the Symposium examined parts of the space puzzle in order to advance the joint efforts of the international community with their insights and ideas.

In the following pages the reader will find information about the history of space exploration how it grew into the complex environment we know today. The legal aspects show how states and organisations try to come to agreements about their space operations so they can avoid accidents, conflicts or the loss of life and equipment. They even tried to give guidelines for the future usage of space. Yet even the area of space law changes and instead of binding treaties and agreements states now increasingly rely on soft law documents to the extent that they might be the main source of space law and the engine behind its development. The characteristics of these types of legal documents is therefore important to understand this segment of space activity.

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Space law also aims to support the idea of sustainability. We need to develop our space activity in a way that can secure long-term usage. Contamination of the space environment or the surface of other celestial bodies proves to be a considerable challenge and a credible source of threat for space activity. Regulation can help to identify the threats to sustainability and also aid the solving of this problem. The methods and ideas used on Earth can provide a good basis to develop solutions for the space environment. The Space Sustainability Rating can also help to tackle this problem. To make it successful, the cooperation between private corporations, legislative bodies and governments is paramount.

While keeping space activity sustainable we also need to make sure the security and economic activity is also regulated, to enhance and protect the benefits arising from space activity and lay the foundation for future growth. The international system is mirroring itself in space as well, tensions and cooperation between different actors can manifest in space and at the same time can be enlarged with the multiplication effect of space assets. The combination and balance of hard power and legal instruments can also help to make space more secure. Humanity also has to find a way to make economic endeavours profitable and at the same time respect already existing laws and guarantee strong state and international oversight. Without these kinds of regulations there is too big of a chance for conflict, misunderstandings, damage to property and loss of life or just simply the collapse of the next phase in space activity.

The problems are difficult but not impossible to solve. One obvious example for a fruitful international cooperation is the International Space Station. It is not just a symbol but also a tool to make the next step possible in space activity. Since the start of the Russian–Ukrainian war in 2022, the future of the station became more uncertain. The strong messages and signals sent by the Russian Federation made the international community think and take steps to assure the safety and operability of the station. This issue can greatly influence the future of cooperation in space and contribute to a new geopolitical order.

Apart from major space powers like the United States, the countries of Asia, among them China, also expand and develop their space activity. Cooperation between the countries in the region is not only important for the nations covered in this endeavour but also for the whole space community. It is enough to consider that, with the exception of North Korea, the other three countries of Northeast Asia (China, Japan, South Korea) are among the top 10 nations of the world in terms of economic and/or military power.

These geopolitical changes and increased competition among actors also reflect in space. The days of space being a sanctuary for the leading space power is over. New technologies make space situational awareness even more important. We also see the reemergence of the strategy of deterrence which was a valid and useful tool to prevent a nuclear war. Yet the times have changed and new technologies make the effectiveness of deterrence questionable. Stealth satellites, new methods of camouflage and deception are in a constant race with novel methods and tools for surveillance and detection.

These are glimpses into the complicated world of space activity. Suggestions, questions and ideas to discuss, to increase awareness and foster dialogue among the different stakeholders. We hope the papers presented here will encourage the reader to refine their knowledge and lead them towards new questions.

Budapest, 2023

The Editors

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Dalma Takó[1]

From Soft Law to Hard Law
A Particular Trend in International Space Law

Introduction

International space activities are governed by a wide variety of sources, including bilateral and multilateral international treaties, customary international law and so-called soft law instruments.[2] Until the 1980s, 1990s, international law-making in space law was characterised by creating legally binding norms. During the 1960s, 1970s states concluded several international treaties, including the following five main multilateral treaties (hereinafter: space law treaties): Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and other Celestial Bodies – 1967 (hereinafter: Outer Space Treaty); Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space – 1968 (hereinafter: Rescue Agreement); Convention on the International Liability for Damage Caused by Space Objects – 1972 (hereinafter: Liability Convention); Convention on Registration of Objects Launched into Outer Space – 1975 (hereinafter: Registration Convention); Agreement Governing the Activities of States on the Moon and Other Celestial Bodies – 1979 (hereinafter: Moon Agreement). These treaties led down the basic rules of international space law and are particularly important ever since their conclusion.

However, during the 1980s, 1990s the category of soft law also started to spread and gradually gained more and more ground.[3] At the same time, a decline of the traditional treaty method started in the era of law-making in outer space.[4] It can be observed in the recent years as well, as states are choosing to assert their interests and opinions through soft law documents rather than adopting new

[1] Széchenyi István University, e-mail: tako.dalma@ga.sze.hu; ORCID: 0000-0001-7019-3184
[2] Aust 2010: 11.
[3] Tronchetti 2013: 14, 85.
[4] Neef 2021: 572–573.

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binding international treaties or amending existing ones.[5] Due to this, several authors[6] believe that for now, soft law has become the dominant and primary tool for the development of international space law.[7] For this reason, it is of particular importance to examine the special features of soft law documents and the impact they have, or could have, on international space law.

Soft law documents in international space law

Examples and special features of soft law

Soft law instruments are legally non-binding documents, the aim of which is generally to establish standards and principles for a particular activity. Due to their non-binding nature, the modest enforcement mechanisms of international law are not applicable for them. It means for example, that the neglect of soft law must not entail countermeasures (reprisals) and soft law documents cannot be invoked before UN bodies.[8] Nevertheless, as soft law documents are easy to create, they can undoubtedly provide a flexible solution to issues that require urgent action and they can help to adapt to new situations and technological developments.

In the field of space law, there has been an increasing amount of non-binding soft law material since the 1980s and 1990s.[9] The reason of it is that by the 1980s and 1990s, the process of creating international treaties in the field of space law had clearly come to a halt.[10] Some authors argue that this can be seen on the example of the Moon Agreement, which has only 18 State Parties and the fact that after this agreement no multilateral treaty could be concluded in international space law.[11] According to these authors, the lack of new binding norms has led

5 Ferreira-Snyman 2021: 34.

6 Tronchetti 2013: 14, 85; Byrd 2022: 834; Neef 2021: 572–573.

7 The important role of soft law documents has been recognised by the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS). *Report of the Committee on the Peaceful Uses of Outer Space* 30.

8 Schmalenbach 2012: 42.

9 Tronchetti 2011: 619.

10 Martinez 2020: 523.

11 Rachel Neef raises, among other issues, the failure of the draft treaty between China and Russia on the prevention of the threat of arms sales and violence in outer space. Neef 2021: 573.

members of the international community to turn to the category of soft law, which has gradually gained more and more importance.[12]

Examples of soft law include memorandum of understanding; certain UN General Assembly resolutions that do not have the status of customary law;[13] various directives; guidelines; declarations; recommendations; programmes and codes of conduct.[14] There are many examples of each of the above categories in the field of space law, but only two categories will be briefly described here for illustrative purposes. First of all, it is worth mentioning the category of directives, which are numerous in many areas of space law. For example, the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) has been developing documents of this kind since the 1990s, dealing with important issues such as space debris[15] and the sustainability of space activities.[16] The other example of soft law is the category of Memorandum of Understanding (MoU) documents, about which many authors note that they are important tools in the hands of the parties, a large number of bilateral and multilateral MoUs are created every year.[17] Among these documents, it is important to highlight the so-called Artemis Accords,[18] which will be examined in detail in the third part of the study.

The potential impact of soft law on international space law

Although soft law instruments are not binding, they may significantly influence states' behaviour and contribute to the progressive elaboration and consolidation of international law. Soft law documents may have several functions, which, according to Fabio Tronchetti, fall into 4 categories: 1. soft law can give guidance on how to interpret and implement existing treaty provisions;[19] 2. it may represent

[12] Tronchetti 2013: 14, 85.
[13] Tronchetti 2013: 7.
[14] Martinez 2020: 522; Aust 2010: 11; Kolb 2016: 171; Remuss 2011: 539.
[15] Space Debris Mitigation Guidelines. Martinez 2020: 530.
[16] Freeland–Zhao 2020: 416–417; U.N. Office for Outer Space Affairs s. a.
[17] Aust 2010: 51–52.
[18] The official English title of the document is *Artemis Accords. Principles for a Safe, Peaceful, and Prosperous Future* (hereinafter: Artemis Accords). NASA 2020.
[19] Francis Lyall and Paul B. Larsen also emphasise this guiding character of soft law. Lyall–Larsen 2009: 51–52.

the beginning of a process leading to an international treaty;[20] 3. it may contribute to the formation of customary law;[21] and 4. it may be declaratory of existing unwritten rules.[22]

From these opportunities, it is worth paying attention to the case when a soft law instrument becomes customary international law. The category of customary international law has two conditions, namely a general and consistent practice of states and the so-called *opinio iuris sive necessitatis*.[23] For the first condition, the practice of so-called specially affected states is important, which means that "in the examination of custom, the practice of the states concerned or interested in the matter in question is of primary importance".[24] In connection with this, time factor is also relevant, however, it is important to highlight that, given a sufficiently large number of representative practice pointing in the same direction, it does not necessarily take a long time for customary law to develop.[25] Several authors have argued that in case of space law, a short period of time is usually sufficient, so-called instant customary law is very common in this area.[26] As for the second condition, the *opinio iuris sive necessitatis* requirement means that states must regard a given practice as a legal obligation and follow it accordingly.[27] Generally speaking, if States establish rights and obligations on a particular practice and enforce them for example before international courts, the condition of *opinio iuris* can be established.[28]

The above-mentioned conditions of customary international law might be met in case of soft law documents as well. Consequently, if a soft law document

[20] Laura C. Byrd also mentions this function of soft law. Byrd 2022: 34.

[21] Anel Ferreira-Snyman stresses that soft law may function as a basis of law-making. Ferreira-Snyman 2021: 34–35.

[22] Tronchetti 2011: 624.

[23] Tronchetti 2011: 625.

[24] Mineiro 2012: 25.

[25] Pershing 2019: 153–154.

[26] Klabbers 2013: 49–50; Pershing 2019: 153–154.

[27] Wouters 2019: 257. This is also mentioned in Article 38 of the Statute of the International Court of Justice, which refers to customary law as a general practice accepted as law. Statute of the International Court of Justice, Article 38 (1) (b).

[28] Klabbers 2013: 49–50.

is applied generally and consistently in practice and is regarded as law, then the document acquires customary law status and thus becomes legally binding. However, this could have further consequences. Since there is no hierarchy between the sources of international law, treaties and customary law are on the same level. It means that a soft law instrument, which becomes customary international law may confirm, but also derogate international treaties. The term derogation refers to the creation of customary law contrary to an international treaty, which more precisely means that after the conclusion of an international treaty, the parties to the treaty may engage in practices contrary to it. In such a case, thanks to the principle of *lex posterior derogat legi priori,* the latter rule derogates the earlier one. It is important to note that customary international law rarely derogates a whole treaty, but rather has this effect only on one or more certain provisions.[29]

A practical example: The Artemis Accords

The above statements can be illustrated by the example of the document named *Artemis Accords.* This document was initiated by the United States and signed by eight states in a virtual ceremony on the 13th of October 2020 at the 71st International Astronautical Congress.[30] These states were Australia, Canada, Italy, Japan, Luxembourg, the United Arab Emirates, the United Kingdom and the United States.[31] Other signatories later joined,[32] including Bahrain, Brazil, Colombia, France, Israel, Mexico, New Zealand, Poland, Romania, Saudi Arabia, South Korea, Singapore and Ukraine.[33]

[29] Szalai 2018: [69].
[30] COPUOS 2021b: 19.
[31] NASA 2020.
[32] The document itself provides the possibility of expanding the number of signatories. Artemis Accords, final provisions.
[33] Thus, the Accords now has 21 signatories (NASA 2020). Furthermore, it can be mentioned that the Isle of Man, a British Crown Dependency, has also declared that the Accords can be applied for the isle. Government of the Isle of Man 2021.

Artemis Accords is a non-binding soft law document,[34] more precisely a *memorandum of understanding* (MoU).[35] Several facts refer to this type, for example the wording in the preamble, according to which the document is intended to establish a political understanding among the parties.[36] This is confirmed by the first section, which states that the Accords merely represents a political commitment by the parties to the principles it contains.[37] The soft law character of the document is further confirmed by the fact that formally it is not divided into articles, as international treaties, but into sections, and that in several cases the document uses the term principles to refer to the matters it contains.[38] Another important factor is that the parties did not wish to register the document in the United Nations Secretariat's United Nations Treaty Collection of international treaties.[39] The final provisions of the document expressly state that the Government of the United States shall maintain the original text of the Accords and transmit a copy to the Secretary-General of the United Nations, but the document shall not be registered under Article 102 of the Charter of the United Nations.[40] Finally, it is worth mentioning that the final provisions of the document state that the signatories commit to periodically consult to review the implementation of the principles contained in the Accords and to exchange views on potential areas of future cooperation.[41] All of these suggest that the parties did indeed intend to create a non-binding, soft law document, a memorandum of understanding, which could be easily reviewed and amended if necessary.

[34] COPUOS 2021b: 3.

[35] The concept of these documents has not yet been defined, but it is certain that they can be created between states and between states and international organisations. According to Francis Lyall and Paul B. Larsen, the term MoU refers to a document that is more than a gentlemens' agreement, but less than a treaty. Lyall – Larsen 2009: 37. Anthony Aust mentions that a large number of bilateral and multilateral MoUs are concluded every year on all kinds of issues. Aust 2010: 51–52.

[36] Artemis Accords, Preamble.

[37] Artemis Accords, Section 1.

[38] The title, the preamble, the first and second sections and the final provisions of the document all contain the term principles. Artemis Accords.

[39] According to the UN Charter, "any international treaty concluded after the entry into force of the Charter [...] shall be registered with the Secretariat as soon as possible [...]". Charter of the United Nations, Article 102.

[40] Artemis Accords, Section 13.

[41] Artemis Accords, Section 13.

After clarifying the form of the document, it is worth paying attention to the content of the Artemis Accords. The table below sets out the issues covered by the document, comparing them with the relevant provisions of space law treaties.

Table 1: The content of space law treaties and the Artemis Accords

	Artemis Accords	**Outer Space Treaty**	**Rescue Agreement**	**Liability Convention**	**Registration Convention**	**Moon Agreement**
Peaceful purposes	Preamble and Section 3	Preamble and Article IV	Preamble	Preamble	Preamble	Article 3
Transparency	Section 4.	Article XI	–	–	–	–
Interoperability	Section 5	–	–	–	–	–
Emergency assistance	Section 6	Article V	Articles 1 and 2	Article XXI	–	Article 10
Registration of space objects	Section 7	–	–	–	Preamble, Articles II and III	–
Release of scientific data	Section 8	–	–	–	–	–
Preserving outer space heritage	Section 9	–	–	–	–	–
Space resources	Section 10	Article II	–	–	–	Articles 6 and 11
Deconfliction of space activities	Section 11	Article IX	–	–	–	Article 2
Orbitral debris	Section 12	–	–	–	–	–

Source: Compiled by the author.

Based on the content of the above-mentioned provisions, it is possible to establish that most sections of the Accords only confirm the content of the five main multilateral space law treaties. These sections govern the questions of peaceful

purposes, transparency, emergency assistance and registration of space objects.[42] Furthermore, some sections supplement the existing rules of space law as they contain issues that are not mentioned in the space law treaties. These sections are in connection with interoperability, release of scientific data, preserving outer space heritage and orbitral debris.[43] Both the confirmation and the supplementation is in conformity with space law treaties.

However, there are two sections in the Accords that raise fundamental questions and thus need to be examined more precisely. These sections are about space resources and deconfliction of space activities. In connection with the first question, the Accords makes it possible to extract and utilise space resources including any recovery from the surface or subsurface of the Moon, Mars, comets, or asteroids. As for the second issue, the document gives opportunity for states to create so-called safety zones.[44] The document records that the extraction of space resources does not inherently constitute national appropriation under Article II of the Outer Space Treaty and that safety zones are necessary in order to implement notification and coordination and thus to avoid harmful interference and fulfil the obligation of due regard.[45]

Based on the above, it can be established that the document tries to create a legal basis for activities in question and regards them as lawful methods. Arguments might be found both for and against this view. Many authors argue that Section 10 of the Accords is not in conformity with Article II of the Outer Space Treaty, and Articles 6 and 11 of the Moon Agreement.[46] Others believe that the extraction and utilisation of space resources is clearly legitimate.[47] There is

[42] In this respect, the content of the Accords is in line with the preamble of the document, which says that the Accords's goal is to reinforce the provisions of the Outer Space Treaty, the Rescue Agreement, the Liability Convention and the Registration Convention. Artemis Agreement, Preamble.

[43] With regard to space debris, it is important to note that the UN Committee on the Peaceful Uses of Outer Space has developed specific guidelines on this issue, but it is beyond the scope of this study to explore them. United Nations 2007.

[44] Mallowan et al. 2021: 156.

[45] Artemis Accords, Sections 10 and 11.

[46] According to these authors, the resources of outer space are the common heritage of mankind and any form of appropriation or acquisition of ownership is prohibited. Mosteshar 2020: 601–602; Hasin 2020: 105–106; Pershing 2019: 154, 156.

[47] Goehring 2021: 582.

a third category of authors, who prefer not to take a position on the issue.[48] The situation is very similar in the case of safety zones, many authors argue for the lawful nature of these zones,[49] while others consider that the zones exhaust the prohibition of extending state sovereignty to outer space.[50]

The contradictory opinions presented here are based on the different interpretations of the articles in question.[51] Due to this, arguments can be made for and against the legality of the Artemis Accords. I believe that the document is trying to exploit the uncertainties described above and the shortcomings in the interpretation of the space law treaties and aims to disseminate a specific interpretation of certain disputed provisions of space law treaties. The point of this interpretation is that safety zones may be established in outer space in order to fulfil the principle of due regard and to avoid harmful interference, and neither these, nor the extraction and commercial use of space resources constitute appropriation. In other words, the Accords wants to suggest that these activities are in conformity with the above-mentioned provisions of space law treaties.[52]

The aim of the document is to disseminate this interpretation as widely as possible.[53] By doing so, the Accords presumably intends to establish customary international law in questionnary issues.[54] According to some authors, this objective can be a reality in the near future if the space-faring states[55] follow

[48] Diego Zannoni, Elya A. Taichman and Sa'id Mosteshar, for example, all believe that there is no international consensus on the status of space resources and the legality of their extraction and use, and that the issue cannot be clearly decided. Zannoni 2020: 334; Taichman 2021: 114; Mosteshar 2020: 598–600. According to Gershon Hasin, the reason for the uncertainty on the subject is that there is no widespread public practice on space mining that would support one view or the other. Hasin 2020: 80–81, 105–106.

[49] These authors mention as a comparison the lawfulness of keep-out zones, safety zones in the law of the sea and the Air Defence Identification Zones. Mallowan et al. 2021: 160; Newsome 2016: 43–48.

[50] Many authors consider that security zones have many similarities with territorial sovereignty, as they provide the possibility of exercising exclusive control over a territory, which violates the right of free access to outer space. Mosteshar 2020: 601–602; Ferreira-Snyman 2021: 31–32; Neef 2021: 570–572; Larsen 2021: 42–43.

[51] Mallowan et al. 2021: 157.

[52] Prahalad 2021: 444.

[53] According to the Preamble, the document tries to achieve a global consensus on critical issues regarding space exploration and use. Artemis Accords, Preamble.

[54] Mosteshar 2020: 601–602; Smith 2021: 661, 687; Taichman 2021: 131–132.

[55] In case of space law, there is no exact list about these states, however, the United States, North Korea, India, Iran, Israel, Japan, China, Russia and the European Space Agency states can be

a consistent practice in line with the Accords and if they regard the document as legally binding.[56] In this respect, it can be noted that, with a sufficiently large number of representative practice pointing in the same direction, it does not necessarily take a long time for customary law to develop.[57] Several authors have argued that, in case of space law, a short period of time is usually sufficient, and that in this area, so-called instant customary law is very common.[58]

There are already some facts that refer to this direction, for example the domestic law regulation in some states. For example, the United States, Japan, Luxembourg and the United Arab Emirates have already adopted legislation in their domestic law that considers the extraction and commercial use of space resources lawful and not appropriation of outer space. The same regulation and practice may arise in other states in the future.[59]

If this happens, if all the two conditions of customary international law are met, Sections 10 and 11 of the Artemis Accords may acquire customary law status.[60] However, this would have a significant impact on Article II of the Outer Space Treaty and Articles 6 and 11 of the Moon Agreement. These articles would be in some sense undermined and derogated by the customary nature of Sections 10 and 11 of the Accords. This would mean that the states that have signed the document and followed a consistent practice in line with its content would be bound by the content of the Accords as customary law, instead of the aforementioned provisions of the space law treaties.[61] However, in this context, it is worth clarifying that derogation may only arise in the sense and to the extent that the texts of space law treaties and the Accords are considered to be in conflict with each other.

confidently regarded as such. Spacepolicy Online s. a.

56 Elizey 2021: 234; Anderson et al. 2021: 227–258; Wouters 2019: 257.

57 Pershing 2019: 153–154.

58 Klabbers 2013: 49–50; Pershing 2019: 153–154.

59 Klabbers 2013: 49–50; Pershing 2019: 159.

60 According to Scot W. Anderson and Charles Elizey, the process is moving in the direction of making the interpretation of the Artemis Accord common law. Anderson 2021: 227–258; Elizey 2021: 208.

61 This customary law, however, cannot be applied for persistent objectors. For example Russia and China have already expressed their opposition to the Artemis agreement. For this reason, it is likely that China and Russia will not be bound by the currently evolving customary law under Articles 10 and 11 of the Artemis Agreement.

Conclusion

Based on the findings of this study, it is possible to declare that the category of soft law has several advantages. With the help of these documents, states are able to lay down principles of interpretation or forms of conduct for themselves without the strict requirements of international treaties. Due to this easy way of creation, soft law might be useful, or even necessary and desirable in certain cases. The category of soft law can undoubtedly provide a flexible solution to issues requiring urgent action and can help to adapt to new situations and technological developments.[62]

However, soft law instruments may also raise questions if they become legally binding hard law. By acquiring customary law status, soft law documents have the opportunity to derogate international treaties. This may well be the case with the Artemis Accords, as the specific interpretation contained in the document may well become customary international law in the future. As we could see, this would in fact provide an opportunity to circumvent or undermine certain provisions of space law treaties. Moreover, this purpose of the Accords is not particularly obvious, as the document seeks to conceal the real reason for its creation by exploiting the uncertainties inherent in the interpretation of certain provisions of space law treaties and by invoking their clarification.

In my view, the Artemis Accords and the possible impact of soft law documents as described above poses a significant challenge for future international space law, but also to the sources of international law and to international justice. These areas must provide answers to the questions raised by this trend, including its legal or illegal nature, and define the framework for this specific law-making process. This is by no means a simple task, however, due to the current needs of states and to the fact that soft law enjoys a growing support, it is undoubtedly necessary.[63]

[62] Lyall–Larsen 2009: 51–52.
[63] Tronchetti 2011: 632.

References

Anderson, Scot W. – La Manna, Julia – Christensen, Korey J. (2021): The Development of Natural Resources in Outer Space. *Journal of Energy and Natural Resources Law,* 37(2), 227–258. Online: https://doi.org/10.1080/02646811.2018.1507343

Aust, Anthony (2010): *Handbook of International Law.* Cambridge: Cambridge University Press. Online: https://doi.org/10.1017/CBO9780511841460

Byrd, Laura C. (2022): Soft Law in Space. A Legal Framework for Extraterrestrial Mining. *Emory Law Journal,* 71(4), 803–840.

Charter of the United Nations.

COPUOS (2021a): International Cooperation in the Peaceful Uses of Outer Space: Activities of Member States. Note by the Secretariat. Committee on the Peaceful Uses of Outer Space, Scientific and Technical Subcommittee, Fifty-eighth session, Vienna, 19–30 April 2021. (A/AC.105/C.1/2021/CRP.4).

COPUOS (2021b): Draft Report, Committee on the Peaceful Uses of Outer Space, 31 May – 11 June 2021. (A/AC.105/C.2/L.314/Add.3).

Elizey, Charles (2021): Objects That Return to Earth. *Journal of Space Law,* 45(1), 201–238.

Ferreira-Snyman, Anel (2021): Challenges to the Prohibition on Sovereignty in Outer Space. A New Frontier for Space Governance. *Potchefstroom Electronic Law Journal,* 24(1), 2–50.

Freeland, Steven – Zhao, Yun (2020): Rules of the "Space Road:" How Soft Law Principles Interact with Customary International Law for the Regulation of Space Activities. *Journal of Space Law,* 44(2), 405–432.

Goehring, John S. (2021): Why Isn't Outer Space a Global Commons? *Journal of National Security Law and Policy,* 11(3), 573–590.

Government of the Isle of Man (2021): *Artemis Accords to Be Extended to the Isle of Man*. Online: https://www.gov.im/news/2021/jul/27/artemis-accords-to-be-extended-to-the-isle-of-man/

Hasin, Gershon (2020): Developing a Global Order for Space Resources. A Regime Evolution Approach. *Georgetown Journal of International Law,* 52(1), 79–160.

Klabbers, Jan (2013): *International Law.* Cambridge: Cambridge University Press. Online: https://doi.org/10.1017/CBO9781139022569

Kolb, Robert (2016): *The Law of Treaties. An Introduction*. Cheltenham–Northampton: Edward Elgar Publishing.

Larsen, Paul B. (2021): Is There a Legal Path to Commercial Mining on the Moon? *University of Pittsburgh Law Review,* 83(1), 1–49.

Lyall, Francis – Larsen, Paul B. (2009): *Space Law. A Treatise.* Farnham: Ashgate.

Mallowan, Lucas – Rapp, Lucien – Topka, Maria (2021): Reinventing Treaty Compliant "Safety Zones" in the Context of Space Sustainability. *Journal of Space Safety Engineering,* 8(2), 155–166.

Martinez, Peter (2020): The Role of Soft Law in Promoting the Sustainability and Security of Space Activities. *Journal of Space Law,* 44(2), 522–564.

Mineiro, Michael C. (2012): *Space Technology Export Controls and International Cooperation in Outer Space.* Dordrecht: Springer. Online: https://doi.org/10.1007/978-94-007-2567-6

Mosteshar, Sa'id (2020): Artemis. The Discordant Accords. *Journal of Space Law,* 44(2), 591–603.

NASA (2020): *Artemis Accords. Principles for a Safe, Peaceful, and Prosperous Future.* Online: https://www.nasa.gov/specials/artemis-accords/img/Artemis-Accords-signed-13Oct2020.pdf

Neef, Rachel (2021): Artemis Accords. A New Path Forward for Space Lawmaking? *Adelaide Law Review,* 42(2), 569–580.

Newsome, Ted Adam (2016): *The Legality of Safety and Security Zones in Outer Space. A Look to Other Domains and Past Proposals.* Montreal, Quebec: Institute of Air and Space Law.

Pershing, Abigail D. (2019): Interpreting the Outer Space Treaty's Non-Appropriation Principle. Customary International Law from 1967 to Today. *Yale Journal of International Law,* 44(1), 149–178.

Prahalad, K. K. (2021): An International Legal Regime for Lunar Mining and India's Way Forward. *Jus Corpus Law Journal,* 2(2), 438–450.

Remuss, Nina-Louisa (2011): Space and Security. In Brünner, Christian – Soucek, Alexander (eds.): *Outer Space in Society, Politics and Law.* Wien – New York: Springer.

Report of the Committee on the Peaceful Uses of Outer Space, 74 UN GAOR, Supp. No. 20. (A/74/20).

Schmalenbach, Kirsten (2012): Article 2. Use of terms. In Dörr, Oliver – Schmalenbach, Kirsten (eds.): *Vienna Convention on the Law of Treaties. A Commentary.* Heidelberg: Springer. 27–48. Online: https://doi.org/10.1007/978-3-642-19291-3_4

Smith, Walker A. (2021): 'Using the Artemis Accords to Build Customary International Law. A Vision for a U.S.-Centric Good Governance Regime in Outer Space', *Journal of Air Law and Commerce,* 86(4) 661–700.

Spacepolicy Online (s. a.): *International Space Activities.* Online: https://spacepolicyonline.com/topics/international-space-activities/

Szalai, Anikó (2018): Nemzetközi szerződések. In Jakab, András – Fekete, Balázs (eds.): *Internetes Jogtudományi Enciklopédia*. Online: http://ijoten.hu/szocikk/nemzetkozi-szerzodesek

Taichman, Elya A. (2021): The Artemis Accords. Employing Space Diplomacy to De-Escalate a National Security Threat and Promote Space Commercialization. *National Security Law Brief,* 11(2), 112–146.

Tronchetti, Fabio (2011): 'Soft Law', in Brünner, Christian – Soucek, Alexander (eds.) *Outer Space in Society, Politics and Law.* Wien: Springer, 619–638.

Tronchetti, Fabio (2013): *Fundamentals of Space Law and Policy.* New York: Springer. Online: https://doi.org/10.1007/978-1-4614-7870-6

United Nations (2007): Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space. Report of the Committee on the Peaceful Uses of Outer Space, 62 UN GAOR, Supp. No. 20. (A/62/20).

U.N. Office for Outer Space Affairs (s. a.): *Long-Term Sustainability of Outer Space Activities.* Online: https://www.unoosa.org/oosa/en/ourwork/topics/long-term-sustainability-of-outer-space-activities.html

Wouters, Jan (2019): International Law. Informal Law-Making, and Global Governance in Times of Anti-Globalism and Populism. In Krieger, Heike (ed.): *The International Rule of Law. Rise or Decline?* Oxford: Oxford University Press. Online: https://doi.org/10.1093/oso/9780198843603.003.0016

Zannoni, Diego (2020): Dilemma Between the Freedom to Use and the Proscription against Appropriating Outer Space and Celestial Bodies. *Chinese Journal of International Law,* 19(2), 329–358. Online: https://doi.org/10.1093/chinesejil/jmaa013

Zsolt Csepregi[1]

Analysis of a Dual-Track Approach to Legislating Military and Economic Activities in Space

Introduction

The current framework of space law emerged as a direct result of the Cold War security architecture based on the need to prevent superpower conflict. This requirement has led to treaties enshrining state responsibility in all space activities, limiting the potential for armed escalation. These international agreements, however, also curb the potential scope of economic activity by restraining sovereignty and ownership in space. In recent years New Space has developed rapidly despite the constraints. Technologically viable solutions have emerged enabling economic utilisation of all potential assets even beyond high Earth orbit.[2] These assets include the Moon, Mars, asteroids and other celestial bodies and theoretically even deep space assets. Despite these developments all these new methods for the utilisation of outer space assets are facing legal constraints. This however does not hinder the ongoing shift in investment, with capital pouring into these enterprises involving the Moon and beyond. The prospect of a dynamically expanding outer space economic activity in spite of the legal constraints are pointing to a difficult and potentially dangerous situation in space governance. At the same time the much-needed legal reform of the regulation of military space activities is blocked by the dual need to guarantee security in space and enable private ventures and research in outer space.

In this study I argue for the viability of a dual-track approach in legislating space activities to resolve the conflicts and asymmetry between the two aspects of space law. There is a differing need and willingness to reform the security and the economic aspects of space law. Security guarantees stemming from the UN Charter and the *Outer Space Treaty* (OST) are sufficient, and peace and

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[2] High Earth Orbit meaning a geocentric orbit above 35,786 kilometers.

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security in space also ultimately depends on the hard military power of the states. Naturally, with all the development in the use of force in space, a reform of the legal framework to respond to the emerging threats would be also welcomed. On the other hand, the existing international legal framework regulating the economic aspect of space is not only lacking, but also debilitating and insufficient. Therefore, I suggest creating a distinct legal regime for space economy, namely a mid-tier legal instrument between hard law represented by the Outer Space Treaty and the soft law and project based legal agreements. This would permit a limited, international form of ownership and sovereignty on celestial bodies and enable the utilisation of profits generated from space ventures, but also guarantee a robust level of state and international oversight, and a rules-based advancement of space economy.

The security track

Security in the military dimension is fundamentally dependent on the balance of power between the actors in the international system, which is an "anarchic" structure with no monolithic guarantor of peace and stability. In such a system the states need to act in three fundamental ways, build up their own military power, cooperate with other states to maximise their security and thirdly deter their enemies or fight them if the use of force is required.[3] This anarchical structure naturally extends into outer space, and similarly to Earth, the main actors are the states. It could be even argued that power relations between states matter much more in space than on Earth, as there are no significant sub-state actors such as insurgents, terrorists, etc. in space due to the technological barriers of launching space objects. As such, states need to develop the defence capabilities in space, build coalitions to guarantee their security and deter and potentially win the conflicts with their enemies. Therefore, in such an anarchical system and a state dominated security environment, it is logical to rely on the legal framework which has emerged on Earth after the Second World War and later extended into outer space as well. The current legal framework is a manifestation of the balance of power as the fundamental force which maintains security in space, displayed in the UN Charter and the OST.

[3] Mearsheimer 2014: 32–40.

The argument of this paper is that relying on the existing security guarantees in space is sufficient, if states understand that their assets' security can only be guaranteed ultimately by hard power and not solely by hard law. Hard law is needed to have codified rules for an otherwise anarchic system and to regulate, but not to exclude the possibility of the use of force. The current legal framework is sufficient but not optimal and significant gaps exist due to new technological achievements of the last decades, leading to new possibilities for using force in space. This approach would enable a focused legislative deliberation of the changed nature of space security in an era which is characterised by heightened great power competition and a higher reliance on space assets. During the Cold War era, because of the heightened tensions, the destruction of a critical military satellite belonging to either superpower would have been considered a direct prelude to an all-out nuclear attack.[4] This threshold has been lowered with the end of the heightened tensions of the Cold War, which on the one hand is welcome news, however, it leaves open the possibility for using force in space under the assumption that it does not necessarily lead to a nuclear Armageddon.

In our current era the satellites themselves are critical assets which guarantee the states' security, stability and well-being, through providing communication, navigation, agricultural and meteorological services. We must understand clearly that currently the use of force in space primarily means the destruction of satellites.[5] A new legislation strictly banning the potential of utilising new and old military technologies to hinder satellite communication is in the interest of all countries. A military conflict between the largest space powers (United States, Russia and China) can cause a non-nuclear, indirect "mutually assured destruction" if they would knock out each other's critical satellite constellations which effectively guarantee 21st century state operation, including communications, meteorology and navigation services. Limiting the ambition of the envisioned reform of the hard legal framework of regulating the military application of space would enable the adoption of new clauses and monitoring processes such as governing the use of anti-satellite technologies without the need to accommodate economic interests. In such an approach the highest tier of space law would rely on hard law as a direct continuation of the UN Charter and the OST and adopt relevant security clauses from the Moon Agreement, without the additional restrictions on space economy.

4 Harrison et al. 2021.

5 Borgen 2020.

The evolving legal framework would be naturally supported by the states' need to maintain a balance of power in space, in which the expanding militarisation of space is a continued key feature of states' space policy. These endeavours for rules-based militarisation of space are demonstrated by national and alliance level efforts in establishing new legal frameworks for the use of force in space, exemplified by NATO after it has regulated space as another operational domain.[6] The paper argues that a legal reform aiming at further limiting the potential for use of force in space has to be in parallel with the development of hard power tools, offensive and defensive military space capabilities and monitoring and verifying technologies. Ultimately these would serve as the guarantors of any new regulatory framework. We know that such efforts aiming at further regulating the military application of space were well on track by the end of 2020.[7] Under the auspices of the Conference on Disarmament based in Geneva the details of such a regulation preventing an arms race in outer space were forming quite clearly. Naturally, there was a hurdle caused by great power competition which led to parallel tracks of furthering regulation, a Western one and a Chinese–Russian effort; however, the details were basically very similar.

While all states aim to maintain that space is undoubtedly a military domain, it does not have to become a war theatre. It is highly doubtful that in the current international environment any state would completely abandon its space weapons program and judging from the accumulation of hard power space assets and weapon development schemes in progress, this trajectory will likely continue. Even in such a volatile security environment favouring the militarisation of space, international norms can reduce the chance for open conflict and collateral damage. Such an initiative was the unilateral ban on ASAT tests by the U.S. in April 2022, which is slowly getting international momentum.[8] In December 2022, 155 countries voted in favour of halting the testing of direct-ascent ASAT weapons in the UN General Assembly based on the U.S. initiative. This shows that there is a broad agreement on the destructive nature of these tests, even if Russia, China and Iran and six other like-minded countries voted against it and India, among others abstained.[9] It is not surprising that these three space powers are reluctant to join such an initiative which does not provide

6 Nasu 2020.
7 European Space Policy Institute 2021.
8 Arms Control Association 2022.
9 General Assembly Resolution 77/41, 7 December 2022, U.N. Doc. A/RES/77/41.

a strong verification mechanism, only a voluntary abstention from the current hegemonic power which already possesses advanced ASAT capabilities. Even though we can see that parallel norm-setting endeavours are in development and a comprehensive international agreement seems impossible at this time, even a patchwork of international norms on limiting the militarisation of space is a highly welcome development. Too much depends on the peaceful usage of space and the above-mentioned initiatives stemming from this realisation shows that we can be optimistic about security in space, if we take a careful approach to the limits and expectations for a regulation and work with gradual steps instead of a comprehensive disarmament which might never come to be.

The economic track

On the second track the paper suggests creating a separate legal framework for orbital and in-space economic activity, including business, commercial transport and research-oriented space economic activities. Unlike security legislation which is underpinned by balance of power considerations and the process of the militarisation of space, current market forces rapidly erode any semblance of a rules-based economic order in space. Companies invest greatly not only in the well-regulated orbital economic ventures, but also into business opportunities aiming at the Moon and deeper into outer space. These initiatives grew to approximately one billion USD per year by 2021, or in relative terms 15% of all private space investment and they are expected to rise steadily in the future.[10] This means that the practice of space economy will quickly undermine any remaining chance for keeping relevant the current very limiting and ill-fitting space legislation. Instead of hard legal norms, soft law has emerged to provide temporary regulation, which, as one very fitting characterisation defines, these soft law instruments "work until they don't".[11] In the absence of strong legislative guidance in conducting business in space, states' and companies' business practices will only be limited by a threat of force from an adversary power. This state of future affairs rightly resembles the most dystopian kinds of science fiction depictions of space with megacorporations undermining state sovereignty

[10] Brukardt et al. 2022a.

[11] Freeland s. a.

and legal norms. Therefore, a reform of the legal framework has to accompany the unstoppable expansion of space economy.

The comprehensive legal framework governing economic activities in space should be based on, but not included in hard international law like the UN Charter and the OST, responding to the growing relevance and sophistication of potential economic activities in space. This approach envisions a mid-tier legal (and associated institutional) instrument between hard law represented by the OST and the soft law and project-based legal agreements. Such an agreement on economic activity in space would not require an agreement by all UN Security Council permanent member states, but it could be formulated, at least initially, as an agreement like the World Trade Organisation or other trade and labour-related international framework. As a minimum, such an agreement would need the buy-in from the United States, the European Union and Japan, in order to create a robust market governed by the new economic agreement. Accession of China, Russia and India is welcome but not necessary for the viability of such an agreement and the formation of competing space economy blocs would not jeopardise the Western-led endeavour. Once the initial Western space powers accept a dedicated space economy regulation, market forces would push other states to join the agreement in order to reap the benefits of joint regulation, security guarantees, opportunities for cooperation, joint ventures and naturally, the most important business motivation, the acquisition of greater profits. I argue that a potential Russian–Chinese space economy bloc, would have severe disadvantages compared to a Western-led one, including capital formation, regulation and providing the highest-tier of technological capabilities, including in microchip manufacturing. As with the Cold War Socialist economy bloc, which was only successful of providing the basics to the population, a less-then-optimal space economy bloc would be hard pressed to compete with the Western bloc in exactly those frontiers (outer space economy) which would bring the most benefit.

An international agreement on space economy would not have to overwrite any of the fundamental values of the OST, but it would need to conflict or at least interpret highly liberally a number of provisions of the internationally much less accepted Moon Agreement. To a great degree, the Moon Agreement became the end of the development of international hard space law exactly because of how it limits the extraction of resources on celestial bodies.[12] The OST bans the national appropriation of outer space, the Moon or other celestial object, which

[12] Ramey 2000.

is why the study argues that unilateral national space economy legislation is null and void in space, as national regulatory rights go hand in hand with full national sovereignty which does not exist in space outside of the space objects. The different national space legislations currently do not and cannot substitute for international law in fostering cooperation, but they do contribute to policy confusion in space governance.[13]

An envisioned international regime must also promote equitable access and the fair sharing of the benefits stemming from all space activities. This is why an international agreement on space economy should be adopted in parallel with the establishment of an 'Outer Space Economy Organisation' which would distribute the profits from space. The particulars of the sharing scheme are not part of this paper, but in order to maintain business incentives a redistribution mechanism should be limited to the profits and highly value what a particular company, the responsible state or international consortium bring to the enterprise. One particular scheme could involve empowering non-spacefaring nations by providing them subsidised or free access to space in order to jumpstart their own space-industry and participation in the space economy supply chains instead of "cash handouts" promoting dependence and exclusion.[14] It is important to note that all states must receive a certain share of the benefits, thereby creating a motivation to join the organisation and the international agreement, but also reward greater participation in each venture by less developed states as well. Such a framework would permit a greater scope of ownership, a limited and shared international sovereignty over celestial bodies and enable the utilisation of profits generated from space ventures, but also guarantee a robust level of state and international oversight, such as with critical economic ventures and infrastructure assets on Earth.

Countering the counterarguments

There are two important counterarguments to this proposal. Firstly, that this could lead to parallel space economic systems, and the second, more serious threat, that unilateral steps taken by a coalition on the economic front would undermine the security achievements of the OST. The paper argues that both

[13] Goguichvili et al. 2021.

[14] Brukardt et al. 2022b: 33.

counterarguments are false. Regarding a countering Russian–Chinese space economic bloc would be as economically viable as the Communist economic bloc was during the Cold War, where inevitable market collapse was only slowed down by political repression, which cannot lead to state of the art and profitable economic enterprises, especially not in space. Naturally, Russia and China possess a high degree of technological prowess in space activities; however, they do not have the agile capitalist economic ecosystem. Russia is not a major financial power, while China on paper is, however, under the burden of years of grave financial mismanagement and bloated domestic debt. Neither of them is able to offer a safe haven for private space companies as they look for legal stability to reap the benefits of the risk-heavy investments in outer space economy. It could be even argued that a danger to a US–EU–Japan lead space economic bloc would not be a parallel Russian–Chinese system, which is effectively being built by China encompassing every major type of international organisation.[15] The greater threat would be a Janus-faced effort of these anti-status quo powers to join the bloc and reap undue benefits from it, like we have seen with Chinese efforts of joining WTO.[16]

Regarding the second, more serious argument, the security aspect of space legislation, it is important to point out that Russia and China have just as much to lose on the security front from an all-out space war as the Western allies. Both countries rely on satellite services in managing their national and international operations and none can afford to completely lose space-based services. The security guarantees in space are underwritten by hard power and the resulting security mechanisms such as balance of power and mutual threat, which would not be negated by any advancement in economic activities. If one country would risk using force in space despite the UN Charter and the OST, it would by extension invite similar or exceeding counterforce by the attacked power or coalition. Based on our current reliance on space services, an open space war would be not unlike a nuclear exchange between the major powers. The main difference would be that a nuclear war would lead to direct devastation, while a non-nuclear space war would strip us of meteorological, agricultural, communication and navigation technologies, thereby indirectly leading to the collapse of modern civilisation as we know it. Therefore, there is no reason to believe that we must maintain the status quo in the space economy in order to keep the status quo in

[15] Heilmann et al. 2014.

[16] Mavroidis–Sapir 2021.

the security dimension. This however does not mean that there are no red lines for Russia and China, Western states must not believe that these states will not resort to waging an all-out space war if their core national interests would be threatened. The possibility of a space war, similarly to a nuclear war, is coded into the system of international relations. A space war would be a logical escalatory step before a nuclear war due to the less direct devastation it would cause and relative advantages a self-sufficient country like Russia would gain compared to the United States. This is to say, however, that economic advancement in space is not a sufficient reason for starting a space war by those actors who are left out of the suggested new economic framework.

Conclusions

This paper argued that it is vital to separate the legal instruments aiming at regulating space security on the one hand and economic activity in space on the other. The reason for this is based on the differing nature of the two dimensions. Security is first and foremost guaranteed by the hard power of the actors, while international law, including the UN Charter has a meaning only to the degree as it is enforceable by hard power. On the other hand, economic activity requires a solid legal framework to operate effectively. Business activities are based on calculations of value and risk based on a particular regulatory framework, which is sorely lacking for space economy. The issue is the lingering Cold War mentality of putting security first is space legislation, which does not enable the emergence of new regulation on space economy. A partial decoupling the security and economic aspects of space policy and space law can lead to more successes on both fronts. Elevating a nascent "dual-track approach" to official level would in effect lift the block on the development of hard space law under the UN, which occurred with the sparse ratification of the Moon Agreement and return on building on the fundamentals of the UN Charter and the OST. Security in space can only be legislated if all major actors, especially the U.S., Russia and China are parties to any emerging treaty. On the other hand, coalitions of the willing can advance faster on the economic track without endangering the security dimension and establish new norms for the benefit of all mankind. A less constraining, more business-friendly legislation of business activities in space would enable the inherent advantages of the economic systems of the European Union, United States and Japan to create a flourishing in-space economy and

greater buy-in from private companies. This is a necessary step to start a new, rules-based space age, based not only on exploration of outer space on and beyond the Moon, but also on bringing life into outer space through economic activity.

References

Arms Control Association (2022): *Seven Countries Join ASAT Test Ban.* Online: https://www.armscontrol.org/act/2022-11/news-briefs/seven-countries-join-asat-test-ban

Borgen, Christopher J. (2020): *Space Power, Space Force, and Space Law.* Lieber Institute. Online: https://lieber.westpoint.edu/space-power-space-force-space-law

Brukardt, Ryan, – Klempner, Jesse – Stokes, Brooke (2022a) Space: Investment Shifts from GEO to LEO and Now Beyond. *McKinsey,* 27 January 2022. Online: https://www.mckinsey.com/industries/aerospace-and-defense/our-insights/space-investment-shifts-from-geo-to-leo-and-now-beyond

Brukardt, Ryan – Klempner, Jesse – Pacthod, Daniel – Stokes, Brooke (2022b): The Role of Space in Driving Sustainability, Security, and Development on Earth. *McKinsey,* 19 May 2022. Online: https://www.mckinsey.com/industries/aerospace-and-defense/our-insights/the-role-of-space-in-driving-sustainability-security-and-development-on-earth

European Space Policy Institute (2021): *UN Resolution on Norms of Responsible Behaviours in Space: A Step Forward to Preserve Stability in Space?* Online: https://www.espi.or.at/briefs/un-resolution-on-norms-of-responsible-behaviours-in-space

Freeland, Steven (s. a.): *Following the Technology: Questions Relevant to the Future Regulation of Space Activities.* International Bar Association. Online: https://www.ibanet.org/article/3E009779-2438-4C90-9E2E-554D6EDFA178

General Assembly Resolution 77/41, 7 December 2022, U.N. Doc. A/RES/77/41.

Goguichvili, Sophie – Linenberger, Alan – Gillette, Amber (2021): *The Global Legal Landscape of Space: Who Writes the Rules on the Final Frontier?* Wilson Center. Online: https://www.wilsoncenter.org/article/global-legal-landscape-space-who-writes-rules-final-frontier

Harrison, Todd – Johnson, Kaitlyn – Young, Makena (2021): *Defense Against the Dark Arts in Space: Protecting Space Systems from Counterspace Weapons*. Center for International and Strategic Studies. Online: https://www.csis.org/analysis/defense-against-dark-arts-space-protecting-space-systems-counterspace-weapons

Heilmann, Sebastian – Rudolf, Moritz – Huotari, Mikko – Buckow, Johannes (2014): *China's Shadow Foreign Policy: Parallel Structures Challenge the Established International Order*. Mercator Institute for China Studies. Online: https://www.merics.org/sites/default/files/2020-05/China_Monitor_18_Shadow_Foreign_Policy_EN.pdf

Mavroidis, Petros C. – Sapir, André (2021). *China and the WTO: An Uneasy Relationship.* Centre for Economic and Policy Research. Online: https://cepr.org/voxeu/columns/china-and-wto-uneasy-relationship

Mearsheimer, John J. (2014): *The Tragedy of Great Power Politics.* New York: W.W. Norton.

Nasu, Hitoshi (2020): NATO Recognizes Space as an "Operational Domain": One Small Step Toward a Rules-Based International Order in Outer Space. *Just Security,* 04 March 2020. Online: https://www.justsecurity.org/68898/nato-recognizes-space-as-an-operational-domain-one-small-step-toward-a-rules-based-international-order-in-outer-space

Ramey, Robert A. (2000): Armed Conflict on the Final Frontier: The Law of War in Space. *The Air Force Law Review,* 48, 1–158.

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Kaja Hopej[1]

Sustainable Development in the Light of Damage Caused to the Outer Space Environment

Introduction

Adequate definition and identification of a specific phenomenon often has the effect of protecting it more effectively. Ensuring the safety of the outer space environment in the context of sustainable development is of particular importance, especially in the era of New Space. Under the existing space law, environmental regulations are negligible, and rather general in nature (such as those contained in the Outer Space Treaty)[2], not to mention the inclusion of the space environment in the definition of damage, or the rare implementation of the definition of space debris in National Space Legislations. Concerning the space environment, there are currently not many provisions to broadly protect it or clearly define the issue of damages caused in outer space, in particular the problem of space debris which affect safety, security and peace – the fundamental principles of sustainable development.[3]

The stakeholders of the space sector are aware of the dynamic situation that is associated with the growing number of space activities. Risks arising from improperly adopted measures or failure to adequately assess these risks

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[2] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies refers to the protection of the environment in particular Article IX where it imposes an obligation on States Parties to the Treaty to conduct space research and exploration of outer space, including the moon and other celestial bodies so as to avoid their harmful contamination as well as to adverse changes in the Earth's natural environment (as a result of the introduction of extraterrestrial matter).

[3] The 2030 Agenda for Sustainable Development containing the Sustainable Development Goals (SDGs) was adopted by a General Assembly Resolution 70/1 on 25 September 2015 in New York by all 193 UN members.

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can have huge consequences not only in terms of environmental pollution but also in the functioning of the entire space ecosystem. Miniaturised systems and large constellations only increase the danger of contamination of the space environment. The absorption capacity of the generated debris in space, like on Earth, seems to be limited.[4] Because of this rapid increase due to the amount of orbital debris there is a high probability of the so-called Kessler Syndrome.[5] The consequence of such a phenomenon may be the uselessness of orbits with a higher value or even complete lack of access to them.[6] Moreover, recent events regarding numerous collision hazards or the direct-ascent anti-satellite test (DA-ASAT)[7] outlines the question of consequences for intensified space activities. Proper recognition of the deployment of risks associated with environmental damage is essential to the sustainability of space activities. The scale of this phenomenon highlights the need to implement appropriate regulations, at both the international and national level to reduce the risk of environmental damage. It is for this reason that a number of dialogues, agreements and guidelines are being undertaken to meet the challenges of sustainable development in outer space.

The aim of this article is to present the regulatory mechanisms as well as measures in order to ensure sustainable development in the space sector and in particular to examine the regulations for the identification of damage to the outer space environment. The author seeks to provide an overview of the different approaches to defining damage to the terrestrial environment and, by analogy, intends to present the possibility of defining damage caused to the outer space environment (based on various definitions of damage and space debris).

[4] Stubbe 2017.

[5] The Kessler Syndrome is a theory used to describe a self-sustaining cascading collision of space debris, i.e. when the amount of debris in orbit reaches a critical point that leads to collisions between already existing objects, creating more and more space debris.

[6] OECDiLibrary s. a.

[7] On 15 November 2021, Russia conducted a direct-ascent anti-satellite (DA-ASAT) test, destroying one of its own space objects (a defunct Soviet satellite, Cosmos 1408). As a result of this activity, thousands of new debris appeared in outer space which threatened the astronauts on the International Space Station (ISS). They had to implement evacuation measures.

The concept of long-term sustainability of outer space activities

The definition of long-term sustainability of outer space activities

The definition of long-term sustainability of outer space activities appears in the *Guidelines for the Long-Term Sustainability of Outer Space Activities* (LTS Guidelines).[8] It is defined as "the ability to maintain the conduct of space activities indefinitely into the future in a manner that realizes the objectives of equitable access to the benefits of the exploration and use of outer space for peaceful purposes, in order to meet the needs of the present generations while preserving the outer space environment for future generations". The issue of securing the space environment in the cited definition plays a major role. A cessation of the relevant activities carried out in this direction may consequently lead to a lack of opportunity to explore outer space in the future. Due to the critical level of space debris orbiting the Earth,[9] the fundamental principle under Article I of the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (Outer Space Treaty) of equal access to space exploration and use is under threat.[10]

Nevertheless, one should be noted that the issue of sustainability has its origins in the already well-established International Space Law. Provisions regarding this matter are found in Article IX of the Outer Space Treaty,[11] in the Convention on Registration of Objects Launched into Outer Space (Registration Convention) through the registration of space objects, in the Convention on International Liability for Damage Caused by Space Objects (Liability Convention) as well as in the Article 7[12] of the Agreement Governing the Activities of States on the Moon

[8] Doc. A/AC.105/2018/CRP.20.

[9] NASA 2021.

[10] NetZeroSpace 2022: 7.

[11] Article IX: "[…] States Parties to the Treaty shall pursue studies of outer space, including the Moon and other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose […]."

[12] Article 7: "In exploring and using the Moon, States Parties shall take measures to prevent the disruption of the existing balance of its environment, whether by introducing adverse changes in that environment, by its harmful contamination through the introduction of extra-environmental matter or otherwise. States Parties shall also take measures to avoid harmfully affecting the environment of the Earth through the introduction of extraterrestrial matter or otherwise."

and Other Celestial Bodies (Moon Agreement).[13] However, only the provisions of the Moon Agreement directly address the protection of the environment and celestial bodies.[14]

The concept of sustainable development in existing regulations

The concept of sustainable development of space activities have already been implemented in several National Legislations. An example is the Finish Act on Space Activities from 2018 which explicitly indicates that the "space activities shall be carried on in a manner that is environmentally sustainable and promotes sustainable use of outer space".[15] Indirectly, the issue of environmental protection is indicated by the French Space Operational Act from 2008 which includes environmental protection (in particular the mitigation of space debris) as part of the requirements for obtaining authorisations and licenses.[16] The notion of long-term sustainable use of space has also emerged in the Polish draft law on space activities from 2020 where Article 9 stipulates that space activities carried out at any stage shall, in particular, be carried out in respect of long-term sustainable use of outer space for peaceful purposes and should eliminate or reduce (as much as possible) the negative impact on the Earth's environment and in outer space.[17] It should be noted that environmental issues such as space debris mitigation can be binding at various levels. In practice, requirements can be binding by law, license or at contractual level as in the case of the German Space Agency (DLR)[18] procurement contracts.[19]

For the purposes of this study, in addition to international principles derived from space treaties, particular emphasis is placed on recommended international

[13] Hofmann 2022.

[14] Hobe 2019.

[15] *Laki avaruustoiminnasta* (Finnish Act On Space Activities 63/2018); Chapter 2, Section 10.

[16] LOI n° 2008-518 du 3 juin 2008 relative aux opérations spatiales (1) (French Space Operations Act, No. 2008-518 2008); Article 5.

[17] Polish Draft Act on Space Activities of 10 June 2020. Work on the basis of the 2020 project have been resumed as part of the Working Group for the Development of the Draft Act on Space Activities established in January 2021 within the Ministry of Development and Technology, in which the author of this article actively participated.

[18] *Deutsches Zentrum für Luft- und Raumfahrt.*

[19] NetZeroSpace 2022: 11.

standards and National Space Legislation (NSL) covering, inter alia, the issue of protection of the environment, space debris as well as the definition of damage caused to the outer space environment.

Definition of environmental damage

Definitions of environmental damage (caused in particular to the Earth's land surface, minerals, water, air, landscape and climate) appear in various legal documents. One example is the EU Environmental Liability Directive (ELD)[20] where environmental damage includes damage to protected species and natural habitats,[21] water damage[22] and land damage.[23] In 2021, the European Commission adopted guidelines that clarify the scope of this concept in the ELD and which is based on established case law.[24] The definition of environmental damage can also be found in Recital 24 of Regulation (EC) No 864/2007 of the European Parliament and of the Council of 11 July 2007 on the law applicable to non-contractual obligations (Rome II Regulation) stating that "environmental damage should be understood as meaning adverse change in a natural resource, such as water, land or air, impairment of a function performed by that resource for the benefit of another natural resource or the public, or impairment of the variability among living organisms".[25] Another example of environmental damage may also be seen in U.S. law where The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) in § 107(a)(4)(C) provides liability

[20] Directive 2004/35/CE of the European Parliament and of the Council of 21 April 2004 on environmental liability with regard to the prevention and remedying of environmental damage ELD, 2004/35/WE.

[21] "Which is any damage that has significant adverse effects on reaching or maintaining the favourable conservation status of such habitats or species. The significance of such effects is to be assessed with reference to the baseline condition, taking account of the criteria set out in Annex I."

[22] "Which is any damage that significantly adversely affects the ecological, chemical and/or quantitative status and/or ecological potential, as defined in Directive 2000/60/EC, of the waters concerned, with the exception of adverse effects where Article 4(7) of that Directive applies."

[23] "Which is any land contamination that creates a significant risk of human health being adversely affected as a result of the direct or indirect introduction, in, on or under land, of substances, preparations, organisms or micro-organisms".

[24] European Commission s. a.

[25] Recital 24 of the Rome II Regulation Preamble.

for "damages for injury to, destruction of, or loss of natural resources, including the reasonable costs of assessing such injury, destruction, or loss resulting from such a release".[26]

Damage in national space legislations

Definition of damage

Protection of the outer space environment arises in the context of National Space Legislations. Some countries such as France and the United Arab Emirates (UAE) have chosen to define the concept of damage separately in their internal regulations. In case of France or Luxembourg (as indicated in the table below) this definition also refers to environmental damage. The Kazakh space regulations only refer to environmental damage, but do not define damage per se.

Table 1: Examples of definitions of damage in the national space legislations

Country	Definition of damage	Definition content
France[27]	Yes	"*Damage* means any harm to persons, property, including public health or the environment, directly caused by a space object in the course of a space operation, excluding the consequences for users of the signal emitted by that object."
Sweden[28]	No	–
Luxembourg[29]	Yes	"*Damage* means any harm to persons, property, public health or the environment directly caused by a space object in the course of a space activity, excluding the consequences for users of the signal emitted by that object."

[26] Comprehensive Environmental Response, Compensation, and Liability Act, Section 107(a)(4)(C).

[27] Loi n° 2008-518 du 3 juin 2008 relative aux opérations spatiales (1) (French Space Operations Act, No. 2008-518 2008), Article 1.

[28] Lag om rymdverksamhet (Act on Space Activities 1982:963).

[29] Loi portant sur les activités spatiales et modifiant: 1° la loi modifiée du 9 juillet 1937 sur l'impôt sur les assurances dite «Versicherungssteuergesetz»; 2° la loi modifiée du 4 décembre 1967 concernant l'impôt sur le revenue (Law of 15 December 2020 on Space Activities and amending: 1° the amended law of 9 July 1937 on the tax on insurance known as "Versicherungssteuergesetz" 2° the amended law of 4 December 1967 concerning income tax), Article 2.

Country	Definition of damage	Definition content
UAE[30]	Yes	"The damage referred to in Clause (1) of this Article means loss of life, personal injury, or any other harm to health, or the loss or damage that is caused to the property of the State, the property of Persons, or the property of intergovernmental organisations."
Kazakhstan[31]	No	–
Belgium[32]	Yes	"*Damage* means any damage as defined by the first Article of the Convention on International Space Liability. Pursuant to this law, the liability of the Belgian State in respect of such damage extends in addition to Belgian citizens, whether they are natural or legal persons, except for those participating in the activities in question."

Source: Malinowska et al. 2022

From the perspective of international space law, it should be emphasised that the definition of damage contained in the Liability Convention refers to damage to a person and property, disregarding the environmental damage.[33] As mentioned above, only the Moon Agreement in Article 7 refers to protection of celestial bodies as well as the outer space environment.

Definition of space debris

Noticeably fewer countries decided to define the space debris themselves. The United Arab Emirates defines space debris as a "Space Object that has no role or purpose, or the remains thereof, and the materials, waste, or fragments resulting therefrom, whether in Outer Space, including the Earth's orbit, or inside the Earth's atmosphere".[34] The United Kingdom used the term 'fragmentation debris'

[30] Federal Law No. (12) of 2019 Issued on 19/12/2019 Corresponding to 22 Rabi' Al-Akhar 1441H. On the Regulation of the Space Sector, Article 20.

[31] О космической деятельности (Law of the Republic of Kazakhstan on Space Activities No. 528-IV of 6 January 2012).

[32] Loi relative aux activités de lancement, d'opération de vol ou de guidage d'objets spatiaux (Law of 17 September 2005 on the Activities of Launching, Flight Operation or Guidance of Space Objects), Article 3.

[33] Article 1 of the Liability Convention.

[34] Federal Law No. (12) of 2019 Issued on 19/12/2019 Corresponding to 22 Rabi' Al-Akhar 1441H. On the Regulation of the Space Sector, Article 1.

which according to the Space Industry Regulations 2021 means "debris that is emitted as a result of an explosion or deflagration".[35] It is also common to refer to definitions of space debris proposed by, for example, the European Space Agency[36] or the Inter-Agency Space Debris Coordination Committee (IADC).[37]

The inclusion of a separate definition of damage in the National Space Legislation is at the discretion of the State. Some legislators choose to stay with the definition that the Liability Convention contains. In many countries, the concept of damage under the civil law system also appears to be sufficient and applicable to the definition of damage provided in the Liability Convention. Nevertheless, the combination of the definition of damage together with the definition of space debris could be the foundation and some sort of a compromise for formulating the definition of damage to the space environment as such.

Sustainable development from the soft law perspective

International guidelines

As of 7 November 2022, the number of debris objects regularly tracked by Space Surveillance Networks was about 32,340 and the total mass of all space objects in Earth orbit amounted to more than 10,400 tonnes. By comparison, in 2021 the number of cataloged space debris oscillated around 29,710[38] which in relation to the current year indicates a difference of 2,630 objects. Such a large increase in nearly 12 months undoubtedly points to an indicative growing threat that needs to be not only effectively but as quickly as possible minimised. One solution seems to be the adoption of regulations at the internal level based on already existing international recommendations in the form of guidelines and standards. An example of National Space regulations referring to the application of internationally recognised guidelines to mitigate of space debris is the Austrian

[35] UK Space Industry Regulations 2021.

[36] "Space debris is defined as all non-functional, artificial objects, including fragments and elements thereof, in Earth orbit around the Earth or re-entering into Earth atmosphere. Human-made space debris dominates the natural meteoroid environment, except around millimetre sizes."

[37] "Space debris are all man made objects including fragments and elements thereof, in Earth orbit or re-entering the atmosphere, that are non functional."

[38] ESA 2022a.

Federal Law on the Authorisation of Space Activities and the Establishment of a National Registry (Austrian Outer Space Act).[39]

Formulating guidelines and recommendations is one method of managing the growth of space debris. However, due to the non-binding nature of these recommendations, their effectiveness is questionable. Nonetheless, a slight increase in adoption and adherence to space debris mitigation practices is observed. However, this is not satisfactory enough to ensure the long-term sustainability of space activities. The application of mitigation measures, analysed through indicators, i.e. as post mission disposal success rates for payloads in LEO or rocket bodies controlled re-entries, involves the decommissioning and deployment of large constellations.[40] Heretofore, many international instructions have been published. The current set of internationally recognised guidelines related to space debris mitigation is quite substantial. These should include already mentioned LTS Guidelines from 2019, Committee on the Peaceful Uses of Outer Space (COPUOS) Space Debris Mitigation Guidelines, Inter-Agnecy Space Debris Coordination Committee (IADAC) Space Debris Mitigation Guidelines, International Organization for Standarization (ISO) Standards[41] and Technical Reports, International Telecommunications Union (ITU)[42] Recommendations and European Code of Conduct for Space Debris Mitigation. These guidelines include recommendations for the security of space operations, recommendations on the legal and policy framework, the issue of international cooperation[43] as well as technical guidance, guidance on management, design or operational measures. Harmonisation of currently existing standards should serve as a basis for countries to introduce regulations at national level so as to also reduce the risk of litigation.

In most cases, compliance with and reference to the international standards relates to the issue of licensing and authorisation of space activities. As already

[39] Article 5: "The operator has to make provision for the mitigation of space debris in accordance with the state of the art and in due consideration of the internationally recognised guidelines for the mitigation of space debris. Especially measures limiting debris released during normal operations have to be taken."

[40] ESA 2022b: 8.

[41] For example, ISO 24113:2019; Space systems – Space debris mitigation requirements, ISO/TR 16158:2021; Space systems – Avoiding collisions among orbiting objects or ISO/TR 18146:2020; Space systems – Space debris mitigation design and operation manual for spacecraft.

[42] Recommendation ITU-R S.1003.2.

[43] ESA 2022b: 9.

mentioned above, legal provisions aimed at, for example, mitigation of space debris can be binding by law or results from contractual clauses.[44] For example, the Space Administration of the German Aerospace Centre, in the implemented national space programme and in its policy, assumes that a contractor who is involved in a space mission applies appropriate requirements for, among other things, space debris mitigation at all stages of the project.[45] In case of Italy, the implementation of appropriate space debris mitigation mechanisms is limited to the provisions of the standard contracts of the Italian Space Agency (ASI).[46] An example of binding regulations at the national level that apply to space debris mitigation is the Law of Ukraine on Space Activity,[47] where Article 9 contains a prohibition on space activities in violation of international norms and standards regarding pollution of outer space.[48]

UNOOSA Resolutions

An example of other activities which are taken internationally in order to change the current state of affairs regarding the problem of pollution of the space environment are the United Nations General Assembly Resolution (UN GA Resolutions). In the context of this analysis, three of them deserve particular attention, namely the 47/68 (Principles Relevant to the Use of Nuclear Power Sources in Outer Space) Resolution from 1992, the recommendations on national legislation provided in Resolution 68/74 and the Resolution adopted by the General Assembly on 7 December 2020 (Resolution 75/36).

[44] UNOOSA 2022. For space projects of DLR, as part of the Product Assurance and Safety Requirements for DLR Space Projects *(DLR Requirements),* space debris mitigation requirements are mandatory.

[45] UNOOSA 2021: 36.

[46] UNOOSA 2021: 44.

[47] Law of Ukraine of 15 November 1996 (VVRU, 1997: 2).

[48] UNOOSA 2021: 77.

UN GA Resolution 47/68

As a consequence of the Cosmos 954 accident[49] the United Nation General Assembly adopted the Principles Relevant to the use of nuclear power sources in outer space (Resolution 47/68) which addressed to the protection of the environment in outer space.[50] This protection was provided in the context of minimization the quantity of radioactive material in space and the risks involved.[51]

UN GA Resolution 68/74

United Nation General Assembly, on 11 December 2013 adopted the Recommendations on national legislation relevant to the peaceful exploration and use of outer space (UN GA Resolution 68/74). This Resolution included recommendations to consider. Among the eight proposed elements was the issue of the conditions for authorising space activities. The document indicates that the "conditions for authorization should help to ascertain that space activities are carried out in a safe manner and to minimize risks to persons, the environment or property and that those activities do not lead to harmful interference with other space activities; such conditions could also relate to the experience, expertise and technical qualifications of the applicant and could include safety and technical standards that are in line, in particular, with the Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space".[52]

[49] A Soviet operational satellite (Cosmos 954), carried a nuclear reactor, fell on Canadian territory on 24 January 1978, spreading a huge amount of radioactivity over an area of 124,000 square kilometers.

[50] Hobe 2019: 109.

[51] Principle 3 of the UN GA Resolution 47/68: "In order to minimize the quantity of radioactive material in space and the risks involved, the use of nuclear power sources in outer space shall be restricted to those space missions which cannot be operated by non-nuclear energy sources in a reasonable way."

[52] Paragraph 4 of the UN GA Resolution 68/74.

UN GA Resolution 75/36

On 7 December 2020, the United Nation General Assembly adopted the Resolution reducing space threats through norms, rules and principles of responsible behaviours (UN GA Resolution 75/36). By UN GA Resolution 75/36, the General Assembly "encouraged Member States to study existing and potential threats and security risks to space system, including those arising from actions, activities or systems in outer space or on Earth, characterize actions and activities that could be considered responsible, irresponsible, or threatening and their potential impact on international security, and share their ideas on the further development and implementation of norms, rules and principles of responsible behaviors and on the reduction of the risks and misunderstanding and miscalculations with respect to outer space".[53]

Conclusion

As can be seen from the above, with regard to the classification of actions taken to ensure sustainable development, three levels can be indicated i.e. international activities (to which we can include for example the work of UNOOSA), the national level related to the enactment of relevant national policies (national space legislations on the example of Ukraine) and finally the contractual level covering industry and operators (for example the standard contracts of the ASI or DLR's policy). The issue of securing both the terrestrial and space environment, as with the insurance requirement, is mostly a necessary element for obtaining a space license.[54] The conditions that should be met when applying for authorisations for space activities should take into account minimising the risk to people, the environment and property, and should be conducted in a safe manner, not interfering with other activities in space.[55]

One can put forward the thesis that due to the obligation to authorise and supervise the space activities, it is the State's responsibility to take care of environmental protection. In general, treaty regimes oblige States to adopt appropriate legislation. Given these aspects, the adoption of a consensus on the regulation

[53] Paragraph 5 of the UN GA Resolution 75/36.
[54] Schildknecht 2022.
[55] UN GA Resolution 68/74.

of long-term sustainable development with a binding character seems to be a process that is too long and even impossible to achieve.[56] In order to adapt as quickly as possible to the changing space environment, it seems appropriate to apply international guidelines, which could be harmonised due to their diversity. On the other hand, however, the proposal to adopt a clear and precise definition of damage to the space environment could contribute to better identification of risks and better protection of outer space environment.

References

Agreement Governing the Activities of States on the Moon and Other Celestial Bodies adopted by the General Assembly in its resolution 34/68, opened for signature on 18 December 1979, entered into force on 11 July 1984.

Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space adopted by the General Assembly in its resolution 2345 (XXII), opened for signature on 22 April 1968, entered into force on 3 December 1968.

Convention on International Liability for Damage Caused by Space Objects adopted by the General Assembly in its resolution 2777 (XXVI), opened for signature on 29 March 1972, entered into force on 1 September 1972.

Convention on Registration of Objects Launched into Outer Space adopted by the General Assembly in its resolution 3235 (XXIX), opened for signature on 14 January 1975, entered into force on 15 September 1976.

Directive 2004/35/CE of the European Parliament and of the Council of 21 April 2004 on environmental liability with regard to the prevention and remedying of environmental damage ELD, 2004/35/WE.

ESA (2022a): *Space Debris by the Numbers.* Online: https://www.esa.int/Space_Safety/Space_Debris/Space_debris_by_the_numbers

ESA (2022b): *ESA's Annual Space Environment Report 2022.* Online: https://www.sdo.esoc.esa.int/environment_report/Space_Environment_Report_latest.pdf

European Commission (s. a.): *Environmental Liability.* Online: https://environment.ec.europa.eu/law-and-governance/compliance-assurance/environmental-liability_en

Federal Law No. (12) of 2019 Issued on 19/12/2019 Corresponding to 22 Rabi' Al-Akhar 1441H. On the Regulation of the Space Sector.

[56] NetZeroSpace 2022.

Guidelines for the Long-Term Sustainability of Outer Space Activities (Doc. A/AC. 105/2018/CRP.20).

Hobe, Stephan (2019): *Space Law.* Nomos Verlag.

Hofmann, Mahulena (2022): *Sustainability Aspects in the UN Space Treaties and the LTS Guidelines.* Online: https://npocspacelaw.univie.ac.at/fileadmin/user_upload/p_npocspacelaw/Sustainability_Mahulena_h.pdf

Lag om rymdverksamhet (Act on Space Activities 1982:963).

Laki avaruustoiminnasta (Finnish Act On Space Activities 63/2018).

Law of Ukraine of 15 November 1996 (VVRU, 1997).

Loi n° 2008-518 du 3 juin 2008 relative aux opérations spatiales (1) (French Space Operations Act, No. 2008-518 2008).

Loi n° 2008-518 du 3 juin 2008 relative aux opérations spatiales (1) (French Space Operations Act, No. 2008-518 2008).

Loi portant sur les activités spatiales et modifiant: 1° la loi modifiée du 9 juillet 1937 sur l'impôt sur les assurances dite «Versicherungssteuergesetz»; 2° la loi modifiée du 4 décembre 1967 concernant l'impôt sur le revenue (Law of 15 December 2020 on Space Activities and amending: 1° the amended law of 9 July 1937 on the tax on insurance known as "Versicherungssteuergesetz" 2° the amended law of 4 December 1967 concerning income tax).

Loi relative aux activités de lancement, d'opération de vol ou de guidage d'objets Spatiaux (Law of 17 September 2005 on the Activities of Launching, Flight Operation or Guidance of Space Objects), Article 3.

Malinowska, Katarzyna – Kłoda, Mariusz Tomasz – Malinowski, Bartosz – Polkowska, Małgorzata – Hopej, Kaja – Szlachetko, Jakub (2022): *The Green Book of Polish Space Law.* Chapter 2. Definitions in Current Space Law (Comparative Analysis) and Proposed Solutions for Polish Space Law, Ad Astra. Astropolitics and Space Law Research Program, no. 4.

NASA (2021): *Nasa's Efforts to Mitigate the Risks Posed by Orbital Debris.* Office of Inspector General, Office of Audits. Online: https://oig.nasa.gov/docs/IG-21-011.pdf

NetZeroSpace (2022): Sustainable Outer Space by 2030: *Fostering Better and More Interoperable Norms: Recommendations for Enhanced Regulations and Public Policy with Regard to Space Debris Mitigation and Remediation Comparing Existing Binding National Requirements Relating to Space Debris.* Paris Peace Forum.

OECDiLibrary (s. a.): *Executive Summary. Accumulating Space Debris Puts the Sustainability of Space Activities at Risk.* Online: https://www.oecd-ilibrary.org/sites/16543990-en/index.html?itemId=/content/publication/16543990-en

Schildknecht, Thomas (2022): *Long-Term Sustainability of Outer Space Activities – International Guidelines.* Online: https://conference.sdo.esoc.esa.int/proceedings/ecsl19/paper/2/ECSL19-paper2.pdf?fbclid=IwAR2-OUNeQGQxbamIgIZN7YS-3LX6APaweCEakPmcNTQdBffS4Yj03nsYupzM

Stubbe, Peter (2017): Legal Consequences of the Pollution of Outer Space with Space Debris. In Read, Peter (ed.): *Oxford Research Encyclopedia of Planetary Science.* Oxford: Oxford University Press. Online: https://doi.org/10.1093/acrefore/9780190647926.013.68

Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies adopted by the General Assembly in its resolution 2222 (XXI), opened for signature on 27 January 1967, entered into force on 10 October 1967.

UK Space Industry Regulations 2021.

United Nations General Assembly Resolution 47/68 Principles Relevant to the Use of Nuclear Power Sources in Outer Space, 1992.

United Nations General Assembly Resolution 68/74 Recommendations on national legislation relevant to the peaceful exploration and use of outer space, 2013.

United Nations General Assembly Resolution 75/36 Reducing space threats through norms, rules and principles of responsible behaviours, 2020.

UNOOSA (2021): *Compedium, Space Debris Mitigation Standards Adopted by States and International Organisations.* Online: https://www.unoosa.org/documents/pdf/spacelaw/sd/Space_Debris_Compendium_COPUOS_28_march_2022.pdf

UNOOSA (2022): *Space Debris Mitigation Standards.* Online: https://www.unoosa.org/documents/pdf/spacelaw/sd/Germany_2_20220222.pdf

О космической деятельности (Law of the Republic of Kazakhstan on Space Activities No. 528-IV of 6 January 2012).

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Quentin Gueho[1]

Why Is the Space Sustainability Rating Not Enough?

Introduction

Space debris is one of the main issues in outer space. The Space Sustainable Rating (SSR) is an initiative that aims to address this problem by encouraging companies to design sustainable space missions. It seems however not enough considering the structure of the contemporary space industry. Other relevant issues have also to be taken into account, making SSR incomplete.

A little bit of context: Today's space environment

According to ESA, more than 130 million debris bigger than 1 mm, including 1 million bigger than 1 cm,[2] are orbiting planet Earth. A space debris is moving between 7[3] and 20 km/s.[4] Each in-space collision, even with a 1 mm debris (e.g. a paint flake), can have catastrophic consequences.

Space is becoming accessible, launches are less expensive, constraints seem to reduce little by little, but the number of debris only increases, making each mission more dangerous. The task of cleaning up space also becomes more difficult.

The ESA 2022 Space Environment report gives a worrying assessment: even if no more launches took place, the number of collisions would continue to increase.

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[2] ESA 2022a.
[3] NASA 2011.
[4] CNES 2020.

https://doi.org/10.36250/01192_05

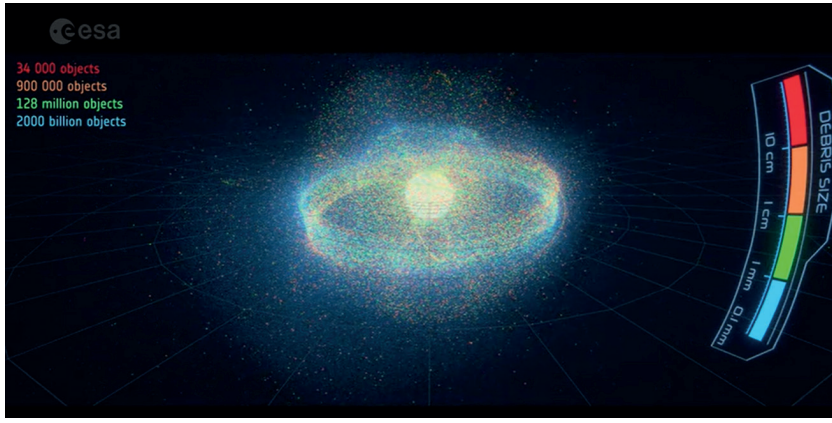


Figure 1: Time to Act
Source: ESA 2021

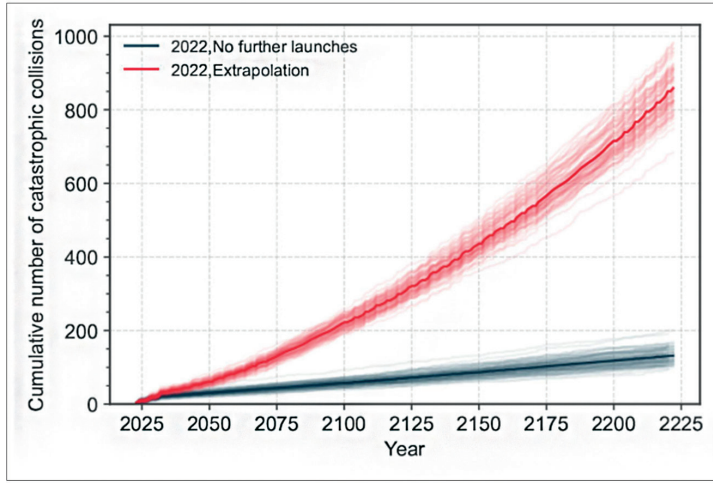
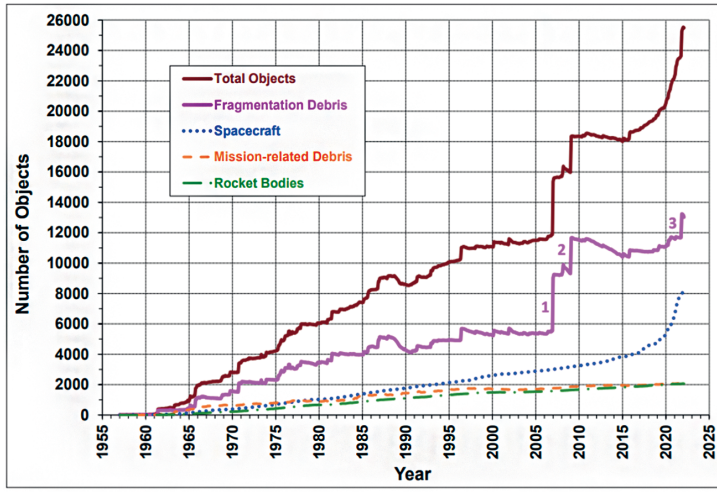


Figure 2: The future of catastrophic in-space collisions
Source: ESA 2022b

This is becoming unmanageable for space agencies and companies. After Russia's November 2021 ASAT test, Planet[5] had to handle an incredible number of CMEs.[6] The ISS was also put at risk.[7] ESA had to manoeuvre a first time a few years ago.[8] The problem becomes critical, and a solution has to be found.



The three upward jumps in fragmentation debris correspont to (1) the ASAT test conducted by China in 2007, (2) the accidental collision between Iridium 33 and Cosmos 2251 in 2009, and (3) the ASAT test conducted by the Russian Federation in November. More Cosmos 1408 fragments are expected to the added catalog in the coming weeks and months.

Figure 3: Historical increase of the catalogued objects based on data available on 1 March 2022
Source: NASA 2022: 2.

What legal protection of outer space against space debris?

Creating space debris is not forbidden. There is no rule today that prevents generating space pollution. Anti-satellite missile tests, i.e. the destruction of satellites in outer space for the sole purpose of testing a missile, are not forbidden, even though they generate thousands of pieces of debris (see Figure 3).

5 Private company owning hundreds of Earth Observation satellites in LEO.
6 Foust 2022.
7 Nelson 2021.
8 ESA 2019.

Article IX of the Space Treaty, which requires States to conduct their activities "with due regard to the corresponding interests of all other States Parties to the Treaty",[9] does not seem to include space debris. Some international law instruments try to mitigate space debris, for instance the Space Debris Mitigation Guidelines of the COPUOS,[10] or the IADC Space Debris Mitigation Guidelines,[11] but these are only soft law tools.

Some national laws require actors to de-orbit their out-of-service satellites located in LEO within 25 years. This measure is useful but insufficient, especially in view of the rapidly developing satellite constellations. Moreover, these are not international standards.

The FCC[12] has gone a step further by imposing a maximum of five years to deorbit out-of-service satellites in LEO.[13] This measure has sparked a lively debate on its feasibility, but would have a double beneficial impact on the space environment: it applies to the many American operators and could encourage other States to do the same. Until they follow the movement, initiatives such as the SSR exist.

What is the Space Sustainability Rating?

Space Sustainability Rating has two goals. The first one is to provide a rating system informed by transparent, data-based assessments of the level of sustainability of space missions. The second objective is to offer practical guidance to space operators on how to improve their sustainability performance, with the goal of helping to address the challenges raised by the proliferation of space debris.

So basically, a grade is given to a space mission. This grade depends on five criteria plus a bonus one. The "Mission Index" quantifies the level of harmful physical interference caused by the mission; the object has to be reliably included in space surveillance and tracking products ("Detectability, Identification and Trackability"); measures have to be taken to reduce the risk of accidental collision

[9] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, 1967, Article IX.

[10] Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space, 2007.

[11] IADC Space Debris Mitigation Guidelines, IADC-02-01, 2020.

[12] The U.S. agency responsible for licensing satellite operators.

[13] FCC 2022.

("Collision Avoidance Capabilities"), the operator has to share space situational awareness data ("Data Sharing"); the adoption of standardisation concepts is also taken into account ("Design and Operations Standards"); and finally, as a bonus, is the mission designed to receive external services? ("External Services").

These modules give a score, ranging from Bronze to Platinum.[14] In addition, there is also a bonus "Step" indicator.

Can the Space Sustainability Rating be effective?

The SSR is a very recent rating so we cannot really tell if it is efficient or not. But I have two main issues regarding the SSR: it is a non-mandatory evaluation, based on the will of space actors to be graded; and this evaluation is not free, companies have to pay to be graded. A question arises: how a costly non-mandatory rating could be widely adopted by space actors?

We have to keep in mind that one of today's goals is to make access to space activities cheaper. That is why there are so many new space companies and new launchers, promising space activities for a fraction of the current price.

Of course, in terms of the image sent back to the space industry, it will be better for a company to have a good SSR grade. But it is not enough to ensure a wide adoption of SSR, because the space sector is largely B2B (business to business) and not B2C (business to customer). In B2B relationships, the image is far less important than in B2C relationships. An economic incentive may be necessary.

Different actors at different levels of space mission preparation can help implement SSR on a large scale.

Insurance is mandatory in a lot of space faring nations, e.g. France.[15] Insurance pricing is calculated according to various factors (risks, orbit, duration, etc.). A good SSR grade could reduce the pricing.

States can also decide to refuse giving public money to companies with low grades. In France for instance there is the France 2030 program, companies have to respect some conditions to compete and get funding. The French Government could choose to only give money to companies with higher grades. National and regional space agencies could also decide to only work with companies with good grades.

[14] Bronze: 40–55%; Silver: 55–70%; Gold: 70–80%; Platinum: 80–100%.

[15] Loi n° 2008-518 du 3 juin 2008 relative aux opérations spatiales (1), Article 6.

The best solution would be that the governments, authorising national space activities,[16] refuse to give the authorisation for missions with low SSR grades.

States "bear international responsibility for national activities in outer space".[17] This responsibility is divided in two: responsibility for fault in space,[18] responsibility without fault on Earth and in the air.[19] A question arises: is it a fault to authorise a space mission that generates unnecessary debris and is not able to avoid collision (thus having a bad SSR score)?

Today it seems that no matter how the space mission was designed, the responsibility of the State is not yet internationally engaged because of space debris.

Is the SSR worse than not enough?

Could SSR have a negative effect on the sustainability of space activities? There are several trends that come to mind.

First of all, we must remember that the majority of States are not space faring nations yet. More and more countries are financing space activities, which are fundamental to face contemporary challenges (climate change, famine, war, migration, etc.). If the SSR becomes a mandatory standard, necessary to cooperate with space faring nations, developing countries will be disadvantaged.

The same competitive disadvantage may be found at national level with on the one hand well-established players (e.g. Ariane Group) that will have the means to both design sustainable missions and pay for the rating of each of their missions, and on the other hand startups that enter the market with (very) limited financial means. If it is clear that startups also have to make an effort to design their missions in a sustainable way, it can strongly impact innovation and the development of new technologies, while reducing the momentum of accessibility to space.

[16] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, 1967, Article VI.

[17] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, 1967, Article VI.

[18] Convention on International Liability for Damage Caused by Space Objects, 1972, Article III.

[19] Convention on International Liability for Damage Caused by Space Objects, 1972, Article II.

Second, the SSR is a private initiative, managed by a private organisation that space operators pay to get a score. Thus, it is almost certain that other initiatives of the same type will appear, with different criteria. Some ratings will probably be easier to obtain, with variable prices. In the end, understanding all these standards will be complex and will not serve the objective of transparency.

Finally, a last phenomenon could occur: the appearance of States of convenience. I have argued that the States themselves should force actors to obtain a good SSR score, or at least impose strict rules on the sustainability of space activities. If space faring nations impose these rules, private actors, especially startups, could decide to move in countries that do not impose these rules.[20] These States would become States of convenience, allowing cheap access to space, because they are provided by companies with no additional costs linked to the control of the sustainability of space missions. The phenomenon is well known in the law of the sea, the majority of ships being registered in States of convenience.[21] The States which regulate should then try to find a way to "punish" these unscrupulous companies and States, but the task is difficult.

The missing part of the SSR

Even if the SSR is not perfect, it has the merit to exist. But it is unfortunate that this rating only focuses on space debris, addressing only one problem at a time. The space sector is constantly growing and the challenges are numerous and interconnected. Having a global vision of these different challenges is necessary to find coherent solutions. Dealing with one problem at a time can be counterproductive.

A 2021 scientific study has criticised the practice of burning space debris in the atmosphere to avoid clogging low earth orbit.[22] Space tourism is also widely criticised, the negative impact on the environment far outweighing the limited usefulness of such missions.[23]

[20] One example is Rwanda's request for 300,000 satellites. De Selding 2022.
[21] CIA 2022.
[22] Boley–Byers 2021.
[23] Ross et al. 2010; Shukla 2021.

Light pollution is not taken into account by the SSR either, a worsening issue.[24] The SSR thus takes into account only the pollution in the traditional, historical sense of the term: space debris.

Despite these shortcomings, the SSR remains interesting because it allows a first awareness and sensitisation to the problem. Moreover, it allows companies that want to be virtuous and take into account the problem of space debris to act despite the inaction of their national State.

However, I must plead for a wider rating, including all types of pollution, free of charge, publicly accessible to ensure absolute transparency.

Conclusion

The real effectiveness of the SSR is questionable. While this type of rating may be beneficial because it puts all private actors on an equal footing, regardless of the State of nationality and/or launch, the optional nature of the rating could make it anecdotal or elitist. The SSR must be widely adopted by a majority of actors, at all levels: States, space agencies, private companies.

I must conclude this article on a positive note: the creation of the Space Sustainability Rating, regardless of its effectiveness, is a further step towards a generalised awareness of the entire space sector.

References

Boley, Aaron C. – Byers, Michael (2021): Satellite Mega-Constellations Create Risks in Low Earth Orbit, the Atmosphere and on Earth. *Scientific Reports,* 11. Online: https://doi.org/10.1038/s41598-021-89909-7

CIA (2022): *The World FactBook, Field Listing – Merchant Marine.* Online: https://www.cia.gov/the-world-factbook/field/merchant-marine/

CNES (2020): *Debris spatiaux – Risques.* Online: https://debris-spatiaux.cnes.fr/fr/risques

Convention on International Liability for Damage Caused by Space Objects, 1972.

De Selding, Peter B. (2022): Rwanda, Home to ITU Filing for 300,000+ Satellite Constellation, Says It Insists Operators Meet Debris-Mitigation Guidelines. *Space Intel Report,* 22 June 2022. Online: https://www.spaceintelreport.com/rwanda

[24] Kocifaj et al. 2021.

-home-to-itu-filing-for-300000-satellite-constellation-says-it-insists-operators-meet-debris-mitigation-guidelines/

ESA (2019): *ESA Spacecraft Dodges Large Constellation.* Online: https://www.esa.int/Space_Safety/ESA_spacecraft_dodges_large_constellation

ESA (2021): *Time to Act.* Online: https://www.esa.int/Space_Safety/Space_Debris/(archive)/0/(type)/video)

ESA (2022a): *Space Debris by the Numbers.* Online: https://www.esa.int/Space_Safety/Space_Debris/Space_debris_by_the_numbers

ESA (2022b): *ESA's Space Environment Report 2022.* Online: https://www.esa.int/Space_Safety/Space_Debris/ESA_s_Space_Environment_Report_2022

FCC (2022): *FCC Adopts New '5-Year Rule' for Deorbiting Satellites.* Online: https://www.fcc.gov/document/fcc-adopts-new-5-year-rule-deorbiting-satellites

Foust, Jeff (2022): Russian ASAT Debris Creating "Squalls" of Close Approaches with Satellites. *SpaceNews,* 18 February 2022. Online: https://spacenews.com/russian-asat-debris-creating-squalls-of-close-approaches-with-satellites/

IADC Space Debris Mitigation Guidelines, IADC-02-01, 2020.

Kocifaj, Miroslav – Kundracik, Frantisek – Barentine, John C. – Bara, Salvador (2021): The Proliferation of Space Objects Is a Rapidly Increasing Source of Artificial Night Sky Brightness. *Monthly Notices of the Royal Astronomical Society: Letters,* 504(1), L40–L44. Online: https://doi.org/10.1093/mnrasl/slab030

Loi n° 2008-518 du 3 juin 2008 relative aux opérations spatiales (1).

NASA (2011): *Frequently Asked Questions: Orbital Debris.* Online: https://www.nasa.gov/news/debris_faq.html

NASA (2022): The Intentional Destruction of Cosmos 1408. *Orbital Debris Quarterly News,* 26(1), 1–10. Online: https://orbitaldebris.jsc.nasa.gov/quarterly-news/pdfs/odqnv26i1.pdf

Nelson, Bill (2021): *NASA Administrator Statement on Russian ASAT Test.* Online: https://www.nasa.gov/press-release/nasa-administrator-statement-on-russian-asat-test

Ross, Martin – Mills, Michael – Toohey, Darin (2010): Potential Climate Impact of Black Carbon Emitted by Rockets. *Geophysical Research Letters,* 37(24). Online: https://doi.org/10.1029/2010GL044548

Shukla, Nikita (2021): The Environmental Costs of the Space Tourism Business. *Earth.org,* 31 August 2021. Online: https://earth.org/environmental-costs-of-space-tourism-business

Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space, 2007.

Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, 1967.

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Tamás Hontvári[1]

The Future of the International Space Station

Introduction

The International Space Station (ISS) has been one of the prime examples of successful international cooperation in outer space. Amongst others, the station has been a major symbol of post-Cold War collaboration between the U.S. and Russia and a platform for exploration and scientific research insulated from tensions and conflicts on the ground. This changed in July 2022 when amid tensions between Moscow and the West over the Russo–Ukrainian war, the head of the Russian space agency Roscosmos declared that Russia would end its part in the programme after 2024.[2] While NASA, ESA, JAXA, and the Canadian Space Agency have all expressed interest in continuing with the programme until 2028 or preferably 2030,[3] the future of the ISS is now threatened by Russia's departure. This paper analyses the effects that Russia's potential departure from the ISS would have and the possible solutions to the challenges this would raise to the functioning of the station. In the first section of this paper, I analyse the inclusion of Russia in the ISS project in the early 1990s and explain what this meant for the future of the ISS project and for international cooperation in space as a whole. I then turn to an analysis of Russia's threats to disassociate from the space station after 2024 and assess whether they should be taken seriously. In the final section of this paper, I outline the possible options available to keep the station operational if Russia were to leave the ISS.

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[2] Sauer 2022.

[3] See for example NASA 2022a.

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Historical context

Beyond the physical and technological obstacles, one of the great challenges that space missions have to overcome is the geopolitical reality of sovereign states meeting in a neutral, unclaimed territory.[4] The principle of international co-operation underlies all space law. Amongst other it appears in the Declaration of Legal Principles[5] and the Outer Space Treaty.[6] The ISS can be considered one of the most significant examples of how this principle has been successfully applied in practice. Involving 15 countries and 5 different space agencies, the ISS was constructed over several years and is by far the largest construction project ever attempted in low Earth orbit (LEO).

The international framework governing the project was first established through the 1988 Intergovernmental Agreement[7] which was ratified by the Government of the United States of America, the Government of Japan, the Government of Canada and the Governments of Members States of the European Space Agency. The agreement set up a framework for a future manned space station called Freedom where each Partner would contribute proportionately to its level of technical expertise and development.[8]

The original proposal in the 1980s spearheaded by NASA to build a permanent international space station did not include Russia. However, following the fall of the Soviet Block in 1991, Russia was also invited to join the programme. The purpose of this was to incorporate Russian expertise and technologies as well as to allow for better international relations. Russia eventually became a full ISS partner in 1993 and has been instrumental in the success of the station ever since. This ushered a new era of international cooperation in outer space,

[4] Sharpe–Tronchetti 2015: 618.

[5] Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space, 1962.

[6] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, 1967.

[7] Agreement Among the Government of the United States of America, Governments of Member States of the European Space Agency, the Government of Japan, and the Government of Canada on Cooperation in the Detailed Design, Development, Operation, and Utilization of the Permanently Manned Civil Space Station, 1988.

[8] Sharpe–Tronchetti 2015: 619.

following the more competitive and militarily dominated era of the Cold War in which space was the ultimate frontier between the U.S. and the Soviet Union.[9]

The ISS was not the first instance of collaboration between Russia and the U.S. As the political landscape of the Cold War began to ease, a milestone was reached as early as 1975 when the U.S. and the Soviets worked together on the Apollo–Soyouz project – a mission which involved both nations docking their capsules together in space.[10] In the 1980, the U.S. Administration supported NASA to build a permanently manned space station.[11] The first partners joined the U.S. in the development of the ISS in 1985.[12] By the 1990s, the development of the ISS was well underway, when the Clinton Administration faced budget constraints, which also affected the amount of funding available to NASA projects. In an attempt to reduce costs and increase international involvement, NASA invited Russia to join the ISS programme.[13] This was a welcome opportunity for Russia as funds significantly decreased for the Russian space programme in the aftermath of the dissolution of the Soviet Union in the early 1990s.[14] The Russian Space Agency (Roscosmos) was formed in 1992 and the following years saw the golden age of Russian–American relations in the space sector.[15] The most notable cooperation between the two states was the Shuttle–Mir programme in which several American astronauts flew to the Mir space station between 1995 and 1998.[16] The programme laid the foundation for future collaboration between the U.S. and Russia. Eventually, Russian officials decided to de-orbit the ageing Mir and focus their resources on the ISS project.[17]

The ISS partners joined with Russia entered into the 1998 Intergovernmental Agreement[18] (the IGA) which superseded the previous agreement signed between the parties over the building and development of the space station. The Russian contribution was critical already in the development phase as the Russians brought the expertise they had gained from operating Mir which was the first

9 Sharpe–Tronchetti 2015: 618.
10 NASA 2020.
11 Sharpe–Tronchetti 2015: 623.
12 Sharpe–Tronchetti 2015: 623.
13 Sharpe–Tronchetti 2015: 623.
14 Howell 2018.
15 U.S. Embassy and Consulates in Russia 2022.
16 Howell 2018.
17 Howell 2018.
18 1998 Intergovernmental Agreement.

modular space station to be assembled in orbit. The actual construction of the ISS began with Russia launching the Zarya control module in 1998 and was gradually completed over the next years with the final module being attached to the station in 2011.[19] At first NASA was concerned that Russia would use the opportunity to transfer advanced technology for their own military use. But after the U.S. decided to suspend the Space Shuttle programme following the Columbia disaster in 2003, NASA had no choice but to rely on Russia to transport to and from the space station.[20] The ISS project not least because of Russia's contributions has been considered a major success in international cooperation and the IGA has been taken as a model for future cooperative endeavours.[21] The operational programme was originally designed to end in 2015 but was gradually extended to 2024.[22]

Russia's potential departure from the ISS

The success story of the ISS took dramatic turns when in July 2022 amid tensions between Moscow and the West over the Russo–Ukrainian war, the head of the Russian space agency Roscosmos, Yuri Borisov declared that Russia would end its part in the programme after 2024 when the IGA is currently set to end.[23] The declaration did not come wholly by surprise as Russia raised concerns over high maintenance costs and ageing infrastructure already in 2021, citing potentially irreparable failures due to outdated equipment and hardware. [24] The recent declaration came as a response to the sanctions imposed by Western countries following Russia's latest invasion of Ukraine on 24 February 2022. On the day of the invasion, the Biden Administration announced the introduction of export sanctions on Russia, cutting more than half of Russia's high-tech imports. In a White House address, Biden said the sanctions would degrade Russia's "aerospace industry, including their space program".[25] Russia quickly retaliated

19 Howell 2018.
20 Sharpe–Tronchetti 2015: 625.
21 Sharpe–Tronchetti 2015: 659.
22 NASA 2014.
23 Sauer 2022.
24 Mishanec 2022.
25 Berger–Foust 2022.

by putting an embargo on the supply of rocket engines used in U.S. spacecraft.[26] Other Western countries responded similarly to the U.S. The European Space Agency also suspended its cooperation with Russia on the ExoMars mission[27] as well as its discontinuing its cooperative activities with Russia on several lunar missions.[28] It was in this context that in March 2022 former head of Roscosmos Dmitry Rogozin threatened that the sanctions could disrupt the operation of Russian spacecraft servicing the ISS, causing the structure to "fall down into the sea or onto land".[29] Rogozin also stated that the restoration of normal relations was only possible if the "illegal sanctions" were to be lifted.[30]

The tension over the sanctions culminated in the July 2022 statement of the newly appointed head of Roscosmos Yuri Borisov who stated that Russia would leave the ISS after 2024 and focus its efforts on building its own space station (the Russian Orbital Service Station set to be launched in 2028).[31] This would end decades of partnership between Russia and the West.[32] And while NASA, ESA, JAXA and the Canadian Space Agency have all expressed interest in continuing with the programme until 2028 or preferably 2030,[33] the future of the ISS is now threatened by Russia's departure. The harshness of Borisov's claims were somewhat softened by his statement that Russia would continue to fulfil its obligations to its partners on the ISS before leaving the project.[34] In the following week after the statement was made, Borisov also clarified that there may have been a mistranslation regarding his claims, as the country's intent to leave the ISS was after 2024, not in 2024, as some translations suggested.[35] The Roscosmos chief also recalled the one-year withdrawal notice period required by Article 28 point 1 of the IGA which was included precisely to prevent sudden withdrawals where partners are left unable to react.[36]

[26] Reuters 2022.
[27] ESA 2022a.
[28] ESA 2022b.
[29] France 24 2022.
[30] France 24 2022.
[31] Howell 2018.
[32] Sauer 2022.
[33] See for example, NASA 2022a.
[34] Sauer 2022.
[35] Dinner 2022.
[36] Dinner 2022; see also 1998 Intergovernmental Agreement, Article 28, point 1.

Consequently, Borisov's claims give reassurance that Russia would honour its legal obligations under the IGA and any previous claims of suddenly dropping the ISS into the ocean or on land were merely empty threats. As per Article 28 point 2 of the IGA, any withdrawal notice would trigger a series of negotiations whereby the parties would try to reach an agreement concerning the terms and conditions of the withdrawal with a view towards ensuring the continuation of the overall programme.[37] Also, under Article 23 on Consultations any partner is required to inform the other partners of any significant flight element changes that would impact on the other partners at the earliest opportunity,[38] and there are built-in provisions regarding dispute resolution mechanisms under the same article if the partners cannot resolve their issues through consultations.[39] To date, NASA has not received a formal withdrawal notice from Russia, so no exit process has been initiated.

Can Russia be replaced?

However, if Russia would indeed leave the Station, the question arises whether it can be replaced. This requires a closer examination of Russia's contribution to the ISS project. The Russian components are essential to the functioning of the space station. They include the Zvezda and the Zarya modules which comprise most of the thermal control systems, the life support systems, the flight control systems and the propulsion systems that provide station-keeping and manoeuvrability in outer space.[40] The Zvezda module also provides communication systems that include remote command capabilities from ground flight controllers, and a docking port for the Soyuz and the Progress spacecraft.[41] The Soyuz provides regular crew transfers, while the Progress spacecraft provides regular cargo flights as well as periodic reboosting for the station.[42] While there are other means of transportation to the ISS, for example, SpaceX's Dragon spacecraft,[43] the station relies entirely on the Zvezda service module thrusters and the Progress

37 1998 Intergovernmental Agreement, Article 28, point 2.
38 1998 Intergovernmental Agreement, Article 23.
39 1998 Intergovernmental Agreement, Article 23.
40 NASA 2018a; NASA 2018b.
41 NASA 2018a.
42 NASA 2018c.
43 NASA 2022b.

spacecraft to keep the ISS in orbit as well as to provide a controlled re-entry at the end of the station's lifetime. Therefore, in the worst possible scenario, if no action is taken and Russia decides to detach their modules and leave the ISS, the station would gradually lose altitude before re-entering the atmosphere where it would break up into pieces and fall into the ocean in an uncontrolled manner.

To avoid the aforementioned scenario and keep the ISS operational, the critical functionalities of the Russian modules would need to be replaced. One option would be to design and launch new modules that would recreate the functions of the Russian segment and attach them before the Russians leave. With the current timelines (2024 being less than two years from now), this option is not practical, because it would take years to build and test new modules, not to mention the amount of resources this would require.

Providing station-keeping via spacecraft propulsion is a more viable option, however, this also faces many challenges. NASA has confirmed that they have been working on contingency plans with multiple space companies to keep the ISS in orbit if Russia were to leave the station.[44] For example, in June 2022 Northrop Grunman successfully boosted the station using an updated version of its Cygnus cargo spacecraft, demonstrating a potential alternative to Russian thrusters.[45] Boeing and SpaceX have also been looking into alternative ways of controlling the station using spacecraft propulsion. In May 2022, Boeing's Starliner spacecraft successfully docked to the ISS for the first time.[46] And while it does have the boost capability required to support the space station, it launches on Atlas V rockets that fly on Russian engines (RD-180 engine) that are currently unavailable due to the embargo introduced by Russia.[47] SpaceX, on the other hand, has been supplying cargo deliveries with its Cargo Dragon capsules since 2012, and the company started providing crew transportation using their Crew Dragon capsules under NASA's Commercial Crew Program in 2020.[48] The problem, however, with Dragon capsules is that their engines do not have the manoeuvrability and the power required to provide station-keeping for the ISS.[49] SpaceX has also been developing Starship which will be the most

[44] Roulette 2022.
[45] Roulette 2022.
[46] Wall 2022.
[47] Reuters 2022.
[48] SpaceX 2023a.
[49] Dragon capsules use Draco thrusters for manoeuevring. These have thrust power of around 90 lbf (400 newtons), which is too little to provide station-keeping for the ISS. The Super Draco Engines

powerful launch vehicle ever developed,[50] designed amongst other for voyages to the surface of the Moon under the Artemis program.[51] Currently the Federal Aviation Administration (FAA) is conducting an environmental review of the launch vehicle as a part of the license application process that will allow SpaceX to carry out test launching.[52] However, even if they obtain the FAA approval, the Starship is years from becoming a dependable launch vehicle capable of launching modules that would fit into the ISS. So the question remains whether NASA and its partners can find a long-term solution to keep the station in orbit as currently there is a lack in reliable U.S. capacity to boost the station.

Of course, the best possible alternative scenario would be if the Russian modules were left in place and kept operational until at least 2028, whilst recognising that a change of ownership may be required for this. The withdrawal provisions of the IGA also require the leaving member to "expeditiously provide hardware, drawings, documentation, software, spares, tooling, special test equipment, and/or any other necessary items requested by the United States",[53] however, this clause only applies to Canada. The Russians are unlikely to entertain such a transfer of equipment. First, at the moment only the Russians have the expertise to operate the Russian components. Secondly, they made the claim already back in 2016 that they intend to detach and reuse their modules for the new Russian space station.[54] That being said, the most ideal scenario would be if Russia stayed on the ISS and continued to contribute towards maintaining the ISS beyond 2024 until the partners decide to retire the ISS. The partners would then have the challenging task of removing the world's largest man-made object from outer space. The most likely solution is to deorbit the space station into an area of the Pacific Ocean called Point Nemo, which is where Mir was deorbited in 2001.[55]

on Dragon V2 is significantly more powerful with a thrust of 16,400 lbf (72,950 newtons) of thrust, but are fuel-constrained as they are designed for powered landings which is a fuel-intensive process. By comparison, the engines on the Progress Spacecraft have a thrust power of approximately 660,000 lbf (2942 kN).

50 SpaceX 2023b.

51 NASA 2021.

52 Federal Aviation Administration 2022.

53 1998 Intergovernmental Agreement, Article 28, point 3 (a).

54 Smith 2022.

55 Shepherd 2021.

Conclusion

In summary, the Russian contributions are essential to the functioning of the space station. Most importantly, they include the flight control and propulsion systems that keep the ISS in orbit. So if Russia decides to quit the programme after 2024, the critical functionalities of their modules would need to be replaced potentially with commercial involvement. The biggest problem is that currently there is a lack in reliable U.S. capacity to boost the station and keep it in orbit, and the timelines are very tight for coming up with alternative solutions to Russian thrusters. This all begs the question of course whether it is really worth maintaining something beyond its life expectancy. The station was originally designed to operate until 2015, and while the programme has been gradually extended by the ISS partners, the station has started experiencing irreparable failures that will multiply in the next few years due to the ageing equipment and hardware.[56] The ISS is roughly the same age as Mir was when they decided to end its operation, and there are other exciting projects around the corner that the ISS partners could focus on such as the Lunar gateway and other deep space projects.[57] At the same time, there are ongoing commercial developments in LEO. For example, Axiom Space is developing the world's first commercial space station and states could use these on a timeshare basis to carry out scientific research.[58] However, until these projects materialise, the ISS partners should operate the station as long as they can so there will be no gap in mankind's capacity to carry out research in an orbital laboratory such as the ISS. To date the partners have not received a formal withdrawal notice from Russia. Recent developments also give rise to hope regarding the future of the station as Roscosmos official struck a more conciliatory tone regarding U.S.–Russian cooperation in outer space after NASA successfully sent two American astronauts, a Japanese astronaut and a Russian cosmonaut to the ISS in October 2022.[59] Roscosmos's head of human space flight programs Sergei Krikalev said that Russia is looking into the technical possibility of keeping the station operational as long as they can.[60] So we can hope that the partners will negotiate an agreement that will see that this major symbol of post-Cold War collaboration continue beyond 2024.

[56] Cuthbertson 2021.
[57] ESA 2022c.
[58] Axiom Space 2022.
[59] Davenport 2022
[60] Foust 2022.

References

1998 Intergovernmental Agreement: The Agreement among the Government of Canada, Governments of Member States of the European Space Agency, the Government of Japan, the Government of the Russian Federation, and the Government of the United States of America Concerning Cooperation on the Civil International Space Station. Washington, D.C., 29 January 1998, entered into force 27 March 2001; TIAS No. 12927; Cm. 4552; Space Law – Basic Legal Documents, D.II.4.

Agreement Among the Government of the United States of America, Governments of Member States of the European Space Agency, the Government of Japan, and the Government of Canada on Cooperation in the Detailed Design, Development, Operation, and Utilization of the Permanently Manned Civil Space Station. Washington, D.C., 29 September 1988, entered into force 30 January 1992; Cm. 705; Space Law – Basic Legal Documents, D.II.4.2.

Axiom Space (2022): *Axiom Station*. Online: https://www.axiomspace.com/axiom-station

Berger, Brian – Foust, Jeff (2022): Biden: Sanctions Will "Degrade" Russian Space Program. *Space News,* 24 February 2022. Online: https://spacenews.com/biden-sanctions-will-degrade-russian-space-program/

Cuthbertson, Anthony (2021): The ISS Is Cracked and Facing 'Irreparable' Failures – And They Could Be about to Get Much Worse. *Independent,* 03 September 2021. Online https://www.independent.co.uk/tech/international-space-station-iss-cracks-b1912379.html

Davenport, Christian (2022): SpaceX Launch Is Latest Sign of Lasting Russia–U.S. Space Partnership. *The Washington Post,* 05 October 2022. Online: https://www.washingtonpost.com/technology/2022/10/05/spacex-launch-russia-nasa/

Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space, G.A. Res. 1962 (XVIII), 18 U.N. GAOR Supp. No. 15 (A/5515).

Dinner, Josh (2022): *New Russian Space Chief Clarifies Comments about International Space Station Departure.* Online: https://www.space.com/russian-space-chief-clarifies-iss-departure-comments

ESA (2022a): *N° 9–2022: ExoMars Suspended.* Online: https://www.esa.int/Newsroom/Press_Releases/ExoMars_suspended

ESA (2022b): *N° 16–2022: Redirecting ESA Programmes in Response to Geopolitical Crisis.* Online: https://www.esa.int/Newsroom/Press_Releases/Redirecting_ESA_programmes_in_response_to_geopolitical_crisis

ESA (2022c): *Gateway.* Online: https://www.esa.int/Science_Exploration/Human_and_Robotic_Exploration/Exploration/Gateway

Federal Aviation Administration (2022): *FAA Requires SpaceX to Take Over 75 Actions to Mitigate Environmental Impact of Planned Starship/Super Heavy Launches.* Online: https://www.faa.gov/newsroom/faa-requires-spacex-take-over 75-actions-mitigate-environmental-impact-planned

Foust, Jeff (2022): *Roscosmos official supports continued cooperation with NASA on ISS.* Online: https://spacenews.com/roscosmos-official-supports-continued -cooperation-with-nasa-on-iss/

France 24 (2022): Russia Warns Sanctions Could Cause International Space Station to CRASH. *France 24,* 12 March 2022. Online: https://www.france24.com/en/ europe/20220312-russia-warns-sanctions-could-cause-international-space-station-to-crash

Howell, Elizabeth (2018): *Roscosmos: Russia's Space Agency.* Online: https://www.space.com/22724-roscosmos.html

Mishanec, Nora (2022): Russia to Withdraw from International Space Station in 2024. *Houston Chronicle,* 26 July 2022. Online: https://www.houstonchronicle.com/ news/houston-texas/space/article/Russia-withdraw-International-Space-station-nasa-17329466.php

NASA (2014): *Space Station 2024 Extension Expands Economic and Research Horizons.* Online: https://www.nasa.gov/mission_pages/station/research/news/2024extension/

NASA (2018a): *Zvezda Service Module Overview.* Online: https://www.nasa.gov/mission_pages/station/structure/elements/zvezda-service-module.html

NASA (2018b): *Zarya.* Online: https://www.nasa.gov/mission_pages/station/structure/ elements/zarya-cargo-module

NASA (2018c): *About the Russian Progress Spacecraft.* Online: https://www.nasa.gov/ mission_pages/station/structure/elements/progress_about.html

NASA (2020): *The Apollo–Soyuz Test Project: An Orbital Partnership Is Born.* Online: https://www.nasa.gov/multimedia/imagegallery/image_feature_2309.html

NASA (2021): *As Artemis Moves Forward, NASA Picks SpaceX to Land Next Americans on Moon.* Online: https://www.nasa.gov/press-release/as-artemis-moves-forward -nasa-picks-spacex-to-land-next-americans-on-moon

NASA (2022a): *ISS 2030: NASA Extends Operations of the International Space Station.* Online: https://solarsystem.nasa.gov/resources/2680/iss-2030-nasa -extends -operations-of-the-international-space-station/

NASA (2022b): *Visiting Vehicle Launches, Arrivals and Departures.* Online: https:// www.nasa.gov/feature/visiting-vehicle-launches-arrivals-and-departures

Reuters (2022): Russia Halts Deliveries of Rocket Engines to the U.S. *Reuters,* 03 March 2022. Online: https://www.reuters.com/world/russia-halts-deliveries-rocket-engines-us-2022-03-03/

Roulette, Joey (2022): NASA game planned contingencies for space station as Russian alliance continued. *Reuters,* 04 August 2022. Online: https://www.reuters.com/world/nasa-game-planned-contingencies-space-station-russian-alliance-continued-sources-2022-08-04/

Sauer, Pjotr (2022): Russia Says It Will Quit International Space Station after 2024. *The Guardian,* 26 July 2022. Online: https://www.theguardian.com/science/2022/jul/26/russia-opt-out-international-space-station-2024-build-own-outpost

Sharpe, Carla – Tronchetti, Fabio (2015): Legal Aspects of Public Manned Spaceflight and Space Station Operations. In Dunk, Frans von der – Tronchetti, Fabio (eds.): *Handbook of Space Law.* Northampton: Edward Elgar Publishing. 618–661.

Shepherd, Tory (2021): Thousands of Kilometres from Anywhere Lies Point Nemo, a Watery Grave Where Space Stations Go to Die. *The Guardian,* 03 September 2021. Online: https://www.theguardian.com/science/2021/sep/04/thousands-of-kilometres-from-anywhere-lies-point-nemo-a-watery-grave-where-space-stations-go-to-die

Smith, Rich (2022): *3 Companies that Could Replace Russia on International Space Station: SpaceX, Boeing, Northrup.* Online: https://eu.usatoday.com/story/tech/science/2022/08/02/3-companies-that-could-replace-russia-on-the-international-space-station/50550793/

SpaceX (2023a): *Space Station: Transporting Humans to the Orbiting Laboratory in the Sky.* Online: https://www.spacex.com/human-spaceflight/iss/index.html

SpaceX (2023b): *Starship.* Online: https://www.spacex.com/vehicles/starship/

Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies. London–Moscow–Washington, 27 January 1967, UNTS vol. 610. 205. (entered into force: 10 October 1967).

U.S. Embassy and Consulates in Russia (2022): *ISS 2030: NASA Extends Operations of the International Space Station.* Online: https://ru.usembassy.gov/embassy-consulates/moscow/sections-offices/nasa/

Wall, Mike (2022): *Boeing's Starliner Spacecraft Docks at International Space Station for 1st Time.* Online: https://www.space.com/boeing-starliner-docking-international-space-station

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Study on Northeast Asia's Feasible Cooperative Solution for Space Security and Space Development

Introduction

Northeast Asia (NEA) is generally defined as China, Japan, South Korea and North Korea. The three Northeast Asian countries, excluding North Korea, are ranked among the top 10 in the world regarding economic and military power.[2] North Korea's economy and military power are not among the top 10 in the world, but it has nuclear weapons. It would not be an overstatement to say that NEA is one of the regions with the highest military tension in the world. NEA countries do not have organisations similar to NATO or OSCE, despite such political/geographical security instability. In other words, rather than multilateral cooperation such as collective defence or cooperative security, bilateral cooperation exists in the region (including between the U.S., Russia and NEA countries) and has continued since the Korean War. Currently, it is divided into two blocs: 1. U.S. – Japan – South Korea; and 2. China – Russia – North Korea. However, in space, even North Korea, which has threatened the regional/international community with its nuclear test, is actively abiding by international law to gain recognition from the international community for space development.

In addition, no multilateral cooperation organisation is run by NEA countries on the ground. However, in the space field, we can find the Asia-Pacific Regional Space Agency Forum (APRSAF), led by Japan, and the Asia-Pacific Space Cooperation Organization (APSCO), led by China. They promoted space cooperation and were established in 1993 and 2008, respectively. However, no meaningful discussion exists on a cooperative plan to solve conflicts among NEA

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[2] Statistics Times 2021; GFP 2022.

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countries using APRSAF and APSCO. This study aims to derive collaborative problem-solving in NEA using APRSAF and APSCO. To this end, the three possible approaches are: First, it analyses why cooperative measures were impossible in NEA by comparing them with Europe. Second, it examines the threats to space security in NEA. Third, it identifies a cooperative solution by comparing the European Space Agency, APRSAF and APSCO.

Northeast Asia in Space

In this section, the paper explores why cooperative measures have been more difficult to implement in NEA by comparing them with Europe. It will also examine what NEA could mean for European space security.

Space development capabilities of Northeast Asian countries

Table 1: 2021 GDP Ranking and 2022 Military Strength Ranking

Rank	GDP Ranking (Statistics Times 2021)	Military Strength Ranking (GFP 2022)
1	United States	United States
2	China	Russia
3	Japan	China
4	Germany	India
5	United Kingdom	Japan
6	India	South Korea
7	France	France
8	Italy	United Kingdom
9	Canada	Pakistan
10	South Korea	Brazil

Source: Compiled by the author.

Table 1 above shows that Northeast Asia Countries have significant economic and military power. North Korea is not in the top 10 strongest military or economic countries. However, it could be considered a nuclear-weapon state.[3] Also,

[3] Kim 2021: 20.

Kim pointed out: "It is logical for economically powerful countries to increase national defense expenditures, especially if there is no regional economic/security organization based on mutual trust in their region."[4] In this sense, it is reasonable that NEA countries with sufficient economic capabilities aspire to develop their space sectors to improve their national security.

Table 2: Timeline of first orbital launches by country

Rank	Country	Date	Rocket
1	Soviet Union	1957 Oct.	Modified R-7 ICBM
2	United States	1958 Feb.	Juno I
3	France	1965 Nov.	Modified Diamant A
4	Japan	1970 Feb.	Lambda 4S (L-4S)
5	China	1970 April	Long March 1 (CZ-1)
6	United Kingdom	1971 Oct.	Black Knight
7	India	1980 July	SLV
8	Israel	1988 Sept.	Shavit 2
9	Iran	2009 Feb.	Safir-1
10	North Korea	2012 Dec.	Unha-3
11	South Korea	2013 Jan.	Naro-1

Source: Compiled by the author.

Table 3: Timeline of first Lunar Probes by country

Rank	Country	Date	Lunar Probe
1	Soviet Union	1959 Jan.	Luna 1
2	United States	1959 March	Pioneer 4
3	Japan	1990 Jan.	Hiten
4	China	2007 Oct.	Chang'e 1
5	India	2008 Oct.	Chandrayaan-1
6	South Korea	2022 Aug.	Danuri

Source: Compiled by the author.

Tables 2 and 3 above show how dedicated the four NEA countries are to space development and security matters. As of 28 December 2022, South Korea became the 6th country in the world to achieve a lunar exploration mission. NEA

4 Kim 2021: 21.

countries with economic, military and space power will be essential actors for the international community and European space security. In the following section, the research will compare Europe and Asia to determine what role Northeast Asia will play in Europe.

Northeast Asia to Europe: As a partner? As an alliance? As a threat?

The question arises if the cultural, linguistic, historical, geographical, etc. factors shaped the European cooperation and if they did to what degree? The idea that Europe has common cultural and ideological roots originating from Latin and Greek culture and language, or that Christianity also serves as a foundation is widespread. But it is yet unclear how much these factors influenced the process of European integration in the 20th and 21st century. A thorough multi-level analysis could be a subject to a future research project.

It is for certain, that Asian countries vary in size and population. The range moves from China, with a population of 1.4 billion, to Brunei, with a total population of 430,000. In addition, it is difficult to find homogeneity between various religions, such as Buddhism, Christianity, Confucianism, Hinduism, Islam, Taoism and various languages. Above all, many Asian countries experienced colonisation by ruling powers such as Portugal, Spain, the Netherlands, France, Britain, the U.S. and Japan. Even after the ruling powers left, it created a new culture with the ruling powers' social, political and economic legacy.[5] As a result, it is quite challenging to cooperate with shared values and ideologies.

In addition, the NEA region was divided into two parts after the Korean War: 1. the democratic bloc with the U.S., Japan and South Korea; and 2. the communist bloc with the Soviet Union, China and North Korea. In this situation, could Northeast Asian countries be partners, allies, or threats to European space security? All three options are possible. There are countries in the NEA region which share similar ideologies, as most European countries, and there are also countries with less convergent ideologies. National interests might also contribute to any outcome regardless of the ideological background. It is possible even for countries having seemingly opposing ideologies to form partnerships or even strong alliances if the conditions are right. Understanding NEA space security is likely to be essential for European space security in the future.

[5] Beeson–Stubbs 2011: 2.

The four major threats to NEA space security

Threat 1: Changes in Japanese legal interpretation

Phase I (1947–2007): Strict interpretation of peaceful purposes (non-military purposes)

After Japan's defeat in World War II, all armed forces in Japan were disbanded, and the newly enacted Japanese constitution of 1947, also known as the "Peace Constitution", clearly prohibited the establishment of an armed force in Japan. The particularly important part is Article 9 on the Renunciation of War below.

"… the Japanese people forever renounce war as a sovereign right of the nation and the threat or use of force as means of settling international disputes. In order to accomplish the aim of the preceding paragraph, land, sea, and air forces, as well as other war potential, will never be maintained. The right of belligerency of the state will not be recognized."

Article 9 is the part that most clearly shows how Japan would behave in the international community after its defeat. In other words, Japan promised the international community that it would not remilitarise by taking an 'anti-militaristic stance' as a peaceful country. Later, following the spirit of the Peace Constitution, in 1967, the principle of peaceful use of space was announced, and the militarisation of space was opposed. Additionally, according to the Peaceful Purposes Resolution (PPR) of 1969, Japan's space activities should be "limited to peaceful purposes", i.e. "non-aggressive" and "non-military".

However, after North Korea launched missiles over Japan in 1998, the strict Japanese interpretation of Peaceful Purposes Resolutions began to crack. In other words, Japan decided that the Japanese Self-Defence Forces (SDF) would "be allowed to use space-based communications, observation, and meteorological data that were already commercially available".[6]

Phase II (2008–2019): From non-military to non-aggressive

Japan has adhered to the strict interpretation of peaceful purposes, which states that space is used only for peaceful purposes. The peaceful purposes restricted

[6] Kallender 2016: 18.

Japan's space activities. More exactly, the United States dismantled Japan's aviation and space industries' production machinery suitable for the war industry and banned all lectures under the name of aviation at universities after the end of the Pacific War.[7] For this reason, the Japanese Basic Space Law (2008) was enacted to give legitimacy to developing space in a non-aggressive way, which is the most significant event in the history of Japanese space and defence policy.

Table 4: New interpretation from the Basic Space Law

JAXA Law No. 161 (2002)	**Basic Space Law (2008)**
Article 4 (Objectives of the Agency) **Only** for peaceful purposes	Article 2 (Peaceful Use of Outer Space) **from "non-military" to "non-aggressive"**

Source: Compiled by the author.

After enacting the Basic Space Law, Japan's first national space law, Japan changed its interpretation of peaceful use from "non-military" to "non-aggressive". It implies that Japan opened the door to military application, increasing military tensions among NEA countries.

Phase III (2020–): Counterstrike capabilities

It is the first time in 2022 that a Japanese defence white paper states that the Japanese Self-Defence Forces can review its "counterattack capability" in a crisis, even though Japan is constitutionally unable to wage war. The white paper introduces Prime Minister Kishida's speech at the joint press conference following the Japan–U.S. Summit Meeting by mentioning, "all the options will be there, not to exclude any one of them including counterstrike capabilities".[8]

Daniel Snyder, a researcher at Stanford University who is an expert on U.S.–Japan relations, said the following about the Japanese Ministry of National Defence's mention of counterattack capability in the 2022 Defence White Paper. "If there is a missile warming up on the launch pad in North Korea, we have the

7 Jo 1995: 9.

8 Ministry of Defence 2022: 196.

right to strike it before it hits us. That would be a self-defense".[9] Furthermore, the Ministry of Defence launched a Space Operations Squadron with about 70 members in 2020. Later it was integrated into the Space Operation force in 2022. Therefore, the interpretation of the peaceful purpose changed over three phases, and this became a factor further accelerating the Northeast Asian space race.

Threat 2: Similarities between ballistic missiles and space launch rockets and North Korea's strategic ambiguity

North Korea has claimed that they launched several long-range rockets, including Baekdusan-1 (Taepo-dong-1) and Kwangmyeongseong, since 1998. However, South Korea defines it as a "missile launch" and responds with sanctions.[10] Furthermore, according to Song, the international community is suspicious of North Korea due to 'the launching window'.[11] North Korea launched the rockets or missiles mainly at 9:00 a.m. to evade the surveillance of South Korea and the U.S. and to promote its regime. The satellite enters the sun's shadow when it launches in the morning hours, making it challenging to charge the battery using solar energy, resulting in malfunction or inoperability of the satellite. Therefore North Korea's launch of a satellite in the daytime can be interpreted as focusing on tests such as rocket operation checks and missile stage separation of long-range missiles rather than the success of launching satellites and entering orbit.

The second reason is the similarities between ballistic missiles and space launch rockets and North Korea's strategic ambiguity. In other words, when North Korea launches a space launch vehicle for artificial satellites, the most controversial issue is the difference between a space launch vehicle and an intercontinental ballistic missile. The Basic Guide by United Nations Office for Disarmament Affairs supported the similarities between missiles and space vehicle launches by mentioning: "There is no technical distinction between rockets and missiles, and the terms are often used interchangeably."[12] The basic technology is the same, but the payload type and flight path will make the difference. For this reason,

9 Park 2022.
10 Jo 2016.
11 Song 2021: 126.
12 Gillis 2017: 63.

verifying whether North Korea launched a missile or a space launch vehicle when seen from the outside is not easy. Therefore, these similarities and ambiguities create mutual distrust and intensify NEA's space and arms race.

Threat 3: Abolition of South Korea – U.S. Ballistic Missile Range Guidelines (1979–2021) and security dilemma in space

Table 5: South Korea Ballistic Missile Range Limits 1979–2021

Year	Range	Warhead weight	Use of solid fuel
1979–2001	180 km	500 kg	All
2001–2012	300 km	500 kg	All
2012–2017	800 km	500 kg	All
2017–2020	800 km	Unlimited	All
2020–2021.5	800 km	Unlimited	Military
2021.5–present	Abolished		

Source: Wikipedia 2022

South Korea had a limitation in developing space launch vehicles and missiles due to the South Korea – U.S. missile guideline. It has been revised four times since 1979 to gradually ease restrictions on the range, warhead weight and fuel. Guidelines that had restricted space development for 43 years were finally abolished in May 2021. It means a country has recovered its missile sovereignty, and restrictions and obstacles to Korea's space development have disappeared.

South Korea accelerated its space development after lifting the guidelines in 2021. The following year, Korea successfully launched the Korean Space Launch Vehicle-II (KSLV-II),[13] making Korea the world's 11th self-propelled space rocket launcher. Moreover, South Korea ranked the 7th country that can put satellites of 1 ton or more into orbit. Additionally, in August 2022, Korea successfully

[13] Also called Nuri (누리).

launched its first lunar orbital probe, Korea Pathfinder Lunar Orbiter (KPLO),[14] and entered lunar orbit on 28 December 2022.[15] Therefore, South Korea's KPLO became the world's 6th lunar explorer, excluding the ESA. The Republic of Korea (ROK) achieved space technology less than a year after the guidelines were abolished. This rapid change could create a security dilemma in space, likely destabilising regional security.

China's independent space system against the United States

China was the third country behind the U.S. and Russia to have its human-crewed spaceflight technology. China has also acquired in-space rendezvous, docking and spacewalking technology. Based on these technologies, it aimed to complete the Tiangong space station. Finally, China successfully launched the Shenzhou-15 to finish the construction of its space station, Tiangong. On 29 November 2022, Shenzhou-15, with three astronauts on board, arrived in 6 hours and 30 minutes and succeeded in docking with the Tianhe core module.[16]

Instead of belonging to the U.S.-led system, China has established an independent space system, such as the Tiangong space station, BeiDou Navigation Satellite System (BDS) and the establishment of APSCO. It is expected to accelerate the U.S.–China competition further and threaten the security of the NEA region, which is split by the U.S. and China. In order to solve those threats in the NEA cooperative way, it is necessary to figure out how to perceive space and neighbouring space activities. Accordingly, it is vital to compare and analyse four NEA countries' space policies, ESA, APRSAF and APSCO.

[14] Also called Danuri (다누리).
[15] Ministry of Science and ICT 2022.
[16] Xinhuanet 2022.

Four NEA cooperative solutions and conclusion

Solution 1: An agreed definition of peaceful use by APRSAF and APSCO

Table 6: Comparison of ESA, APRSAF and APSCO's structures

	ESA	APRSAF	APSCO
Led by	European Countries	Japan	China
Characteristics	Europe's comprehensive space agency	Open and flexible regional cooperative framework	Intergovernmental, independent non-profit body with full international status
	Member States work together, sharing financial and scientific resources to achieve the best results.	Voluntary and cooperative activities	The cooperative mechanism in the Asia-Pacific region for peaceful uses of space
Establishment	1975	1993	2008
Member states	22	52	8
NEA members	X	China, Japan, South Korea	China
Convention (Regulations)	Yes	No	Yes
Fund	It is mandatory, funded by a financial contribution from all the Agency's Member States, calculated per each country's gross national product. Member States also add voluntary funds to the budget	X	The Council, through consensus, shall decide the scale of the financial contribution of each Member State's average GDP per capita

Source: Compiled by the author.

Table 6 compares ESA to complement cooperative solutions through APRSAF and APSCO. APRSAF, established by Japan, has no convention or regulation. This makes the starkest difference from the other two organisations. APRSAF is an open and flexible regional cooperative framework, but it is challenging to operate projects for cooperative solutions because there is no financial contribution

obligation among member countries. Namely, it is easy to join due to this openness, and thus it is the reason APRSAF has 52 member countries. APSCO, founded in China, is similar to the ESA model. It is an intergovernmental, independent non-profit body with full international status where convention or regulation exists. Furthermore, its convention was registered in the United Nations as a Multilateral International Organisation. Also, there are financial contribution obligations among member countries, like ESA. Therefore, APSCO's cooperative solutions are feasible, but the cooperation is limited between 8 countries.

Therefore, APRSAF and APSCO must build the universally (at least regionally) agreed definition of peaceful use in Space on the convention or regulations of APRSAF and APSCO. Moreover, APRSAF and APSCO must make financial contributions mandatory to make cooperation solutions feasible.

Solution 2: Mutual agreements on the validation method

NEA intergovernmental organisations or APRSAF and APSCO should build a mutually agreed validation method to identify missiles and space launch rockets and clarify similarities and ambiguities. These agreements should be incorporated into national laws as well. In this case, NEA can prevent mutual distrust arising from being unable to distinguish between missiles and rockets, especially in the case of North Korea.

Solution 3: International customary law

If Solution 2 is no longer available for two reasons: 1. there is no legally binding agreement at the international or regional level; and 2. there is a great burden on the legal binding force among NEA countries, customary law could be an alternative and the most feasible solution. As pointed out earlier, North Korea showed a willingness to actively abide by the norms of the international community in order to participate in space development. In this aspect, the North Korean National Space Agency joined the International Astronautical Federation (IAF) and was approved on 15 October 2015, but on 16 October, the IAF decided to revoke the approval at the final deliberation stage. IAF explained that more

investigations were needed to determine whether the North Korean agency met the IAF's goal of pursuing only peaceful activities.[17]

Accordingly, North Korea's space development has been restricted, and Northeast Asia countries are not able to identify North Korea's intentions regarding space launch vehicles and missiles, which will increase distrust and anxiety. In this respect, customary law could be the most viable solution since it does not carry a legal binding force like international or regional law, but it could obtain the status of international or regional law when it becomes standard and globally accepted over time. Namely, if APRSA, APSCO, or a regional intergovernmental body conducts the validation method to identify space launch rockets 'repeatedly' and 'continuously', similar effects to international law can be expected.

Solution 4: Create more practical joint programs

NEA intergovernmental organisations or APRSAF and APSCO should create more practical joint programs in space, such as International Space Station (ISS). Multilateral cooperation in space among NEA countries would be possible if more significant common interests and coexistence were guaranteed and when the benefits of participating in the program are far greater than not participating. The case of North Korea is a suitable example of the above. As mentioned earlier, North Korea has been continuously conducting missile launches and nuclear tests without paying attention to the eyes of neighbouring countries and the international community. However, they have shown efforts and will to actively comply with international norms concerning space launch vehicles. In other words, North Korea considered that they could obtain more advantages from following international norms and taking a cooperative stance about space development. From this point of view, if NEA countries promote a joint program that guarantees more significant benefits, it is possible to maintain peace while enabling each country to develop in space. Hopefully it can also help to prevent tensions of the arms race and security dilemma in space from the Chinese independent space system against the United States. But development could also trigger this arms race; therefore, decision-makers and stakeholders should be careful about this.

[17] Choi 2017: 112.

Conclusion

Proceeding from what has been said above, it should be concluded that in Northeast Asia, divided into two camps, seems to be a limit to the direct application of international law led by the United States. In particular, it is hardly an exaggeration to say that there will be strong opposition from North Korea and China against the international law led by the U.S. Therefore, feasible solutions should establish 1. the regionally agreed concept of peaceful use in space through regional or intergovernmental space organisations; 2. mutual agreements on the validation method through regional or intergovernmental space organisations; 3. mutual agreements on the validation method through customary law; and 4. practical joint programs.

References

Beeson, Mark – Stubbs, Richard (2011): *Routledge Handbook of Asian Regionalism.* London: Routledge. Online: https://doi.org/10.4324/9780203803608

Choi, Eun-suk (2012): 북한의「우주개발법」제정과 전략로켓 [North Korea's Space Development Law and Strategic Rockets]. *Military Forum,* 90.

GFP (2022): *2022 Military Strength Ranking.* Online: https://www.globalfirepower.com/countries-listing.php

Gillis, Melissa (2017): *Disarmament: A Basic Guide.* New York: United Nations Office for Disarmament Affairs.

Ha, S.E. (2016): 북한의 '탄도미사일' 혹은 '우주발사체 [North Korea's 'Ballistic Missile' or 'Space Launch Vehicle']. North Korean Science and Technology Network. Online: http://www.nktech.net/inform/nkt_briefing/nkt_briefing_v.jsp?record_no=266

Jo, Hwang-H. (1995): 일본의 장기대형과제 추진체계와 정책에 관한 연구 -우주개발을 중심으로 [A Study on Japan's Long-Term Large-Scale Project Promotion System and Policy – Focused on Space Development]. Science and Technology Policy Institute.

Jo, Seung-H. (2016): 우주개발? 미사일 발사? 북한의 장거리 로켓들 [Space Development? Missile Launches? North Korea's Long-Range Rockets]. *Hankyoreh,* 12 February 2016. Online: https://www.hani.co.kr/arti/politics/defense/730086.html

Kallender, Paul (2016): Japan's New Dual-Use Space Policy. The Long Road to the 21st Century. *Asie.Visions,* (88).

Kim, Mo Rang (2021): The Role of the US–ROK Alliance in the NATO–ROK Global Partnership. *Vojenské reflexie,* 16(3), 18–31. Online: https://doi.org/10.52651/vr.a.2021.3.18-31

Ministry of Defence (2022): *Defense of Japan 2022.* Online: https://www.mod.go.jp/en/publ/w_paper/wp_2022.html

Ministry of Science and ICT (2022): 다누리, 달 궤도 진입 최종 성공… "세계 7번째 달 탐사국" [Danuri Successfully Enters Lunar Orbit... "The 7th Lunar Exploration Country in the World"]. *Korea Policy Briefing,* 28 December 2022, Online: https://www.korea.kr/news/policyNewsView.do?newsId=148909930

Park, Seung-H. (2022): 전문가들 "일본 방위백서 '반격 능력' 언급, 북한 잇단 미사일 도발이 계기" [Experts "Mention of 'Counterattack Capability' in Japan's Defence White Paper, Following North Korea's Series of Missile Provocations"]. *VOA,* 23 July 2002. Online: https://www.voakorea.com/a/6670340.html

Song, Geun-H. (2021): 북한의 우주개발 위협 현황 분석과 한국군의 대응 방안에 대한 제언 연구 [Analysis of North Korea's Space Threat Development Status and Proposal for Countermeasures by the Korean Army]. *The Korean Journal of Defence Analysis,* 37(1), 105–137. Online: http://dx.doi.org/10.22883/jdps.2021.37.1.004

Statistics Times (2021): *GDP (Nominal) Ranking.* Online: https://statisticstimes.com/economy/projected-world-gdp-ranking.php

Wikipedia (2022): *South Korea Ballistic Missile Range Guidelines.* Online: https://en.wikipedia.org/wiki/South_Korea_Ballistic_Missile_Range_Guidelines

Xinhuanet (2020): 中유인우주선 선저우15호, 우주정거장 결합체와 신속 자동 도킹 완료 [China's Human-Crewed Spacecraft Shenzhou-15 Completed Rapid Automatic Docking with the Space Station Assembly]. *Xinhuanet,* 30 November 2022. Online: https://kr.news.cn/20221130/48dfadd6ef1c4c45be87c22dab9995ee/c.html

András Edl[1]

Stealth Satellites, Trust and Deterrence

Introduction

The New Space age is characterised by an increased number of spacecraft and satellites placed in orbit by old and new space actors. This traffic is hard to manage on its own and is made more difficult by the growing space junk problem. In addition, the changing geopolitical landscape and the rising tensions between the United States, China and Russia make the space environment more competitive and a possible domain for conflict. New, emerging space-faring middle powers like Iran, Brazil, India, Japan and a multitude of small countries also add variables to the already complex space environment, not to mention multinational corporations and startups with disrupting technologies and innovations.

Space Situational Awareness

To solve the issues arising from such a complex environment and the activities conducted within new regulations and real-time knowledge of objects and activities would be required. Thus, Space Situational Awareness would be a key factor in solving the space junk problem and other security issues. To be able to determine what happens and why allows stakeholders to take a responsible and accurate course of action. Due to this reason, every country or company active in space relies heavily on these capabilities and the most important actors in space allocate considerable funding to SSA development. Some of the obtained data is shared worldwide because it is in the best interest of all parties to be able to avoid accidents. At the same time, anything which can damage or limit the opponent's SSA systems can guarantee significant advantages in a conflict. On the other hand, these kinds of weapons might come with a heavy price because

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they will increase the chance of accidents, could produce additional debris, and further damage the relations between the two sides. Because the chance of damaging their own space infrastructure is also present an initial attack could result in a Pyrrhic victory.

There is also a trend of satellites taking part in SSA observation. These in-orbit satellites would have major advantages compared to Earth-based radars. They are closer to the observed objects; therefore, the resolution might be better. The usage of optical sensors would not be obstructed by clouds or night time, and satellites could also function above areas where there is no land-based observation facility, like the middle of the Pacific Ocean. And finally, space-based sensors could detect or use wavelengths which do not penetrate Earth's atmosphere.[2] There are already satellites even in higher orbits, to provide more accurate data about the space environment. Since 2014, the U.S. Space Force operates the Geosynchronous Space Situational Awareness Program (GSSAP) with at least four satellites close to the valuable geosynchronous orbit. The satellites' capabilities are classified but they can approach objects in these orbits and carry out enhanced surveillance.[3] There is also the intention to attach cheap additional sensors to satellites which otherwise would not offer SSA services. These hosted payloads can be attached even to foreign satellites, as happened to the Japanese region-specific navigation system the Quasi-Zenith Satellite System (QZSS).[4]

Deterrence, transparency and trust

Due to the possible long-term damages, strategists think about how to avoid serious damage to their assets, while also limiting events which could even threaten space as an environment important to the whole of humanity. The strategy of deterrence – ideally combined with other elements – seems to be one of the viable routes to avoid conflicts in space or the terrestrial realm. The Western interpretation of deterrence has two main methods: deterrence by denial and deterrence by punishment. The first is based on the idea that the enemy will not succeed with their attack. The second aims to deter with the promise of

2 Eves 2022.
3 Air Force Space Command 2017.
4 Hitchens 2022.

retaliation, after the attack. Even when the initial attack might be successful, the cost will be much higher than the benefits of it. Russian and Chinese deterrence concepts have different approaches, they also include coercion and put a bigger emphasis on deception.[5]

Regardless if coercion is involved or not, it is important to note that any of these approaches are rooted in human psychology and the key component is the image created in the enemy decision-makers' minds. For deterrence strategy to work, the enemy requires knowledge about the adversaries' capabilities. Therefore, apart from having the means to execute an effective retaliation or defend against an incoming attack, deterrence also requires credibility and communication. This is the only way current (and to some degree future) adversaries might be deterred before they commence their attack. The potential rival therefore must know to some degree what capabilities the opposing party has, otherwise they would not fear the consequences or the failure of an attack.

Earth observation and SSA both help to evaluate the adversaries' possible intentions and true capabilities. Of course, all countries try to hide or obscure some of their equipment and deceive their rivals, but they can also count on observation and a lot of information will be available for their adversaries. This is good news when the actual potential of one's military power is enough to deter the enemy.

An additional benefit arising from accurate Earth observation and SSA could be a higher degree of transparency. Other countries will simply see what is going on in their region or even globally. It makes building up military forces secretly on a mass scale nearly impossible. Likewise, infrastructure developments can be spotted from space and this alone is sometimes enough to verify if the other country keeps their end of the deal in case of a disarmament agreement. Seeing what the opposing side is up to makes it easier to build trust between nations because there is a reduced chance of unpleasant surprises. The underlying psychological foundations are the same when meeting an unknown, possibly hostile person and seeing what is in their hand or what they are looking at because both can be a basis to deduct intentions. In conclusion, transparency and trust building are one of the most important tools in conflict prevention.

[5] Edl 2022: 256–269.

Stealth Satellites 1.0

Despite the advantages mentioned above, there is a strong incentive to hide one's capabilities or mislead the enemy because, during an actual conflict, this might secure a victory. The concept of stealth satellites, therefore, is a logical extension of the stealth and deception techniques applied on Earth. In the early stages of the Cold War, the United States already experimented with these kinds of satellites which were supposed to be undetectable to the Soviet Union's SSA forces. There is information about a program which started in the 1960s and after spending 10 billion USD the program supposedly produced two stealth satellites launched in the 1990s. These highly classified orbital platforms, under the code name "MISTY", were launched in 1990 and 1999.[6] The special design and surface of the satellites were able to decrease the chances of detection and identification. In so doing the potential enemy could not target these assets with ASAT weapons, unlike regular satellites which can be easily tracked and targeted. Neither could the rivals predict when they would fly over a certain area and use this information to hide and conceal their movements during that time.

In theory, the program was shut down after a few test satellites. Meanwhile, various concepts emerged about how to build such a potent spacecraft. One idea involves a special outer hull for the satellite, clad or painted with dark, special radar-absorbent material. Another idea would deploy mesh screens to interfere with radar returns. The third idea had inflatable materials at its core, these devices could inflate and hide the satellites behind them until they had to photograph something important.[7] The technology for such inflatable components and machines developed significantly since the 1990s. One such module is currently part of the International Space Station (ISS). With the expertise and sufficient dedication, the building of such a satellite would be even easier today.

In addition, due to strategic advantages, great powers tried to conceal and disguise some of their activities as something else. However, a rocket launch is a highly visible action, observed by all major powers with surveillance capabilities. Therefore, they cannot hide the launch itself, but disguise some parts of the payload as something else for example a piece of space junk. Both the

6 David 2005.

7 National Reconnaissance Office 2016.

United States and Russia claimed to have identified satellites.[8] After years of observation, the seemingly inactive objects started to change orbit or perform another type of action. A similar technique is also possible: launch a satellite and place a decoy object in its likely orbit, so the competitors follow that object, while the real satellite moves away in secrecy. This is a normal competition between deception and detection, highly reliant on technical capabilities.

Another similar method would be to claim that the payload of an otherwise successful launch got damaged or destroyed. Certain rumours appeared surrounding a launch performed by SpaceX in early 2018. The payload was manufactured by Northrop Grumman, one of the top producers of arms and military equipment for the Pentagon. All concerned parties were extremely secretive about the payload called "Zuma". The operators of Zuma, its purpose, or what happened exactly during the launch are still unknown. After the launch, news started to spread that there was something wrong with the launch and the payload got destroyed. SpaceX denied any such problems and claimed the rocket worked perfectly, but they – just like the Pentagon or Northrop Grumman – refused to give any information about the payload. The explanation was given that there was some problem with the payload and could not separate from the second stage but this was not confirmed.[9] CelesTrek raw satellite data still has Zuma on its list (COSPAR ID 2018-001A) but with no details about the satellite's orbit, which is not unusual for classified projects.[10]

Private corporations

A serious counterargument against the deployment of disguised or stealth spacecraft and devices would be the ever-growing civilian space sector. SSA services are provided by companies like LeoLabs which focuses on the LEO region. The company keeps improving its radar network, and it had six operational tracking stations in 2023 March, which are spread across the globe. Two of them are in the Southern hemisphere, giving a company an advantage in a geographical area – and the skies above – where the lack of dry land makes it more difficult to position tracking stations. In addition, LeoLabs will work together with

[8] Pappalardo 2018.
[9] Rogovay–Trevithick 2018.
[10] CelesTrak 2023.

the U.S. Department of Commerce to establish a new civil-led Space Traffic Management (STM) system. The company also secured a deal with the Japanese Air Self-Defence Force and will support Japan's SSA capabilities.[11]

Other private companies provide high-resolution Earth observation images or various valuable data. They offer their services to governments (theoretically they could sell the same data to multiple interested parties), their coverage is already good and it will only improve with mega-constellations or further developments. This cooperation and interconnection between governments and the private sector could also offer the opportunity to hide a government satellite in a constellation or a few extra sensors on privately owned spacecraft.

One rapidly expanding subsector of private observation services is the SAR (Synthetic Aperture Radar) industry. The technology was originally a highly classified military tech. Initially, these radar devices were installed on the board of aeroplanes, like the SR-71 Blackbird, the first stealth aircraft. SeaSat, the first civilian SAR satellite entered orbit in 1978, but for a while, it was a lone example of its kind. At the same time, military SAR satellites were already numerous. In our present days, SAR technology is widely accessible and multiple private companies sell these kinds of images. The undeniable advantages are that clouds, fog, haze, smoke, or night time do not affect the picture quality, which is not the case with optical satellites.[12]

Startups are also numerous in the multispectral Earth observation domain. Orbital Sidekick Inc. (OSK), intends to deploy 6 identical satellites in 2023 to provide commercially available images. The small constellation is named GHOSt for Global Hyperspectral Observation Satellite. The hyperspectral imagery sensors will capture waves in the visible and the short-wave infrared region. The satellites will be around 100 kg of weight each and a SpaceX Falcon 9 rocket will carry the payloads into space. The company intends to sell the images to civilian and military customers. The design will make it especially effective to aid national defence, infrastructure monitoring, environmental and agriculture monitoring.[13]

[11] LeoLabs 2022.
[12] Scoles 2022.
[13] eoPortal 2022.

Stealth Satellites 2.0

Even considering the above-mentioned changes in Earth observation and SSA, it seems that there is a resurgence in stealth satellite research. Chinese scientists and decision-makers find the development of such capabilities important. According to Chinese news outlets a research team in Nanjing, led by Kong Xiangku has developed a special coating suitable for the space environment which will reduce the reflected radar signals' strength by 80%. They also claim that the team could fully coat a satellite in a honeycomb pattern, with special composite materials, which would make detection by radar nearly impossible. Maintenance of these satellites cannot be carried out like for stealth aircraft on Earth, so the coating and the frame must endure repeated spikes in temperature and cosmic radiation. It cannot be too heavy either, so the research team had to use lightweight materials, like paper or plastic to construct the coating, which they theoretically managed to keep under 3 mm thickness and a maximum weight of under 6 kg per square meter. Other solutions were proposed as well, like hiding the satellite behind a piece of space junk, and painting it with a special black layer so it blends into the space background. One patented Chinese design proposes a "transformer" satellite. This would orbit Earth as a small, compact object, and only unfold solar arrays, antennas, etc. and get active when needed. Until that times come, the compact form has a 300 times reduced radar signature.[14] Needless to say, similar research efforts are on the way in other countries as well. Some of them are far less secretive about their results. There are even advances in making composite materials not only able to absorb microwaves or radar waves but as it is very useful in space, radiation shielding was also improved.[15]

Yet another Chinese research team seems to be making progress in manufacturing a flexible material which can hide objects from radar satellites. Assuming the reports are true, this layer on its own will not be sufficient to disguise a spacecraft. But combined with other layers and methods, even satellites could be made highly resistant to multiple detection methods.[16]

One of the promising fields of new research is quantum technology. The four main areas of research are quantum computing, imaging, communication

[14] EverythingRF Editorial Team 2021.
[15] Cha et al. 2022.
[16] Tiwari 2022.

and sensors. The area of sensors seems to be the most advanced and closest to military applications. There are already examples of cooperation between research institutions and arms manufacturers, like the one between BAE Systems and a technology hub led by the University of Birmingham. As a first step maybe no fundamentally new technologies will emerge, but quantum capabilities can enhance existing methods. These sensors can measure gravitational forces, electric or magnetic fields, temperature and also time. A radar boosted with quantum tech could detect smaller objects and maybe even stealth aircraft.[17] So-called ghost imaging is also in the experimental phase. China and the U.S. both conducted tests and they aim to use the technology in satellites as well, especially to detect stealth aircraft. This technology would analyse the tiniest changes in light reflection so even current camouflage or high-tech coating would be obsolete.[18] One other possible application could be the combination of gravity gradiometers and quantum clocks – in case miniaturisation and cost-effectiveness reaches a certain level – this might allow engineers to design equipment that can detect the mass of objects, thus identifying unusual variations for a specific surrounding. The devices could be installed on satellites as well, but this technology still has to mature and has a long way to go.[19]

The research in this field and the deployment of such satellites could seriously damage trust building, lead to a new kind of armament race and have a double effect on deterrence. It might increase and decrease the effectiveness of deterrence at the same time. The problem cannot be solved by states alone or with more R&D investments in SSA, but the international community must participate in this endeavour as well.

Parallel paths in research

Predicting the future with 100% certainty is of course impossible. However, a few possible trends or challenges to overcome might be assumed. The reappearance of stealth satellites, and the dire need for sophisticated sensors in Earth observation and space situational awareness (including space junk detection), will encourage companies and research institutions to further experiment with new technologies,

[17] Neumann 2021.
[18] Griffin 2018.
[19] Kubiak 2020: 7–8.

besides the ones mentioned above. The space landscape will be increasingly complex and stealth and detection will interact and fuse with other types of space activity or devices.

Launches, payloads and the resulting (seemingly) space junk can and will be observed from more angles and with different types of sensors, including the help of private corporations. In-orbit servicing will not only make it possible to extend the lifespan of satellites but to update and modernise sensors or attach no equipment to already deployed high-capability spacecraft. The dual use of co-orbital manoeuvres and the capability to grab or dock with other satellites will also result in the unavoidable parallel development of hunter-interceptor satellite capabilities. These might approach to grab enemy satellites to force them to enter Earth's atmosphere. Jamming or damaging targets in other ways can be more effective from close proximity as well. Russia and China experimented with such co-orbital manoeuvres since the late 2010s.[20] Although reported less frequently, the U.S. does follow suit with their systems.

These tests in return gave rise to the concept of bodyguard satellites. The core idea is to deploy multiple smaller spacecraft to examine and neutralise any possible threats to the central satellite. The applied countermeasures could be to simply push away any hazardous spacecraft or space junk, although this would be time and propellant-consuming. Onboard lasers, jamming or spoofing are also an option. Using kinetic ammunition to destroy them would create a dangerous debris cloud, therefore this method is not recommended.[21] However, applying stealth technology to the interceptor satellites would yet again make the protection of the most valuable space assets increasingly difficult, therefore installing better, mostly short-range sensors to the bodyguard system and using them combined with the more capable detection networks is plausible.

Conclusion

Taking into consideration the latest events and reports it is clear that there is a renewed interest in the development of stealth satellites. The need to avoid detection not only is a natural reaction to the more sophisticated and wide-spread surveillance networks, but also a fail-safe mechanism to still have some

[20] Sankaran 2022; Weeden 2022.

[21] Mowthorpe 2022.

orbital capabilities left if the more visible and prominent systems are seriously obstructed or damaged. Possibly, a small number of stealth satellites – especially with more potent SSA systems, supported by private service providers – might not disrupt the balance of power and would not seriously damage transparency and trust between adversaries. It might even improve it a little because the rivals could count on being observed by undetectable spacecraft as well. But the advancement and proliferation of stealth technology can destabilise the current space architecture and encourage space powers to engage in a new round of arms race. Widely accepted international agreements could slow down or even stop this type of rivalry in space, but based on current trends the banning of stealth tech research is not likely. Strategic planners therefore must think ahead and incorporate the growing threat of such satellites into different levels of guidelines, protocols, action plans, etc. New and more capable SSA systems could limit the spread of such spacecraft, which would be preferable to keep transparency and trust between potential rivals and to keep deterrence as an effective tool of conflict avoidance in space.

References

Air Force Space Command (2017): *Geosynchronous Space Situational Awareness Program.* Online: https://www.afspc.af.mil/About-Us/Fact-Sheets/Article/730802/geosynchronous-space-situational-awareness-program/

CelesTrak (2023): *Satcat.* Online: https://celestrak.org/pub/satcat.txt

Cha, Ji-Hun – Jang, Woo-Hyeok – Noh, Jung-Eon – Choi, Won-Ho – Kim, Chun-Gon (2022): A Space Stealth and Cosmic Radiation Shielding Composite: Polydopamine-Coating and Multi-Walled Carbon Nanotube Grafting onto an Ultra-High-Molecular-Weight Polyethylene/Hydrogen-Rich Benzoxazine Composite. *Composites Science and Technology,* 230(1). Online: https://doi.org/10.1016/j.compscitech.2022.109711

David, Leonard (2005): *Anatomy of a Spy Satellite.* Online: https://www.space.com/637-anatomy-spy-satellite.html

Edl, András (2022): Deterrence in Space. *Hadtudomány,* 32(1), 256–269. Online: https://doi.org/10.17047/Hadtud.2022.32.E.256

eoPortal (2022): *GHOSt (Global Hyperspectral Observation Satellite).* Online: https://www.eoportal.org/satellite-missions/ghost#overview

EverythingRF Editorial Team (2021): *Chinese Researchers Develop Stealth Technology for Small Satellites.* Online: https://www.everythingrf.com/news/details/12890-chinese-researchers-develop-stealth-technology-for-small-satellites

Eves, Stuart (2022): *Reasons to Conduct SSA from Orbit.* Online: https://gnosisnetwork.org/blog/reasons-to-conduct-ssa-from-orbit/

Griffin, Matthew (2018): China's New "Ghost Imaging" Satellites Will Make US Stealth Obsolete. Online: https://www.311institute.com/chinas-new-ghost-imaging-satellites-will-make-us-stealth-obsolete/

Hitchens, Teresa (2022): *Space Force Plans Multiple Hosted Payloads for GEO Belt Monitoring.* Online: https://breakingdefense.com/2022/01/space-force-plans-multiple-hosted-payloads-for-geo-belt-monitoring/

Kubiak, Katarzyna (2020): *Quantum Technology and Submarine Near-Invulnerability.* London: European Leadership Network. Online: https://www.europeanleadershipnetwork.org/wp-content/uploads/2020/12/Quantum-report.pdf

LeoLabs (2022): *Newsroom – Press.* Online: https://leolabs.space/newsroom/?np=3

Mowthorpe, Matthew (2022): The Russian Space Threat and a Defense Against It with Guardian Satellites. *The Space Review,* 13 June 2022. Online: https://www.thespacereview.com/article/4401/1

National Reconnaissance Office (2016): *Stealth Satellite Sourcebook.* Online: https://spp.fas.org/military/program/track/stealth.pdf

Neumann, Norbert (2021): *Will Quantum Transform Defence Capabilities? Yes and No.* Online: https://www.army-technology.com/analysis/quantum-defence-computer-sensing-nato-china-us-uk-eu-submarines-radar-bae-systems/

Pappalardo, Joe (2018): *Space Junk Could Provide a Perfect Hiding Spot for Tiny Spy Satellites.* Online: https://www.popularmechanics.com/military/research/a25349950/nro-satellite-space-junk/

Rogovay, Tyler – Trevithick, Joseph (2018): *The Secret Zuma Spacecraft Could Be Alive and Well Doing Exactly What It Was Intended to.* Online: https://www.thedrive.com/the-war-zone/17612/the-secret-zuma-spacecraft-could-be-alive-and-well-doing-exactly-what-it-was-intended-to

Sankaran, Jaganath (2022): *Russia's Anti-Satellite Weapons: An Asymmetric Response to U.S. Aerospace.* Online: https://www.armscontrol.org/act/2022-03/features/russias-anti-satellite-weapons-asymmetric-response-us-aerospace-superiority

Scoles, Sarah (2022): *Spies' Night Eyes: Once-Restricted Tech Is Helping to Spot Russian Troops, Chinese Missile Sites and Raging Wildfires.* Online: https://www.grid.news/story/science/2022/05/23/spies-night-eyes-once-secret-tech-is-helping-spot-russian-troops-chinese-missiles-and-raging-wildfires/

Tiwari, Sakshi (2022): Invisible to Radars, China Claim Development of 'Stealth Tech' that Can Conceal Its Tanks & Military Infra on the Ground. *The EurAsian Times,* 15 April 2022. Online: https://www.eurasiantimes.com/china-claim-development-of-stealth-tech-that-can-conceal-its-tanks/

Weeden, Brian (2022): *Russian Co-orbital Anti-satellite Testing.* Online: https://swfound.org/media/207373/swf-russia-co-orbital-asat-may-2022.pdf

What is the future of the International Space Station? What are stealth satellites and how do they influence trust and deterrence? How is international space law developing? How can we use space in a sustainable way and how can we measure the progress? How are East Asian nations developing their space capabilities? How can we regulate economic and military activity in space? These are all relevant questions in the new space age, when many possibilities open for humankind but also lots of trials and challenges await us. The young professionals presenting a part of their work in this conference paper wish to contribute to the discussion about space, each in their respective field. The papers compiled do not intend to give a definitive, rigid answer instead they are about raising questions, offering new perspectives and starting a discussion with laypersons and professionals alike. We encourage the reader to engage with the texts, investigate and most importantly: ask their own questions.