International Society of Philosophy and Cosmology
Scientific Institute of Public Law

Advanced Space Law

Volume 14

Kyiv, 2024

Advanced Space Law, Volume 14, 2024
Academic Journal
ISSN 2663-3663 (Online); ISSN 2663-3655 (Print)
The State Registration Certificate of the print media KB No 23886-13726P, May 11, 2019
http://asljournal.org
E-mail: info@asljournal.org

Printed according to the resolution of the Scientific Board of the International Society of Philosophy and Cosmology (Minutes of meeting No 52, December 26, 2024)

Printed according to the resolution of Scientific Board of Scientific Institute of Public Law (Minutes of meeting No 20, December 26, 2024)

The Journal is indexed and abstracted:
Central and Eastern European Online Library (CEEOL);
Directory of Open Access Journals (DOAJ); ERIH PLUS; Index Copernicus;
Ulrich's Periodicals Directory; Vernadsky National Library of Ukraine
The Journal included in the List of Scientific Professional Publications of Ukraine, Category "B." Decision of the Ministry of Education and Science of Ukraine, April 15, 2021.

International Society of Philosophy and Cosmology:
http://www.bazaluk.com/
Scientific Institute of Public Law
http://sipl.com.ua/

Table of Contents

The Enforcement of Law and Policy on STM with the Emergence of Advanced Technologies

Elham Farahani

Ph.D. in Law School of Law, Beijing Institute of Technology (Beijing, China)
E-mail: elham@bit.edu.cn
https://orcid.org/0009-0000-5717-5387

Shouping Li

School of Law, Beijing Institute of Technology (Beijing, China)
E-mail: lishouping@bit.edu.cn

Farahani, Elham, and Shouping Li (2024) The Enforcement of Law and Policy on STM with the Emergence of Advanced Technologies. *Advanced Space Law*, Volume 14, 4-14. https://doi.org/10.29202/asl/14/1

Space Traffic Management (STM) using advanced technologies is effective for the safety and sustainability of outer space by improving Space Situational Awareness (SSA), data sharing information system, collision avoidance, and space debris mitigation methods. Nevertheless, developing an effective STM using advanced technologies without considering an effective legal and regulatory framework can pose some difficulties in terms of monitoring and enforcement. This paper presents the relevance of innovative advanced technologies and STM, focusing on the enforcement of law and policy. It highlights an urgent need to update the legal framework to ensure their practicality amidst the widespread use of advanced technologies in space activities. It also examines the fact that the utilization of advanced technologies in the environment of outer space presents both opportunities and challenges, especially with the emergence of Artificial Intelligence (AI) and Machine Learning (ML). Although revising all regulations is anticipated to be a challenging and time-consuming process, it can be implemented through communication and cooperation between spacefaring countries, private space operators, and other relevant entities at the national and international levels, as well as permanent monitoring and evaluation of all technologies to ensure that they are used in a manner that is consistent with established laws and policies.

Keywords: Space Traffic Management, Space Law and Policy, advanced technologies, Space Safety and Security, Space Situational Awareness.

Received: 07 September 2024 / Accepted: 28 September 2024 / Published: 30 December 2024

Introduction

Recent developments in space activities, especially in the private sector, and the huge amount of space debris in outer space without any significant achievements in space debris control necessitate the implementation of an international STM regime. According to the current space law regime, there is no international consensus on the definition and scope of STM. In general, STM includes technical and regulatory provisions to promote safe access into outer space, operations in outer space, and re-entry from outer space to Earth, free from physical or radio-frequency interference, as stated in the International Academy of Astronautics (IAA) report (Contant-Jorgenson et al., 2006). However, it is not a proper definition for STM, and it consists of its objectives rather than the concept of STM (Yang, 2019). The objective of STM to provide safety, stability, and sustainability of space activities is consistent with the principles of space law, which include international cooperation and peaceful purposes. It is a vital necessity in space law to establish an international STM regime that involves appropriate technical capacity and effective regulatory arrangements at both domestic and international levels. The enforcement of law and policy on STM is crucial to ensuring the management of risks. However, the emergence of advanced technologies is completely evolving the scope of space operations (Yang, 2019).

At the same time, many spacecrafts are launched into different orbits around the Earth with various missions, such as commercial, defense, scientific, and educational. Ensuring the safety of all space missions and the long-term sustainability of space exploration is a crucial necessity. All of the risks and threats in the environment of outer space must be taken into consideration, and the legal framework should consider all kinds of space missions (Marty et al., 2023). As mentioned above, according to the Cosmic Study on STM published in 2006 by the IAA study group, STM is defined as the collection of technical and regulatory measures that support the safety of space missions (Contant-Jorgenson et al., 2006). This definition encompasses a broad variety of the procedures involved in launching, tracking, controlling, supervising, and re-entering all kinds of spacecrafts with any purpose. Additionally, STM's primary objective is to ensure the sustainability and safety of space operations by reducing the possibility of spacecraft collisions and reducing the amount of space debris. It includes ensuring concerns regarding the application of law and policy with developing advanced technologies in the space environment. Even though advanced technologies offer incredible prospects for space traffic control, they cause new difficulties for space legislation. For example, there are issues with the existing laws governing liability issues in the event that highly intelligent computers cause harm (Martin & Freeland, 2021). Therefore, the regulations have not kept up with technological advancements in outer space, and there is a lack of a coherent legal system. The rules have not been able to keep pace with technology, and today there are shortcomings in the legal environment (Schrogl, 2008).

This paper highlights the legal regulatory framework of STM that must keep pace with advanced technologies, especially with the increase of commercial companies, mega-constellations of small satellites, and space tourism in the future. The primary contribution and difference of this work includes addressing the challenges and opportunities of advanced technologies in outer space.

The use of advanced technologies in STM

NewSpace advanced technologies provide effective opportunities to enhance STM's capabilities while also creating new challenges. The Regulatory Horizons Council (RHC) has identified key technologies, which are the fundamental building blocks for current and future space capabilities, including AI and ML, novel materials and nanotechnology, software and automation, quantum technologies, and robotics. For instance, the opportunities of AI and ML include analysis of large, complex data sets, real-time and predictive spatial awareness, and enhanced decision-making, whereas their challenges include biased or partial training data, "black box" decision-making, lack of trust or public concern, cybersecurity, standards for interoperability, and liability issues (Report, 2024).

Therefore, with the emergence of NewSpace, the number of private space companies using advanced technologies has increased (Heinrich et al., 2022). It includes large LEO constellations and small satellites like cube satellites, which will radically change space operations and, combined with new sensor systems, necessitate changes in the way STM is conducted. For instance, there are multiple constellations, each with thousands of satellites, being proposed to provide global broadband Internet services (Peterson et al., 2018).

The opportunities of advanced technologies

To control space traffic and ensure the sustainability and safety of space operations, many innovative technologies are under development. Despite the lack of precise data on their quantity, research indicates that most technological innovations remain unimplemented. But based on the available information, less than ten percent of patent applications are filed worldwide. Actually, the vast majority of novel technologies in the twenty-first century remain unpatented (Krichevsky, 2018). We are currently experiencing the greatest shift in the space environment since activities in outer space first began. Globally, commercial opportunities in the space area are providing innovation among a large number of multitude actors across a spectrum of markets that include new satellite platforms and launch services, data gathering, analysis, and transmission for information services (Hayden et al., 2020).

Firstly, modern space communication systems use sophisticated software to enable different stages of space missions. With the emergence of AI and ML, satellites can seamlessly manage these systems, making decisions in real-time without waiting for instructions. Drawing on AI, cognitive technologies are being developed to enhance the efficiency and sustainability of communication networks for space missions. In space, one of the issues that a cognitive radio can manage is interference from solar and astronomical electromagnetic radiation. Cognitive radio applications use ML to either transmit beyond the interference range or correct distortions within it. AI has allowed rovers and orbiting devices to gather and evaluate scientific data automatically, deciding which information to communicate to Earth without human intervention, whereas previously they managed onboard systems like power usage (Soroka & Kurkova, 2018).

Secondly, space traffic control uses technologies including AI, to monitor and direct spacecraft movement in orbit through Space Surveillance and Tracking (SST) and SSA. In this field, mitigating space debris in outer space is gaining significant boosts (Muelhaupt et al., 2019). The space industry needs uninterrupted access to reliable, actionable information to adequately address space traffic. Innovations in technology could help collect reliable information through revolutions in the space industry. The aim of the advanced technologies used in SST and SSA

is to identify objects in space and determine their position, their necessary features, and their motion in orbit, with a specific interest in the motion relative to other objects for sustainability and security reasons. Globally, both institutional and private entities are deploying or planning SST systems, including radars and telescopes. This trend will result in a more comprehensive knowledge of the orbital population. Currently, numerous databases have been developed using data gathered from various sources worldwide. It could be useful to merge and share measurements from these databases. Although there are many issues related to the protection of some data, specifically issues related to military systems (Bonnal et al., 2020). SSA entails the constant tracking of satellites and debris in orbit using ground-based radar and optical stations to forecast the orbital trajectory of debris (Sheer et al., 2023). Therefore, satellite operators can prevent potential collisions with space debris by positioning their operational spacecraft away from their intended debris orbits (Pelton, 2019). Ground-based sensors are indispensable for achieving effective SSA and STM. Accurate orbital parameters, technical status, and knowledge of the attitude of cooperative and non-cooperative Resident Space Objects (RSOs) are crucial under normal or contingency operations. Particularly for Active Debris Removal (ADR) missions, targeted studies of candidate objects are vital (Shan et al., 2016). ADR and On-Orbit Servicing (OOS) missions require a high level of preparedness, incorporating high-quality and actionable information on target objects from the planning phase onward. This information includes particular knowledge of the target's shape, size, etc. (Karamanavis et al., 2023).

Thirdly, automated collision avoidance systems use innovative algorithms and ML to predict potential collisions between objects in space and take the necessary actions to avoid them. Similar to air traffic control, STM is keeping an eye on and guiding the movement of spacecrafts in orbits in order to avoid collisions. Advanced algorithms and ML are used in automated collision avoidance systems to predict potential collisions and take the necessary actions to avoid them.

Fourthly, the current methods for describing avoidance manoeuvres and recognizing collision probabilities in outer space mainly rely on human procedures, which means that they depend on human experts to analyse the optimal manoeuvre for collision avoidance as well as to determine if an occurrence is a high or low risk. Existing methods face issues such as insufficient data and a lack of scalability. Additionally, a multitude of false alarms and ambiguity indicate that the optimization of data processing methods remains incomplete. At the same time, every space operator needs to have access to performable information about RSO and their relative movement, as well as performable information regarding the environmental conditions in space in a more general sense. So, current methods for satellite operators are non-scalable and require a lot of time. Operator effort is required to handle an exponential growth in the number of space objects, including debris and active satellites. This increases the possibility of human error and incorrect classification, which makes operations more expensive. Furthermore, it is more difficult for insurance providers to appropriately handle the risk faced by operators due to the complexity and lack of certainty around the risk exposure assessment. Advanced technologies provide reliable, practical data and an assurance of uninterrupted information to effectively tackle STM. As the space industry develops, the adoption of these advanced technologies for STM and space activities towards autonomy will be significant to ensure space sustainability and limit the number of risks to space assets (Manfletti et al., 2023).

Fifthly, following the theme of the protection of the Earth, climate change is an important challenge to our environment with potentially catastrophic consequences and is an area where satellite technologies can support tackling the threat (Bru¨nner et al, 2018). Satellites provide impartial information to monitor the environment and develop and validate models, improving our predictive capabilities. However, greater effort has to be placed in producing actionable information related to specific needs and issues, reducing the vast amount of data to simpler interpretations that can inform the political discourse (Aglietti, 2020).

Finally, researchers are developing Space Debris Removal (SDR) technologies, such as harpoons, nets, and robotic arms, to capture and remove debris from orbit, thereby mitigating the amount of space debris and the risk of collisions. Therefore, advanced technologies, such as AI and ML algorithms, enhance the quality and speed of each stage and procedure of space activities and decisions, making them the most important samples in the space industry.

The challenges of advanced technologies

On the one hand, advanced technologies can greatly improve STM efficiency, providing significant opportunities in outer space. On the other hand, if they are not used properly, they raise significant privacy and legal concerns. To realize the sustainable and equitable benefits of these technologies, space exploration and communication require careful consideration and collaborative approaches. Specifically, the increasing launches of private companies like SpaceX's Starlink, Amazon's Project Kuiper, and OneWeb, the growth of LEO mega constellation satellites, and future space tourism pose the most critical challenges to outer space.

Firstly, without a proper regulatory framework in place, there is a risk of misuse of advanced technologies by the widespread operation of satellites, particularly by private operators, potentially leading to a more congested outer space environment, collisions of space assets, and the growth of space debris. With so many satellites communicating wirelessly, coordinating Radio Frequencies Interferences (RFI) becomes more complex, requiring international cooperation. The issue of the overcrowded radio-frequency spectrum, as well as the sustainability of the space environment, which is threatened by the growing amount of space debris, have to be tackled.

Secondly, there are challenges with data protection. Technologies like AI require large volumes of data, but weakly drafted laws and regulations can prevent useful access without mitigating the risk of AI activities (Oche et al., 2021). In January 2020, the United States imposed immediate interim export controls regulating the dissemination of AI technology software that possesses the ability to automatically scan aerial images to recognize anomalies or identify objects of interest, such as vehicles, houses, and other structures (Carlin et al., 2020). Also, the use of AI in satellite imagery raises concerns about losing control over one's private information and causes privacy and legal issues (Finn et al., 2013).

Thirdly, cyber-attacks on critical infrastructure could disrupt satellite operations, compromise communication systems, or even endanger the safety of astronauts on board spacecraft. Hackers could potentially control satellites or manipulate data, leading to serious consequences for space traffic. Advanced technologies, such as drones and autonomous robots, can be misused for harmful purposes, including surveillance and weaponization.

Fourthly, advanced technologies have the potential to automate many aspects of STM, reducing the need for human intervention. However, this chance provides reliable, practical

data and an assurance of uninterrupted information to effectively tackle STM, it can also lead to a lack of human oversight and decision-making, which is essential for addressing unforeseen challenges or emergencies in space. The use of space technologies capable of functioning completely without human intervention could result in unpredictable outcomes, which pose fundamental issues for the international community (Abashidze et al., 2023).

Finally, there are challenges to the liability of intelligent space objects. Existing liability regulations in space law treaties are not adequate to address the future role of AI in space activities. In addition to the liability issues, the current international treaties that regulate the activities of States in the environment of outer space aren't sufficient for issues arising from the potential use of advanced technologies.

The current legal framework of STM

Since the space age began, approximately 16990 satellites have been sent into orbit, with roughly 11500 still in orbit as of December 2023 (Space, 2024). The significant increase in space activities necessitates the development of the best rules and regulations for an international STM legal framework. So far, there is no established international legal system for STM. There are still many debates between countries on whether STM is an international issue or an internal one to manage.

Considering the hard law, the Treaty on the Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, or the Outer Space Treaty (OST) provides the basic framework for international space law. Article I of the OST stipulates that the outer space shall be free for exploration and use by all States without discrimination of any kind, on the basis of equality and in accordance with international law, and there shall be free access to all areas of celestial bodies. Article II of the OST stipulates that outer space is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means. Except for the prohibitions on nuclear weapons tests in space and the prohibition on the placement of nuclear weapons or other weapons of mass destruction in space, which have been mentioned in Article IV, there aren't any international, legally binding treaties or agreements that restrict the freedom of countries action in outer space. It is also stipulated in Article III that States Parties to the Treaty shall carry on activities in the interest of maintaining international peace and security and promoting international cooperation and understanding. The Convention on International Liability for Damage Caused by Space Objects, or the Liability Convention, provides in Article II that launching States shall be absolutely liable to pay compensation for damage caused by their space objects on the surface of the Earth or to aircraft in flight. The Convention on Registration of Objects Launched into Outer Space, or the Registration Convention, also provides in Article II that the launching State shall register the space object by means of an entry in an appropriate registry, which it shall maintain. Each launching State shall inform the Secretary-General of the United Nations of the establishment of such a registry.

While the basic principles outlined in these treaties align with the establishment of a Space Traffic Management (STM) regime, there is currently no legally binding international treaty regime in place to exclusively address space traffic rules (Gleason, 2020). There are only international initiatives aimed at establishing voluntary standards or guidelines to enhance the sustainability and safety of space operations as soft law. There are some soft laws, like the Long-Term Sustainability of Outer Space Guidelines (LTS) by the United Nations Committee

on the Peaceful Uses of Outer Space (UNCOPUOS), that could strengthen STM as the most important issue for the safety and security of space activities in outer space (Polkowska, 2021). Although there is no legal framework on how to calculate the chance of collisions and different probabilities of space risks (Li et al., 2022), there are a number of agreements (Spencer et al., 2024). Satellite operators implement bilateral agreements between themselves to decrease accidental collision risks (Nonreimbursable, 2021). Meanwhile, the European Cooperation for Space Safety Standards (ECSS) is also intended to organize clear standards for European space operations. The International Organization for Standardization (ISO) has also made many suggestions to improve safety in outer space by mitigating space debris and regulating space activities, even though ISO standards are not binding (Kaul, 2019).

Furthermore, many countries assume responsibility for their space operations by highlighting the importance of STM. For example, France believes that STM should remain the responsibility of States because it concerns their security (Marty et al., 2023). In this regard, national space policy documents exist for STM, such as the U.S. Space Policy Directive-3, the most significant national measure for STM regulation, and the European Union's joint communication.

Advanced space technologies and the need for the enforcement of an appropriate legal framework

Following the challenges of advanced technologies in outer space, there are many challenges with the enforcement of law and policy in this environment. If there is a threat of the rule of law being displaced by the rule of technology, the legal community needs to address these developments as an urgency (Brownsword & Yeung, 2008). Advanced technologies, including AI and ML, provide new services offered through applications of space data. They can be used to improve SSA and assist in more accurate tracking of space debris and other objects in orbit. This can help reduce the risk of collisions and improve safety for all spacecraft in orbit. However, malfunctioning or hacked automated collision avoidance systems could potentially lead to spacecraft collisions and increase space debris. Similarly, improper use of satellite servicing or debris removal technologies could unintentionally damage existing satellites or create new debris (Frey & Lemmens, 2017).

The increase of advanced technologies has led to the diversity and growth of space operations and, subsequently, the increase of space object break-ups, explosions, collisions, and other anomalous events resulting in fragmentation, rendering human activities that rely on space platforms precarious or even impossible (Kessler & Cour-Palais, 1978; Klinkrad, 2017; McKnight et al., 2021). At the same time, it could pose more futuristic legal complexities, including challenges with space tourism and liability issues. With the era of private space flights, it is becoming vital to have a common understanding of the current space legal systems through the applicability of the Liability Convention in handling damage that might occur during space tourism (Wang & Li, 2021). Based on Article III of the Liability Convention, fault liability is assumed to be the fault of a State or the fault of a person. Here is where we can identify the first challenge, identifying the liable entity when a decision is taken by an intelligent space object. Hence, challenging liability issues arise with the increased implementation of innovative space technologies. The growth of space tourism also requires a robust regulatory regime to ensure that companies comply with safety and operational standards. A clear licensing system needs to be developed to assess and approve commercial space operations. The rapid pace of

technological advancements in space tourism necessitates a flexible legal framework that can adapt to new innovations, such as reusable rockets and suborbital flights, while still ensuring safety and compliance with existing laws.

On the one hand, States should consider the development of a new international treaty, the amendment of existing treaties, or the adoption of an interpretative declaration, if at least temporarily, as an adequate measure to resolve relations arising from the use of advanced technologies in space activities. Space activity is defined as both activity in outer space and activity on Earth associated with outer space (Abashidze et al., 2022). It needs States to be pragmatic to work on a resolution to reflect the demands of all parties in a balanced manner, so they can achieve a clear understanding of the deficiencies of the old legal system in dealing with new threats and challenges and see the direction of rule interpretation and rule-making (Wang & Chen, 2023). This could be a possible solution for States to participate in cooperative efforts to access and use the space environment (Blount, 2021).

On the other hand, national regulatory bodies and legislators must approve further special regulations. The national legislation of countries has not yet made prominent achievements for managing the emergence of new technologies in outer space, and every country faces significant challenges due to technological advancements. All courts will encounter challenges in applying traditional rules to new technologies like AI (Dempsey, 2020).

Conclusion

While advanced technologies present new opportunities for space exploration and utilization, their irresponsible use also poses new challenges to outer space's safety and sustainability. In this situation, there is a need to enforce law and policy within the framework of STM. To enforce the required rules and regulations, governments and industry must cooperate both in international forums and at the national level. Establishing a legal framework and implementing advanced technologies in pace operations require consistent communication between countries and the private sector. As a result, the enforcement of an effective legal regime on STM should include data sharing, which requires countries' cooperation, as well as regular updating of the law and policy to keep up with the evolution of technologies.

🕮 References

Abashidze, AK, Ilyashevich M., and Latypova A. (2022) Artificial intelligence and space law. *J. Legal Ethical & Regul*. Volume 25, Special Issue 3. Available online: https://www.abacademies.org/articles/Artificial-intelligence-and-space-1544-0044-25-S3-040.pdf

Aglietti, G. (2020) Current Challenges and Opportunities for Space Technologies. *Frontiers in Space Technologies*, Volume 1. https://doi.org/10.3389/frspt.2020.00001

Blount, P. (2021) Space Traffic Coordination: Developing a Framework for Safety and Security in Satellite Operations. *Space: Science Technology*, Volume 2021, 1-10. https://doi.org/10.34133/2021/98303

Bonnal, C., Francillout, L., Moury, M., Aniakou, U., Perez, J.C.D., Mariez, J. and Michel, S. (2020) CNES technical considerations on space traffic management. *Acta Astronautica*, Volume 167, 296-301. https://doi.org/10.1016/j.actaastro.2019.11.023

Bru¨nner, C., Ko¨nigsberger G., Mayer H., and Rinner A. (2018) Satellite-Based Earth Observation Trends and Challenges for Economy and Society: Trends and Challenges

for Economy and Society. Conference proceedings. https://doi.org/10.1007/978-3-319-74805-4

Brownsword, R., and Yeung K. (2008) Regulating technologies: legal futures, regulatory frames and technological fixes. Bloomsbury Publishing.

Dempsey, JX. (2020) Artificial Intelligence: An Introduction to the Legal, Policy and Ethical Issues. USA, Berkeley: Berkeley Center for Law & Technology.

Contant-Jorgenson, C., L´ala P., and Schrogl KU (2006) The IAA cosmic study on space traffic management. *Space Policy*, Volume 22, 283-288. https://doi.org/10.1016/j.spacepol.2006.08.004

Carlin, John P., Nicholas J. Spiliotes, Charles L. Capito, Joseph A. Benkert, Panagiotis C. Bayz, Amy S. Josselyn, Jonathan M. Babcock (2020) US department of commerce imposes immediate export controls on artificial intelligence software used to automatically detect and identify objects remotely. The Journal of Robotics, Artificial Intelligence & Law, Volume 3, 9.

Finn, RL., Wright D., and Friedewald M. (2013) Seven Types of Privacy. In: European Data Protection: Coming of Age. Ed. by Gutwirth S, Leenes R, Hert P de, and Poullet Y. Dordrecht: *Springer Netherlands*, Volume 3, 32.

Frey, S., and Lemmens S. (2017) Status of the Space Environment: Current Level of Adherence to the Space Debris Mitigation Policy. *Journal of the British Interplanetary Society*, Volume 70, 118-124.

Gleason, MP. (2020) Establishing space traffic management standards, guidelines and best practices. *Journal of Space Safety Engineering*, Volume 7, 426–431.

Hayden, Nancy Kay, Reinhardt Jason Christian, Stewart Mallory, Doak Justin E, Gunda Thushra, and Abel Kelsey (2020) Artificial Intelligence and Autonomy in Space: Balancing Risks of Unintended Escalation. Conference: Proposed for presentation at the 38th International Systems Dynamics Society Conference held July 19-24, 2020 in Bergen, Norway.

Heinrich, S., Lucken, R., Mazieres, F., Belaud, A.? and Giolito, D. (2022) Space sustainability in the NEWSPACE Era: NO NEWSPACE without GREENSPACE. *Journal of Space Safety Engineering*, Volume 9, 464-468.

Karamanavis, Vassilis, Heinrich Dirks, Lars Fuhrmann, Frank Schlichthaber, Nora Egli, Thomas Patzelt, and Jens Klare (2023) Characterization of deorbiting satellites and space debris with radar. Advances in Space Research, Volume 72. Issue 8, 3269-3281. https://doi.org/10.1016/j.asr.2023.07.033

Kaul, S. (2019) Integrating Air and Near Space Traffic Management for aviation and near space. *Journal of Space Safety Engineering*, Volume 6,150-155.

Kessler, DJ and Cour-Palais BG. (1978) Collision frequency of artificial satellites: The creation of a debris belt. *Journal of Geophysical Research: Space Physics*, Volume 83, 2637-2646.

Krichevsky, S. (2018) Super global projects and environmentally friendly technologies used in space exploration: realities and prospects of the space age. *Philosophy and Cosmology*, Volume 20, 92-105. https://doi.org/10.29202/phil-cosm/20/8

Klinkrad, H. (2017) *Orbital Debris and Sustainability of Space Operations*. In: Handbook of Satellite Applications. Ed. by Pelton JN, Madry S, and Camacho-Lara S. Springer International Publishing, 1413-46.

Li, JS, Yang Z., and Luo YZ. (2022) A review of space-object collision probability computation methods. *Astrodynamics*, Volume 6, 95-120.

Manfletti, C., Guimara˜es M., Soares C. (2023) AI for space traffic management. *Journal of Space Safety Engineering*, Volume 10, 495-504.

Marty, JY., Bonnal C., Faucher P, and Francillout L. (2023) Space traffic management as a necessity for future orbital operations a French perspective. *Acta Astronautica*, Volume 202, 278-282.

Martin, AS., and Freeland S. (2021) The advent of artificial intelligence in space activities: New legal challenges. *Space Policy*, Volume 55, 101408.

McKnight, Darren, Rachel Witner, Francesca Letizia, Stijn Lemmens, Luciano Anselmo, Carmen Pardini, Alessandro Rossi, Chris Kunstadter, Satomi Kawamoto, Vladimir Aslanov, Juan-Carlos Dolado Perez, Vincent Ruch, Hugh Lewisi, Mike Nicolls, Liu Jing, Shen Dan k, Wang Dongfang, Andrey Baranov, Dmitriy Grishko (2021) Identifying the 50 statistically-most-concerning derelict objects in LEO. *Acta Astronautica*, Volume 181, 282–91. https://doi.org/10.1016/j.actaastro.2021.01.021

Muelhaupt, T., Sorge, M., Morin, J., and Wilson, R. (2019) Space traffic management in the new space era. *Journal of Space Safety Engineering*, Volume 6, 80-87. https://doi.org/10.1016/j.jsse.2019.05.007

Nonreimbursable Space Act Agreement Between the National Aeronautics and Space Administration and Space Exploration Technologies Corp for Flight Safety Coordination with NASA Assets (2021) NASA. Available online: https://www.nasa.gov/wp-content/uploads/static/saa/domestic/33007_NASA-SpaceX_Starlink_Agreement_Final_(Fully_Signed).pdf

Oche, P., Ata E., and Ibekwe N. (2021) Applications and Challenges of Artificial Intelligence in Space Missions. IEEE Access. Volume 12. Available online: https://ieeexplore.ieee.org/document/9634015

Pelton, J.N. (2019) A path forward to better space security: Finding new solutions to space debris, space situational awareness and space traffic management. *Journal of Space Safety Engineering*, Volume 6, 92-100.

Peterson, G., Sorge, M., and Ailor, W. (2018) Space traffic management in the age of new space. Center for Space Policy and Strategy, the Aerospace Corporation. Available online: https://aerospace.org/sites/default/files/2018-05/SpaceTrafficMgmt_0.pdf

Polkowska, M. (2021) Space traffic management (STM) – Legal aspects. *Polish political science yearbook*, Volume 50, 159-169.

Report on the Future Regulation of Space Technologies. Tech. rep. Regulatory Horizons Council (2024) RHC. Available online: https://assets.publishing.service.gov.uk/media/66278d17838212a903a7e5af/rhc_report_on_the_future_regulation_of_space_technologies_executive_summary.pdf

Schrogl, KU (2008) Space traffic management: The new comprehensive approach for regulating the use of outer space – Results from the 2006 IAA cosmic study. Acta Astronautica, Volume 62: 272-276.

Shan, M., Guo J., and Gill E. (2016) Review and comparison of active space debris capturing and removal methods. *Progress in aerospace sciences*, Volume 80, 18-32. https://doi.org/10.1016/j.paerosci.2015.11.001

Sheer, A., Fatima S., Farooqui MO., and Kasuri M. (2023) A Panacea to Address the Legal, Administrative and Economic Aspects of Space Debris. *Advances in Space Research*, Volume 72. https://doi.org/10.1016/j.asr.2023.02.023.

Soroka, L., and Kurkova K. (2019) Artificial Intelligence and Space Technologies: Legal, Ethical and Technological Issues. Advanced Space Law, Volume 3, 131-139. https://doi.org/10.29202/asl/2019/3/11

Spencer, DB, Sorge ME, and Skinner MA. (2024) Establishing "norms of behavior" for satellite collision avoidance maneuver planning. *Journal of Space Safety Engineering*, Volume 11, 120-126.

Space Environment Statistics. Space Debris (2024) ESA. Available online: https://sdup.esoc.esa.int/discosweb/statistics/

Wang, G., and Li C. (2021) Applicability of the Liability Convention for Private Spaceflight. *Space Science & Technology*. Volume 2021. https://doi.org/10.34133/2021/9860584

Wang, G. and Chen J. (2023) On the New Initiative for Responsible Space Behaviours Proposed by UK, U.S. and other States. *Space Science & Technology*, Volume 3, 10. https://doi.org/10.34133/space.0033

Yang, Kuan (2019) Chinese perspective on an international regime of space traffic management. *Journal of Space Safety Engineering*, Volume 6, 156-160.

Unexplained Air Disasters: Compensation for Indirect Victims

Jean Michel Haziza

Ph.D. in Law, Institute of Criminal Sciences and Justice (Bordeaux, France)
E-mail: jean-michel.haziza@hotmail.com

Haziza, Jean Michel (2024) Unexplained Air Disasters: Compensation for Indirect Victims. *Advanced Space Law*, Volume 14, 15-27. https://doi.org/10.29202/asl/14/2

The air disaster of Malaysia Airlines Flight MH370, which disappeared on March 8, 2014, remains an enigma. The reasons for the deaths of the passengers and crew remain unexplained even after ten years of fruitless searches. Although the Malaysian government may relaunch the search for the missing plane this year, nothing can erase the moral trauma suffered by the indirect victims. The moral and financial repercussions on the indirect victims of passengers who died in an unexplained air disaster manifest as a feeling of not being able to grieve due to the lack of obvious causes of the accident. While international legal texts provide frameworks for compensating the damage suffered, national courts apply compensation scales that are inequitable among indirect victims. To address current inequities, recognizing the prejudice of waiting and worry could alleviate the suffering endured by indirect victims.

Keywords: unexplained air disaster, carrier liability, indirect victims, loss, loss of expectation and worry, compensation.

Received: 07 September 2024 / Accepted: 28 September 2024 / Published: 30 December 2024

Introduction

The air disaster differs from an accident. Indeed, in an air disaster, there is an element of accident, but what occurs goes far beyond, establishing "a dimension of collective drama that escapes the ordinary accident." (Cahier, 2009) The definition of an air disaster implies "an idea of suddenness, surprise, and incredulity. By its magnitude, the disaster strikes minds" (Cahier, 2009). It is horrific for those who perish in an air disaster. Thus, the term "disaster" implies the severity of an air crash (Delpech, 2021). It specifically refers to the crash of a large aircraft that either violently hit the ground or crashed into the sea.

Annex 13 of the Chicago Convention of December 7, 1944, on civil aviation includes a scenario of an air disaster presupposing the deaths of passengers and crew in its definition of air accidents. Indeed, an air accident occurs particularly when "*the aircraft has disappeared or is completely inaccessible*" (OACI, 2010). The disappearance of an aircraft is thus a type of air disaster. Unlike an *accidental air disaster* where the wreckage of the aircraft is found, an air disaster following the disappearance of an aircraft is not materialized by the discovery

of the wreckage. What strikes minds here is the lack of material evidence of the disaster. In this situation, the outcome envisaged by Annex 13 of the aforementioned Convention is the presumed death of the passengers and crew following the disappearance. The definition of disappearance thus implies an additional idea of anxiety weighing on the relatives of the presumed dead passengers.

Two scenarios arise following an air disappearance:

The discovery of the wreckage in the days following the disappearance, definitively confirming the death of passengers. The disappearance will thus be explained by a technical investigation following the disaster. This is the most common situation and remains an explained air disaster.

The absence of discovery of the wreckage in the days, months, and years following the disaster. In this situation, the disappearance remains "unexplained": the day of the disappearance continues to resonate and raises many questions about the exact reasons for the disaster. This is where unexplained air disasters are categorized. It is a situation that has already occurred in the history of aviation and deserves legal responses.

Many high-profile cases have documented unexplained disappearances of aircraft from radar since the early 1960s. Wrecks found after the disappearance of radars: Egyptair Airbus Cairo-Paris in 2016, Airbus A330-220 Rio-Paris Air France 2011, Boeing 737 Adam Air Surabaya-Manado 2007, Mayamarr Airways 1998, Saeta 1972. Moreover, these unexplained accidents have left severe moral traumas on the relatives of the passengers. Currently, the only case with no wreckage found is *Malaysia Airlines Flight MH370*, which disappeared in 2014. The disappearance of Flight MH370 has been the subject of media attention and recent reports that still maintain the mystery over the true causes of the accident. The most recent case is that of Malaysia Airlines (MH370, 2023; MH370, 2024). Departing Kuala Lumpur on March 8, 2014 with 239 people on board bound for Beijing, this Boeing 777 abruptly changed course an hour after take off and ceased all contact with air traffic controllers. On July 29, 2015, aircraft debris measuring around two square meters was found on the east coast of the island of La Réunion. According to the Paris public prosecutor's office, analysis showed with certainty that it was a wing fragment from the Malaysia Airlines Boeing.

Technical and technological advances have resulted in increasingly severe and numerous mass bodily injuries due to mechanization and new risks that have emerged (Larribau-Terneyre & Buffelan-Lanore, 2020). It is the theory of risk (Grynbaum, 2011) that penalizes those who create a risk due to their activity by bearing the financial burden, which includes compensating for the damages caused. This theory devised by Raymond Saleilles and Louis Josserand at the end of the 19th century in response to the mechanization of society and an increase in workplace accidents.

Jurisprudence has developed, in this sense, the general principle of civil liability for things (Grynbaum, 2011). The Jaland'har decision uses the expression "presumption of liability" (Ch. réun., 1930) to define the system put in place by the adoption of a general principle of vicarious liability. Even though subsequent rulings and legislation such as the Badinter Act of July 5, 1985 on accidents involving motorized land vehicles have used the concepts of "de jure liability" or "strict liability" (Civil, 1957; Viney & Jourdain, 2006).

However, the process of developing the legal framework for the liability of air carriers is based not on common law but on air law. Although in certain specific cases the carrier is the guardian of the structure of the flying machine and is presumed to be responsible for its apparatus, there is a specific liability system for international air transport (Commercial, 2012)

The first liability system was established within the Warsaw Convention of 1929. However, to better respect economic realities and consumer interests, the Montreal Convention, the product of a diplomatic conference organized by ICAO, was adopted in 1999, unifying certain rules relating to international air transport. (Schubert, 2017)

In essence, air accidents necessarily result in mass bodily injuries with no escape for those on board. Facing an air disaster, the Montreal Convention establishes a two-tier liability system in case of death under Article 17: an objective liability of the carrier requiring proof of damage and a strict liability. The Montreal Convention thus establishes a regime of proven fault in the first case and presumed fault in the second case. The Montreal Convention always obliges the carrier to compensate for bodily injuries caused to transported victims. This implies that this obligation to compensate applies even in the case of unexplained air disasters. This obligation to compensate imposes a repair burden on the carrier. This principle of compensation is regularly monitored by the European Court of Human Rights. The principle of full compensation is fully recognized by Community law (ECJ, 1996; ECHR, 2004; ECHR, 2006). However, in the event of death, the Court refuses to establish an absolute and general obligation to award pecuniary compensation for non-pecuniary damage (ECHR, 2009). This obligation of the air carrier to compensate victims meets a compensatory need that also extends to indirect victims. According to article 16-1 of the French Civil Code, "Everyone has the right to respect for his body." For this reason, tort law pays particular attention to damage to bodily integrity. All bodily and mental injuries, whatever their origin (such as unexplained air accidents), must be compensated on a lump-sum basis. New Zealand has adopted an even more comprehensive system tending towards a "right to compensation" (Accident Compensation Act), which came into force in 1972 and was recently amended by a law passed on July 19, 2018: its central idea is that compensation for bodily injury, especially those caused by dangerous objects, should be based on solidarity (Le Tourneau, 2022).

The moral and financial repercussions on the close relatives of passengers who died as a result of an unexplained air disaster manifest as a feeling of not being able to grieve due to the lack of obvious causes in the course of the accident. The close relatives of deceased passengers are considered indirect victims who can claim full compensation for their damage (Casson, 2017). However, in the face of these moral and material damages, nothing is truly fair to compensate for the loss of a loved one due to an unexplained death. Thus, in the *face of an unexplained air disaster, is the applicable compensation system truly fair for indirect victims*? Although international texts provide legal responses to frame the compensation of damage suffered by indirect victims, such damage, which has been consolidated over time by the lack of explanation, cannot adequately compensate for the unexplained death of a passenger relative. The rights of indirect victims, who suffer greatly, lie in their ability to choose the most generous jurisdiction in terms of compensation. Their grief will be comforted in the absence of being able to mourn (Grynbaum, 2011). The risks associated with technological development have multiplied. The legislator is taking particular care to ensure that specific and fair provisions are in place to compensate victims of personal transport accidents. In this sense, international air transport law provides two conditions of applicability in terms of compensating indirect victims following an unexplained air disaster (**I**). But this international compensation system compensates limitedly for the damage suffered by indirect victims because, in practice, compensation is inequitable (**II**).

I. A compensation system subject to a double restrictive condition

According to air law provisions, a double condition is necessary to recognize the inexplicable nature of air disasters. First, the unexplained disappearance is assimilated to the presumed death of passengers on board during a flight (**A**). Then, despite search and rescue operations and official investigations over several months, it is impossible to explain an obvious cause of the accident following a technical investigation (**B**).

A) The Presumption of Death of Passengers and Crew

The factual situation that concerns us refers to the terms of Annex 13 of the Chicago Convention. An air disaster must occur when the aircraft is operated by a pilot and in flight, that is, between the moment passengers board until they disembark. The accident therefore occurs during the aircraft's operational phase when passengers are on board. The situation in question concerns an "aircraft" that "has disappeared" or is "completely inaccessible" (*situation c*). Note 2 in the margin of the accident definition specifies the term "disappeared." The aircraft is considered disappeared "*when official searches have ended without the wreckage being found*." There is a lack of precision on the term disappearance and also on the definition in note 2. General international aviation law does not have a clear definition regarding the disappearance of a commercial aircraft during a flight. However, it is possible to deduce a practical definition. The disappearance of an aircraft in flight would actually correspond to the lack of news regarding the aircraft's position from the captain or a loss of communication between the captain and air traffic control services, materialized by the disappearance of the aircraft from control radars.

The causative event must be an "accident" and not an "incident" as provided in Article 17.1 of the Montreal Convention of May 28, 1999. In air transport, French jurisprudence defines an "accident" as an event external to the victim and sudden (Mercadal, 2000; Cour, 1988). This notion naturally excludes any fact attributable to the transported passenger (Judicial, 1997). Similarly, American courts consider an accident as an unexpected or unusual event or occurrence external to the passenger (Supreme, 1985). This unexpected or unusual nature perfectly aligns with unexplained and external reasons that caused an accident.

The disappearance of an aircraft in flight is perceived when there is a loss of contact with the aircraft's electronic signal in air traffic. This is therefore a *serious anomaly* that raises concerns for both States and accident investigation services. The disappearance is actually always "temporary" because for each case of aircraft disappearance, either the entire wreckage or only a few pieces of it have always been found, whether after a few days or fifty years of searching. In international general aviation law, an aircraft is considered missing when, following search and rescue operations and a series of measures taken by the *neighboring* States of the location of the aircraft's disappearance, it has been impossible to locate the wreckage of the disintegrated aircraft. Subsequently, the rescue teams go to the site to try to find survivors once the wreckage has been located. Most often, they were alerted by air traffic control, which witnessed the event, but not always. Rescue teams generally implement a specific emergency plan taking into account the particular difficulties and the large number of victims, all deceased.

The disappearance of an aircraft from radar control also presupposes the death of the passengers on board as well as the crew. Indeed, in all cases of disappearance, the first stage

of disappearance from the radars has been followed by the discovery of an air crash with no survivors. This is why the disappearance of an aircraft results in the immediate death of the passengers on board. Thus, there is the presence of fatal injuries proving the existence of bodily harm. This is not about adopting the interpretation of Articles 88 to 90 of the French Civil Code. The Warsaw and Montreal Conventions adopt a presumption of death for passengers in the event of disappearance since there is a system of financial advances before any compensation for the damage suffered by the relatives of the direct victims of the accident only a few days after the crash (Mercadal, 2000). The unexplained disappearance of an aircraft in flight can only be recorded following an absence of an obvious cause after a technical investigation into the accident.

B) The absence of an obvious cause of the air disaster following a technical investigation.

Investigators belong to three main categories: the local investigation bureau (In France the *Bureau d'enquêtes et d'analyses* (BEA) of the Ministry of Transport; In Canada, the Transportation Safety Board (TSB); In the United States, the National Transportation Safety Board (NTSB)), the investigation bureau of one or more concerned countries, and the "accident management" division of either the airline or the aircraft manufacturer or one or more insurance companies. These organizations systematically seek to have the maximum information taken at the source and bring technical skills to serve the local investigation bureau. It is always the local bureau that remains in control of the investigation. The airline and the civil authorities of the location of the disaster organize the reception and information for the relatives of the victims or the presumed victims. Today, this is generally done with the help of psychologists trained for extreme shock situations that represent the announcement of the sudden disappearance of a relative or friend.

An airplane accident rarely has a single cause. The specialists from the investigation bureau most often seek the determining cause of the accident. They look for the breakage of an element or the malfunction of an element or any other causes identified by post-accident technical investigations. Therefore, the investigation bureau's report must contain the determining cause of the disappearance of the aircraft in flight. In principle, the investigation bureau's report does not determine liabilities, but it is an essential element for potential legal actions. The investigation begins once a rescue plan has been implemented. One or more investigation organizations go to the site to search for the black boxes, analyze the available information, and investigate the causes of the disaster. The investigation results (which can take several months or several years) are then used in several ways: victim compensation by insurance companies, search for liabilities; possible correction of inherent defects in the aircraft involved; possible correction of defects in the procedures used. However, the problem here lies in the fact that it is still not possible to explain the results of a technical investigation with certainty in the absence of an obvious cause proving the origin and course of the accident. This happened with Flight MH370.

Malaysia Airlines Flight 370 ended with the unexplained disappearance of a Boeing 777 on March 8, 2014, between Kuala Lumpur, Malaysia, and Beijing, China, its planned destination. The crew operating for *Malaysia Airlines* last communicated with air traffic control about 38 minutes after take-off while the plane was over the South China Sea. The aircraft disappeared from radar screens a few minutes later, but continued to be tracked by military radar for an additional hour. The aircraft's trace was lost about 370 kilometers northwest of Penang Island.

With the 227 passengers and 12 crew members presumed dead, the disappearance of Flight 370 is the deadliest air accident involving a Boeing 777. The search for the missing plane, which became the costliest in aviation history, initially focused on the South China Sea and the Andaman Sea, before analysis of the aircraft's automated communications with a satellite of the British company *Inmarsat* indicated that the aircraft had continued its route for several hours and over thousands of kilometers, ending up somewhere in the southern Indian Ocean, off the coast of Australia. The lack of official information in the days following the disappearance sparked strong criticism in China, especially from the relatives of the passengers, the majority of those on board being of Chinese origin. Between 2015 and 2016, several marine debris washed up in the western Indian Ocean were identified as coming from the aircraft. However, the three-year search over a maritime area of 120,000 km2 failed to locate the aircraft. After the end of the first phase of the search in January 2017, a second campaign launched in January 2018 by the private company *Ocean Infinity* also ended in failure after six months. Relying mainly on the analysis of Inmarsat satellite data, the *Australian Transport Safety Bureau* (ATSB) initially suggested that a hypoxia event was the most likely cause given the available evidence, although no consensus was reached among investigators. At various stages of the investigation, possible hijacking scenarios were considered. However, the final report of the Malaysian Ministry of Transport in July 2018 did not provide any conclusion on the exact cause of the disappearance. In the absence of a definitive explanation, the aviation industry's safety recommendations and regulations mentioning Flight 370 mainly aim to prevent the recurrence of the circumstances associated with its disappearance, including increasing the battery life of underwater locator beacons, extending flight recorder durations, and implementing new aircraft position reporting standards over oceans. Published on July 30, 2018, the Malaysian investigation report details numerous technical elements already announced, without concluding to a specific cause. It conditions the eventual formulation of the cause of the disappearance on future discoveries, excluding the hypothesis of pilot suicide and a major malfunction, while admitting the possibility of a hijacking by a passenger. This entire investigation leaves the jurist perplexed and plunges the victims' relatives into an even deeper and more lasting trauma. On August 6, 2018, at the request of the judiciary, France reopened the investigation, becoming the last country to do so. The investigation was entrusted to the air transport gendarmerie research section (SR-GTA). Subsequently, the report indicates that it is likely the pilot maneuvered the aircraft until the end and that nothing supports the suicide theory. Certainly, this rules out the suicide cause, but it does not admit an obvious cause.

In such situations, there is an inequitable application of the *quantum* of compensation for the emotional distress suffered by indirect victims.

II. An inequitable compensation regime.

Even if international and European texts provide for automatic compensation for indirect victims in such disasters (**A**), this does not prevent the real compensation for the damage suffered by indirect victims from being inequitable depending on the jurisdiction seized (**B**).

A) An international system of automatic compensation for indirect victims in the event of an unexplained air disaster

The applicable text for a flight whose disappearance remains unexplained depends on the departure location of the disappeared aircraft. Subject to community law are, firstly, all flights (regular or otherwise) departing from an airport located in a member state of the European Union, Iceland, Norway, or Switzerland, regardless of the destination airport (same state, another EU state, third country) and irrespective of the carrier's nationality. Secondly, all flights to an airport located in an EU member state, Iceland, Norway, or Switzerland, regardless of the departure airport, provided that the carrier is considered "community-based," meaning it holds a license issued by an EU state. The flight that caused the accident is therefore subject to the provisions of the Montreal Convention, provided that the state of the departure location is a signatory. This Convention significantly modernized the regime of the 1929 Warsaw Convention, which already governed the liabilities of air carriers in case of passenger deaths, allowing for a shift to a single legal instrument. The Montreal Convention thus establishes a uniform legal framework to govern the liability of airlines, especially in the event of passenger deaths. At the community level, it is the regulation of October 9, 1997 (Council, 1997), modified by the regulation of May 13, 2002 (Regulation, 2002), that imposes unlimited liability on community air carriers in case of passenger deaths. This regulation also applies the rules of the Montreal Convention to all flights operated by community air carriers, both domestic and international. According to the provisions of the regulation of September 24, 2008, there are common rules for operating air services within the European Union.

The Montreal Convention establishes a unique regime of compensation ceilings in case of passenger deaths, applicable to indirect victims. These new compensation principles had already been applicable in Europe since the Council Regulation of October 17, 1997. The rules are imposed on community air carriers for both internal and international flights. The carrier's liability will be engaged under the conditions provided by the Montreal Convention. Article 17 of the Montreal Convention stipulates that the carrier is responsible for the damage caused in particular in case of a passenger's death onboard the aircraft. The right holders in case of death do not need to prove fault since it is a liability "by operation of law" (Bloch & Le Tourneau, 2023b) for both death and injuries when the accident occurred onboard the aircraft and during boarding or disembarking operations. This concept is similar to that of "gardien" (guardian) within the meaning of article 1384, al. 1er in fine, of the Civil Code (Bloch & Le Tourneau, 2023a). The carrier can only exonerate itself by establishing the victim's fault. As in the Warsaw Convention, the presumption only applies when the accident was the cause of the victim's damage, which means proving that the damage is attributable to an accident external to the victim. The victim passenger is entitled to full compensation, which is the most remarkable contribution of the Montreal Convention. Compensation for indirect victims is thus provided. The victims are entitled to full compensation for the damage suffered:

(1) If the amount of compensation is less than the equivalent of 128,821 Special Drawing Rights (SDR), approximately 130,000 euros, the carrier will be automatically liable, meaning liable by operation of law. It can only exclude its liability if it proves that the victim contributed by their fault or negligence to the damage suffered; in which case, shared responsibility would be possible. Thus, the carrier cannot exclude or limit its liability except in cases of the victim's negligence or detrimental omission.
(2) If the amount of compensation exceeds 128,821 SDR or approximately 130,000 euros, the carrier is only presumed liable, it can not only exclude or limit its liability by proving the passenger's fault but also by proving that it, its agents, and representatives were blameless. When the damages exceed 128,821 SDR per

passenger, there are two other exoneration causes provided by Article 21 of the Montreal Convention: the "due diligence" of the carrier (i.e., absence of fault) and third-party fault (Convention, 1999).

To exonerate itself from liability, the carrier can demonstrate that it was impossible to take necessary appropriate measures in the face of an unexplained cause (Mercadal, 2000, Actualisation 2023). In this sense, the carrier can demonstrate, as invited by the terms of Article 20§1 of the Montreal Convention, that it was impossible to take necessary measures due to the criteria of force majeure. Indeed, the impossibility of taking necessary measures would stem from the unforeseeable and irresistible nature of the event that caused an unexplained disappearance. For example, courts consider weather conditions as exonerating only if they exhibit the characteristics of force majeure. In this regard, their intensity must have been exceptional considering the time of year and location. Thus, a company that could not land on the airport runway is not exonerated by the presence of "moderate" (Commercial, 1993) fog. Therefore, an accident of unknown origin should not result in compensation from the carrier as long as it demonstrated due diligence. Often, the carrier will only manage to exonerate itself by proving what precisely caused the damage. However, in the case of an unexplained origin, it will be impossible for it to prove the precise cause of the damage. The ceilings set by the Montreal Convention cannot be excluded in the event of an accident of unknown origin. There can be no exclusion of compensation limits when the accident is of unknown origin (Cour, 1980) or when the causal link between the fault and the damage is not established with certainty (Cour, 1979).

Regarding the Montreal Convention, regardless of the amount of compensation and regardless of whether the liability is by operation of law or presumed, the carrier will be obliged to compensate indirect victims. It must provide an immediate advance to allow indirect victims to meet their immediate needs without waiting for the outcome of a lengthy procedure. The amount of this advance is not determined by the Montreal Convention but is generally set by national laws. In case of death attributable to a European carrier, the 1997 European regulation provides that the advance cannot be less than the equivalent of 16,000 SDR, approximately 20,900 euros per deceased passenger, knowing that it must be paid within fifteen days of the accident. Payment of this advance does not constitute an acknowledgment of the company's liability. This payment will be deducted from the final full compensation payment.

The company *Malaysia AirLines* was obliged to compensate the victims' relatives. Reference must be made to the Montreal Convention. This text was ratified by Malaysia and China in 2008. This text incorporates certain rules related to international air transport. Article 17 of the Montreal Convention specifies that "*the carrier is liable for the damage*" when the passenger dies during the flight. It is a principle of automatic liability, but the compensation can be capped under certain conditions. However, the 280 companies that signed the Kuala Lumpur agreement adopted on October 31, 1995, had committed not to cap compensation. This is notably the case for *Malaysia Airlines*. The compensation procedure is always carried out based on the provisions of the Montreal Convention. First, airlines offer advance compensation as provided by the Convention. The airlines then attempt through their insurers to negotiate amicably with the victims. But if the parties cannot reach an agreement, the relatives can directly sue the airline, even if the compensation scales will sometimes be inequitable depending on the jurisdiction seized.

B) Inequitable compensation scales according to states.

The rules of jurisdiction for hearing a liability action against an air carrier are determined by international air transport conventions. One might be inclined to invoke the Montreal Convention of May 28, 1999, for the unification of certain rules relating to international air transport. Article 28 sets out the rules of territorial jurisdiction for a liability action against the air carrier in the context of international transport. According to the first paragraph of this article, "*An action for damages must be brought, at the option of the plaintiff, in the territory of one of the High Contracting Parties, either before the court of the domicile of the carrier, the principal place of its business or the place where it has an establishment by which the contract has been made, or before the court at the place of destination*." The Court of Cassation adds that Article 28, paragraph 1, of the Warsaw Convention "*enacts a rule of direct jurisdiction that has an imperative and exclusive character, so that it precludes any derogation by applying internal rules of jurisdiction, particularly that of Article 42, paragraph 2, of the Code of Civil Procedure*." This solution is not new (Cour, 2006). This rule of direct jurisdiction means that the French judge seized, when called upon to rule on their own jurisdiction, must apply this Article 28 to assess this jurisdiction, to the exclusion of any other conflict of jurisdiction rule, particularly the French rule of territorial jurisdiction.

For the indirect victims of an air disaster, there are legal difficulties in terms of recourse possibilities. Article 33.2 of the Montreal Convention provides for a liability action against the carrier. This article reiterates the terms of Article 24 of the Warsaw Convention, which posed numerous difficulties. Jurisprudential responses are divided between supporters of the exclusivity of the Warsaw regime, prohibiting any other form of recourse, and defenders of the victims' interests, who consider it unjust to leave them without recourse. There is thus a conflict of norms in certain national laws between the application of Article 24 of the Warsaw Convention and the application of a national law text. For example, British case law on December 12, 1996, relied on Article 24 of the Convention, which states that "*in the cases covered by Articles 18 and 19, any action for damages, however founded, can only be brought subject to the conditions and limits set out in this Convention*." The U.S. Supreme Court ruled similarly to the *House of Lords* on January 12, 1999, overturning a decision by the Second Circuit *Court of Appeals* that had decided that the recourse instituted by the Warsaw Convention was not exclusive and had thus allowed the plaintiff to base their action on internal law. In France, the situation is different: Article 24 of the Warsaw Convention does not give the contracting party of the carrier a direct right of action against the agent. It leaves it to the applicable national law to settle this issue. In France, the doctrine opts for the quasi-delictual liability, more specifically of former Article 1382 of the Civil Code, now Article 1240.

Whether states rely on Article 33.2 of the Montreal Convention to delineate the action of indirect victims, this article does not address the nature of the compensable damage. This leaves it to the applicable national law to settle this issue. The qualification of compensable damage is thus subject to the law of the forum. There is therefore a disparity in terms of compensation according to the scales set by the states, which creates a certain injustice for indirect victims. In practice, the amount of compensation is highly variable from one family to another. Article 33.2 of the Montreal Convention offers indirect victims the choice of the country in which they can bring a liability action against the carrier: the place of residence of the passenger victim, the place of purchase of the ticket, that is, the conclusion of the contract, the place of departure, the place of arrival, and the seat of the company. In this sense, the indirect victim has great

procedural choice. Is it a concealed *forum shopping*? This can allow them to choose the law of a state that will be more likely to justly compensate the damage suffered, especially since the action can be brought both against the aircraft manufacturer and the airline. Each state has its own jurisprudence that is more or less generous (Cour, 2015; Cour, 2019). In the event of an aviation accident resulting in the death or injury of passengers, the carrier, if it is required to do so by the law of its country, will without delay make advance payments to natural persons who are entitled to compensation to enable them to meet their immediate economic needs. This solution is obviously transposable under the Montreal Convention, which succeeded the Warsaw Convention. It is preferable to choose the United States, where justice grants much larger compensations than in China or Malaysia.

Indirect victims can justify having suffered emotional damage due to the death of a close passenger (children, parents, cohabitants, spouses...). This moral damage can be accompanied by material damage when these victims justify that they lived off the work of the deceased victim (Mercadal, 2000, Actualisation 2023). It is up to the indirect victim to demonstrate that the damage they complain about comes from an accident external to their person, which can result, for example, from unexplained circumstances. In French law, all damage is compensable for indirect victims provided it is certain and direct (Cour, 1986). It can be bodily damage, material damage, resulting in financial loss, or moral damage, that is, other than financial. In Great Britain, courts also compensate for moral damage (Division, 1956). However, in some cases, plaintiffs can only obtain damages for loss of affection. For example, Nigerian law only compensates for pecuniary damage in the event of an air crash on its territory (Cour, 2023).

To calculate the amount of compensation following an unexplained air disaster, the damage suffered is assessed by experts. In France, the damage suffered depends on numerous conditions that allow the accumulation of several applicable scales from the Dintilhac report:

Fixation of emotional damage according to the relationship with the victim. If the passenger is the father, mother, or spouse of the indirect victim, then the compensation is almost automatic (Casson, 2017). This should include the proven pathological repercussions that the death may have had on certain relatives. In practice, it is almost automatic to compensate the loss of affection of the direct victim's closest relatives (father and mother, etc.). For example, the amount of moral damage for the spouse in case of death is between 20,000 and 30,000 euros, according to a scale set by the Victims' Aid Association of France. For the death of a father, a child receives 30,000 euros. However, it is also necessary to consider individuals without a family relationship, provided they can prove a real emotional connection with the deceased.

Fixation of emotional damage due to the sudden and unexplained disappearance of a plane. In case of sudden disappearance or painful circumstances, the amount of compensation will be much higher because the moral damage is considered "emotional damage." This will be the case for the victims of the missing *Malaysia Airlines* Boeing 777.

Fixation of economic damage due to losses suffered. For this, it is necessary to assess the losses suffered and the loss of earnings for the families of the crash victims. A proven economic dependence link is required, as in the case of a child and a parent. Material damage, which is assessed based on the deceased parent's income and the economic damage suffered by the family, can be much higher than moral damage.

Regardless of the reasons for the disappearance of flight MH370 (conspiracy, fiction, official cover-up), (Van De Winkel, 2015) the courts that compensated indirect victims could not consider the *damage of waiting and anxiety*, deemed by the mixed chamber of the Court of Cassation as a particular category of moral damage since March 25, 2022 (Mixed, 2022).

According to the French Supreme Court (Cour de cassation), meeting in a mixed chamber, in a ruling dated March 25, 2022, this damage exists when: "a person's next of kin, who learn that the person is or has been exposed, on the occasion of an individual or collective event, to a danger likely to affect his or her physical integrity, experience anxiety linked to the sudden discovery of this danger and the uncertainty weighing on his or her fate... ." The damage of waiting and anxiety constitutes a new category of damage for the relatives of the direct victim (damage suffered particularly by indirect victims). It is defined as the fear and anxiety experienced by the relatives of a direct victim when they learn that they have been involved in an attack, assault, or accident, and they wait for the outcome, namely information about the life or death of the direct victim (Steinle-Feuebach, 2000). This exceptional damage applies to exceptional situations. In this case, the indirect victims of passengers on flight MH370 have for many years experienced anxious waiting for the exact reasons for the flight's disappearance and the lack of certain cause for the death of the close passenger. Now that this damage is referenced in the French legal order, if a similar situation arises again, this specific damage in the Dintilhac nomenclature will likely be compensated in addition to the damage of affection.

Conclusion

A compensation system is provided by the Montreal Convention. This system outlines the main lines in terms of compensation procedures applicable to indirect victims (an immediate financial advance following the unexplained disappearance, an automatic compensation threshold). The carrier's liability will always be presumed since there is an absence of fault on the part of the passenger, knowing that the exonerating cause based on force majeure will be difficult to apply. The need for compensation is so important in the situation of an unexplained air disaster that the compensatory function of civil liability takes precedence over any possible evidence of the carrier's exoneration. The amount of compensable damages depends on the competent jurisdiction. There is no harmonization in these terms provided by the Montreal Convention, which creates inequalities between the full compensation of damage suffered by victims. For example, indirect victims of flight MH370 with a nationality of a third-world country (Malaysia) will face less significant compensation from their jurisdiction compared to indirect victims with a nationality of a developed country (France). Unexplained air disasters being exceptional situations, the recognition of the damage of waiting and anxiety applicable to attacks and collective accidents is a particular exceptional damage that can be taken into account alongside traditional damages (moral and material). This could help alleviate the suffering endured by indirect victims who cannot grieve their loved ones who died following an unexplained disappearance in the airspace.

🕮 References

Cour de Cassation (1930) Chambre réunie, 13 fév. 1930, Jeand'heur, DP. 1930. 1. 57, rapp. LE MARC'HADOUR, concl. MATTER, note RIPERT. G; S. 1930. 1. 121, note ESMEIN. P ; GAJC, t. 2, 12th éd., 2008, Dalloz, n° 199. Avaible online: https://www.legifrance.gouv.fr/juri/id/JURITEXT000006952821/.

Cour de cassation Chambre Civile 1 (1979) 1re, 2 Mai 1979, pourvoi n° 78-10719, RFD aérien 1979.309. Available online: https://juricaf.org/arret/FRANCE-COURDECASSATION-19790502-7810719.

Cour de cassation Chambre Civile 1 (1980) 1ère, 1 fév. 1980, pourvoi n° 78-14538, Bull. civ. des arrêts Cour de cassation Civ.1ère n°47. Available online: https://www.legifrance.gouv.fr/juri/id/JURITEXT000007005036

Cour de cassation Chambre civile 1 (1986) 1re, 15 avr. 1986, pourvoi n° 84-15.810., RFD aérien 1986.241, Gazette du Palais 1986.2. panor. 144; CA Paris. Available online: https://www.legifrance.gouv.fr/juri/id/JURITEXT000007016638

Cour de Cassation Chambre civile 1 (1988) No 28 1989, D. RCA 1990 somm. 273. REMOND-GOUILLOUD. Chr.-M.

Cour de cassation Chambre civile 1 (2006) 1ère, 11 Juil. 1986, pourvoi n°. 04-18.644 P, D. 2006. 2055, obs. DELPECH. X; RTD com. 2006. 703, obs. DELEBECQUE. P; JCP 2006. Actu. 373; Nov. 12th, 2009, N°. 08-15.269, Rev. crit. DIP 2010. 372, note H. MUIR WATT; RTD com. 2010. 456, obs. DELEBECQUE. P; J. Avaible online: https://www.legifrance.gouv.fr/juri/id/JURITEXT000007053692

Cour de Cassation Chambre civile 1 (2015) Rio-Paris Case, D. 2015. Actu. 622, obs. DELPECH. X.

Cour de cassation, Chambre civile 1 (2019), 1ère, 26 juin 2019, pourvoi n° 18-12.541, Dalloz actualité, Sept. 26th 2019, obs. DELPECH. X. Avaible online: https://www.dalloz.fr/documentation/Document?id=CASS_LIEUVIDE_2019-06-26_1812541&FromId=RECUEIL_CHRON_2020_1149#texte-integral

Cour de cassation Chambre civile 1 (2023), 1ère, 1er Mars 2023, pourvoi n°. 21-22.015: "9. Having noted that Nigerian law (...) did not provide for compensation for moral prejudice, the Court of Appeal (...) legally justified its decision to award sums in compensation for material prejudice". Avaible online: https://www.legifrance.gouv.fr/juri/id/JURITEXT000047268963

Bloch, C., & Le Tourneau, P. (2023a) Contrats relatifs aux transports et aux voyages. Dalloz action, Droit de la responsabilité et contrats (Chap. n° 3314, n° 3314. 213).

Bloch, C., & Le Tourneau, P. (2023b) Responsabilité du fait des aéronefs. Dalloz Action, Droit de la responsabilité civile et contrats (Chap. n° 6221, n° 6221.21).

Larribau-Terneyre, Virginie, and Yvaine Buffelan-Lanore (2020) Droit civil, Les obligations 2020-20221 (17th ed.). Sirey.

Cahier, B. (2009) Le gouvernement du ciel: prevent et surmonter la catastrophe aérienne. *Les Cahiers du Portique*, (22), p. 13.

Casson, P. (2017) Dommages et interests. *Répertoire civil*, p. 86.

Civil (1957) Bull. civ. II, n° 89. – Nov. 14, 1958, JCP 1959. II. 10394, note RODIERE. R.

Commercial (2012) n° 11-21.362 P: D. 2012. 2866, note TOSI. J.-P; ibid. Act. 2384, obs. DELPECH. X; JCP E 2012, n° 1662; RD Transp. 2012, n° 54, note DELEBECQUE. P.

Commercial (1993) BTL 1993.312. Bobigny.

Council Regulation No 2. (1997) OJEC, L 285, Oct. 17, 1997.

Delpech, X. (2021) Catastrophe aérienne: règles de compétence. Dalloz Actualité.

Division, Q.B. (1956) Preston v/ Hunting Air Transport, W1956.

ECHR (2006) Scordino v/ Italy, req. n° 536813/97. 213. Available online: https://hudoc.echr.coe.int/eng#{%22itemid%22:[%22002-3358%22]}

ECHR (2009) *Zavoloka v/ Latvia, req. n° 58447/00*, 40. Available online: https://hudoc.echr.coe.int/app/conversion/pdf/?library=ECHR&id=002-1417&filename=002-1417.pdf&TID=ihgdqbxnfi

ECHR (2004 Cataldo v/ Italy, req. n°, 45656/99. Available online: https://hudoc.echr.coe.int/eng#{%22itemid%22:[%22001-45065%22]}.

ECJ (1996) Brasserie du pêcheur and Factortame III, §82. Available online: https://www.cvce.eu/obj/arret_de_la_cour_de_justice_brasserie_du_pecheur_et_factortame_affaires_jointes_c_46_93_et_c_48_93_5_mars_1996-fr-bc577e46-8c3d-43c7-9f35-3504ca31671f.html

Grynbaum, L. (2011) Responsabilité du fait des choses inanimées. Répertoire civil, p. 17.

Judicial Tribunal (1997) September 3rd. RFD aerial RCA 1998.146.

Le Tourneau, P. (2022). Dépassement de la theory du risque. Dalloz Action, Droit de la responsabilité civile (Chap. 0124, 2022, n° 0124.12.).

Mercadal, B. (2000). Transports aériens. Répertoire Commercial, p. 220.

Mixed court (2022, March 25th). No. 20-17.072, Dalloz actualité, April 5, 2022, obs. CAYOL. A; D. 2022. 774, note PORCHY-SIMON. S; ibid. 1934, obs. BACACHE.M, GUEGAN. A and PORCHY-SIMON. S; ibid. 2023. 34, obs. BROWN. P, GOUT. O and QUEZEL-AMBRUNAZ.

Convention for the Unification of Certain Rules for International Carriage by Air (the Montreal Convention) (1999) Art. 21.2. Official Journal L 194 , 18/07/2001 P. 0039 – 0049.

MH370: L'avion disparu [Motion Picture] (2023). Netflix (Director).

MH370: La vérité disparue [Motion Picture] (2024) France.

OACI (2010) Annexe 13, Enquêtes sur les accidents et incidents d'aviation. The Chicago Convention, 10th, p.1-1.

Regulation No 8. (2002) OJEC, L 140/2, May 30th, 2002.

Schubert, F. (2018) Droit aérien. SCHULTHESS.

Steinle-Feuebach, M.-F. (2000) Victims de violences et d'accidents collectifs. Exceptional situations, exceptional prejudices: reflections and interrogations. Médecine et Droit (45), p. 1.

Supreme Court of California (1985) Air France v. Hermien Saks, Air and Space Law 1985.173, Rev. dr. uniform RCA 1986.542.

Van De Winkel, A. (2015) La disparition du vol MH370 : plot, dissimulation, bluff et fiction. Diogène PUF(249-250), pp. 203-216.

Viney, G., & Jourdain, P. (2006) Les conditions de la responsabilité (3rd ed.). (LDGJ, Ed.)

Administrative-Legal Regulation of Ukraine's Space Activities: Challenges in Wartime and Strategic Perspectives

Inesa Kostenko

Ph.D. in Law, Fellow Researcher at the University of Leicester (Leicester, United Kingdom), Researcher at the Research Institute of State Building and Local Self-Government of the National Academy of Legal Sciences of Ukraine (Kharkiv, Ukraine)
E-mail: kostenko.inesa@outlook.com
https://orcid.org/0000-0002-8784-5422

Kostenko, Inesa (2024) Administrative-Legal Regulation of Ukraine's Space Activities: Challenges in Wartime and Strategic Perspectives. *Advanced Space Law*, Volume 14, 28-44. https://doi.org/10.29202/asl/14/3.

This article examines the administrative and legal mechanisms for coordinating Ukraine's space activities during martial law and post-war recovery. Particular attention is paid to the impact of large-scale armed aggression on the development of the space sector as a strategic factor in ensuring national security and defense capability. The paper highlights the main issues in legal regulation, including the fragmentation of the legislative base, inadequate coordination between state bodies, and weak integration of the private sector. Key areas for reform are analyzed, such as the modernization of the State Space Agency of Ukraine, harmonization of national legislation with international standards, and the development of public-private partnerships. The importance of space technologies in military intelligence, navigation, and communication is underscored, as well as the prospects for attracting foreign investment to develop the sector. The article contains recommendations for enhancing the effectiveness of state policy in the field of space activities and integrating Ukraine into the international space community.

Keywords: *space activities, administrative-legal regulation, public-private partnerships, national security, post-war recovery, international cooperation*

Received: 27 November 2024 / Accepted: 18 December 2024 / Published: 30 December 2024

Introduction

Recent large-scale armed aggression against Ukraine has precipitated pivotal changes in the global security system, highlighting the critical need for an accelerated development of space activities. These activities are increasingly recognized as central to enhancing national security, defense capabilities, and catalyzing the economic revival of the state. In today's context of

hybrid warfare, space technologies are strategically indispensable, serving as essential tools for reconnaissance, navigation, maintaining continuous communication, and swiftly responding to emerging and ongoing threats. Beyond their defense applications, these technologies also hold potential as catalysts for scientific and technical progress, drivers of innovative development, and key facilitators of Ukraine's integration into global economic processes.

Despite the inherent potential, the effective realization of these capabilities is significantly hindered by systemic flaws in state governance, a fragmented legal framework, and a lack of a cohesive strategic vision. The absence of an approved National Space Program and a definitive Strategy for Space Activities between 2018 and 2023 led to planning and coordination discrepancies, which subsequently resulted in suboptimal implementation of national-scale projects. A dispersed array of functions across numerous executive bodies has critically obstructed the development of a unified strategic direction for the industry (Recommendations, 2024).

With the imposition of martial law, the urgency to reform and modernize the governance of space activities has become more pronounced. It is essential to integrate the national space infrastructure more deeply into the broader state security apparatus. This involves the establishment of a robust space monitoring system, the adoption of advanced Earth remote sensing technologies, the expansion of satellite communication capabilities, and the refinement of navigation systems. These initiatives aim to enhance the nation's defensive capabilities, ensure reliable information support, and promote the sustainable advancement of the space sector post-conflict.

Post-War Challenges and Strategic Directions. The post-war reconstruction phase requires a more profound integration of space activities into the strategic dimensions of national policy. This necessitates not only a restructuring of the institutional architecture but also the creation and implementation of innovative administrative and legal frameworks to facilitate effective coordination. Elevating the State Space Agency of Ukraine's status and capabilities becomes crucial, positioning it as a central actor in formulating and executing a comprehensive national space policy. The agency's modernization and technological enhancement are vital for improving the management and coordination of national space initiatives.

Moreover, the extensive consequences of war pose a formidable challenge to the international community, particularly in terms of reconstruction. Kotsur (2023) highlights that these include widespread human casualties, significant environmental degradation across Central and Eastern Europe, extensive land mining, emerging migration issues, and a rise in the number of socially vulnerable populations and individuals suffering from mental health disorders. Ukraine, alongside several European countries, confronts the arduous task of reconstruction, requiring resources that may surpass its current capacities. The potential reduction in material support post-conflict poses significant risks to timely and efficient recovery. However, a model resembling the post-World War II Marshall Plan could provide a structured approach for rapid economic and infrastructural rebuilding, thereby reinforcing Ukraine's role as a robust partner in the international arena and showcasing the effectiveness of democratic solidarity in mitigating authoritarian influences. The EU's backing for Ukraine's swift reconstruction during the 2023 Ukraine-EU summit underscores this strategic pathway (Kotsur, 2023).

Harmonization with International Norms. The synchronization of Ukraine's national legislation with international legal norms in space activities is of paramount importance. This not only enhances the internal capabilities of the sector but also strengthens Ukraine's position as a reliable and competitive partner in the global space community. Future development strategies

in the post-war period should focus on attracting private capital, fostering joint ventures with international partners, and embedding innovative Ukrainian solutions into global value chains. Establishing effective interactions between state structures and private investors is essential for crafting a new governance model for space activities that combines innovation, strategic resilience, and adaptability to modern challenges.

Implications for Policy. This research intends to provide a detailed analysis of the administrative-legal mechanisms coordinating space activities in Ukraine, the challenges faced by the space sector under martial law, and the prospects for reforming space activity management in alignment with strategic national reconstruction priorities post-war. The findings will inform the development of policy recommendations aimed at enhancing the effectiveness of state policy in space activities and ensuring the strategic development of the sector for long-term national and international benefit.

Current state of administrative-legal mechanisms for coordinating space activities in Ukraine

Ukraine possesses considerable potential in the field of space activities, formed through decades of engineering experience, numerous scientific and technical achievements, and an advanced infrastructure inherited from the Soviet era. The uniqueness of the Ukrainian space sector is characterized by a combination of high-level scientific thought, innovative capacity, and a robust industrial base, enabling the implementation of projects both nationally and internationally.

A critical phase in the institutional establishment of space activities was marked by the approval of Ukraine's first five-year State Space Program, adopted by the Cabinet of Ministers of Ukraine on May 25, 1993. This strategic document outlined the main directions for the sector, including the launch of Ukraine's first satellite "Sich-1," the creation of the "Lybid" telecommunications satellite, active international cooperation, and the commercialization of space activities through agreements with leading global space agencies (History, 2024). These initiatives laid the foundation for the independent development of the national space infrastructure and positioned Ukraine as a reliable partner in the international space exploration arena.

A significant achievement of the first program was Ukraine's involvement in international space missions. For instance, on May 13, 1994, following intergovernmental agreements between Ukraine and the USA, an agreement was reached for a Ukrainian astronaut to join the crew of an American spacecraft. The successful launch of the first national satellite "Sich-1" on August 31, 1995, confirmed Ukraine's technical and organizational capability to independently implement large-scale space projects, opening new opportunities for the development of space science and technology.

An important organizational step was the creation of the National Center for Aerospace Education of Youth in June 1996, aimed at training new specialists in the field of space activities. In August of the same year, the National Center for Control and Testing of Space Means was founded, which played a key role in coordinating the activities of the space sector. These institutions facilitated the formation of a comprehensive management system for the space sphere and engaged young people in scientific research, ensuring the continuity of generations of specialists in the field (History, 2024).

A particularly notable achievement was the space flight of Leonid Kadeniuk, the first astronaut of independent Ukraine, who participated in an international mission aboard the space

shuttle "Columbia" in 1997. The mission's program included conducting unique experiments in space botany, aimed at studying the effects of microgravity on plant development. The research findings were of significant value to fundamental science and applied fields such as the agricultural industry and biotechnology. Moreover, the mission had a substantial educational impact, reaching about 40,000 students from Ukraine and the USA, promoting the popularization of science among youth and solidifying Ukraine's international reputation in the space sector (Vavilova, 2023).

In the early 2000s, Ukraine strengthened its position in the international market for space services, establishing itself as one of the leading space nations. This period was marked by active participation in international projects, infrastructure development, and the introduction of innovative technologies in space activities. As noted by Horbulin, Shevtsov, and Shekhovtsov (2000), Ukraine secured a prominent place in the global space services market through the successful implementation of strategic projects and the creation of competitive space systems. One of the most striking achievements of the Ukrainian space industry in the late 1990s and early 2000s was the establishment of joint ventures that implemented significant international projects. In particular, the "Kosmotras" project, aimed at operating the converted SS-18 missile ("Satan") adapted for commercial use under the name "Dnepr," gained special significance. The successful launch of the "Dnepr" rocket on April 21, 1999, demonstrated the high efficiency of conversion rocket technologies as a tool for Ukraine's entry into the international space services market. This project exemplified successful international cooperation for Ukraine, opening new horizons for the use of space technologies for peaceful purposes (Kuznetsov, 2022).

Leading Ukrainian enterprises, the Yangel Design Bureau "Pivdenne" and the Production Association "Pivdenmash" named after O.M. Makarov, have played a pivotal role in advancing the development of the space industry. Their active participation in international projects, such as the launch of the low-orbital satellite system "GlobalStar," has significantly bolstered Ukraine's international reputation as a reliable partner in space technology.

A project of particular importance was the "Sea Launch," which unified the efforts of Ukraine, the USA, Russia, and Norway. Within this program, the "Zenit-3SL" launch vehicle, developed by the Yangel Design Bureau, was used to launch satellites from the "Odyssey" floating sea platform located in the Pacific Ocean. The first successful launch of the "Zenit-3SL" took place on March 28, 1999. The program witnessed a total of 36 launches, demonstrating the high reliability of Ukrainian technologies and the effectiveness of international cooperation. The Ukrainian side, particularly the chief designer of rocket and space direction, Volodymyr Komanov, exhibited a high level of technical expertise and organizational capability in the execution of this ambitious project (Kuznetsov, 2022).

Thus, the early 2000s marked a defining period for Ukraine's integration into the global space market. Through the adoption of innovative technologies, participation in large-scale international projects, and strengthening of its own infrastructure, Ukraine solidified its status as a key player in the global space arena, showcasing high levels of technical excellence and organizational potential. This era not only underscored Ukraine's commitment to space innovation but also set a foundation for future ventures in the international space industry, emphasizing its capability to contribute significantly to global space endeavors.

Institutional Changes and Strengthening International Cooperation. The appointment of Yuriy Alekseyev as the General Director of the State Space Agency of Ukraine (SSAU) in 2005 marked a significant milestone in the transformation of the national space sector. Under

his leadership, the sector saw strategic reforms in management mechanisms, enhancement of international cooperation, and integration of Ukraine into the European space framework.

A key initiative during this period was the Ukrainian-European TWINNING project (2008–2010), implemented in collaboration with France and Germany. The project aimed to deepen interactions between national space agencies, particularly through the exchange of experiences in regulating space activities and improving the normative-legal base. TWINNING served as a platform for harmonizing Ukrainian standards with European ones, strengthening Ukraine's position as a strategic partner to the EU in the space sector (Horbulin, et al., 2000).

A significant achievement in this direction was the signing of several key international agreements. Notably, the Agreement between Ukraine and the European Union on Cooperation concerning the Civil Global Navigation Satellite System Galileo, ratified by the EU on October 8, 2013, opened new opportunities for the development of navigation technologies in Ukraine. This document not only defined the framework for the implementation of modern satellite systems but also consolidated Ukraine's role in creating a global infrastructure for navigation technologies.

Another crucial step was the signing of the Agreement between the Government of Ukraine and the European Space Agency (ESA) on the use of outer space for peaceful purposes. This agreement laid the foundation for creating the "Ukraine-EU" joint working group, which focused on developing long-term cooperation strategies in the space sector. The joint efforts included the implementation of innovative scientific research, the development of cutting-edge technologies, and the initiation of projects in the fields of Earth remote sensing, satellite navigation, and telecommunications (On the Signing, 2008).

Thanks to such initiatives, Ukraine has strengthened its positive image on the international stage, demonstrating a high level of technical and scientific capability in space activities. This has facilitated the formation of new partnerships with leading space nations, expanding opportunities for integration into global programs and enhancing the use of space technologies for civil, scientific, and innovative purposes.

Challenges and Changes in the Administrative-Legal Regulation of Space Activities in Ukraine (2014–2021)

During the period from 2014 to 2021, the State Space Agency of Ukraine (SSAU) underwent significant internal organizational changes that had a profound impact on the strategic management of the space sector. The frequent changes in leadership, with six general directors over this period, posed serious challenges to the implementation of long-term programs. Notably, the fifth State Space Program (2013–2017) was not fully implemented due to systematic funding shortages, instability in management decisions, and frequent adjustments of goals and objectives (Vavilova, 2023).

A significant step in the legal regulation of space activities was the enactment of the Law of Ukraine "On Amendments to Some Laws of Ukraine Regarding State Regulation of Space Activities" in October 2019. This law opened opportunities for entities of all forms of ownership to participate in space activities, crucial for engaging the private sector in the industry. However, significant issues emerged, particularly the underdevelopment of the legal framework necessary for the effective functioning of public-private partnerships, which limited the full realization of the innovations' potential (The Head, 2019).

Further complications in organizational processes were induced by the Cabinet of Ministers of Ukraine's Resolution No. 819 on September 7, 2020, "Some Issues of the Ministry of Strategic Industries of Ukraine." According to this resolution, SSAU was subordinated to the newly

established Ministry of Strategic Industries. This decision provoked mixed reactions among experts. Instead of the expected optimization of management processes, the creation of a new administrative level led to the complication of bureaucratic procedures and further imbalance between the needs of the industry and the capabilities of state management (Kuznetsov, 2022).

Against this backdrop, on April 12, 2021, during an interdepartmental meeting, President Volodymyr Zelenskyy emphasized the necessity to develop a new scientific and technical space program for 2021–2025. However, the absence of a State Space Program since 2018 continued to pose challenges for the sector, which operated without clearly defined priorities, complicating Ukraine's integration into the international space market (Kuznetsov, 2022).

It is also important to note a significant step for Ukraine in December 2020 – the signing of the agreement to participate in NASA's international Artemis program (Artemis, 2020). This program is aimed at returning humans to the Moon and establishing a prolonged presence on its surface, as well as preparing for a manned mission to Mars. Ukraine's participation in the program is significant as it opens new prospects for integrating national space infrastructure into global initiatives involving advanced technologies and international cooperation. This step underscored Ukraine's potential as a reliable partner in space research and laid the groundwork for deepening cooperation with leading space agencies worldwide.

In the contemporary landscape of Ukraine's rocket and space sector, approximately 40 large enterprises operate alongside numerous small and medium-sized companies specializing in the development of innovative solutions, technologies, and scientific research. Key players include the Yangel Design Bureau "Pivdenne" and the production association "Pivdenmash" named after O.M. Makarov in Dnipro. Their activities have led to the creation of over 400 Earth satellites and the development of launch vehicles, control systems, orientation, and flight trajectory systems.

Ukrainian specialists have achieved significant results in the creation of spacecraft such as "Sich-1," "Ocean-O," "AUOS," "Micron," and launch vehicles "Zenit-3SL," "Dnipro," and "Cyclone-3." The "Zenit-3SL" rocket gained international recognition through its participation in the "Sea Launch" program, and "Dnipro" through the conversion of military technologies into commercial satellite launch projects. Moreover, the "Kurs" docking apparatus, developed by Ukrainian specialists, has become a standard for space missions to the International Space Station. The targeting systems developed in Ukraine are actively used in "Soyuz," "Progress," and "Proton" rockets (Koshova, 2022). Ukraine possesses unique ground infrastructure, including control-correction stations for global navigation satellite systems (GNSS) and a network for monitoring geophysical phenomena. Specifically, the National Unified Network of Reference Stations provides high-precision real-time positioning (RTK), along with a network of seismic and geophysical observations that includes the National Data Center of NSSU and the Main Special Control Center (GCSK) (National, 2024).

It is evident that Ukraine has significant potential in the space sector, based on inherited infrastructure, advanced technologies, and engineering expertise. However, despite substantial achievements, the contemporary development of the industry faces several challenges, including instability in administrative-legal regulation, funding deficiencies, and difficulties in implementing strategic programs. For instance, Ukraine's participation in international projects such as "Artemis" and partnerships with the European Space Agency demonstrates potential for further integration into global initiatives, but consolidating these positions necessitates reforming the legal framework and eliminating structural barriers (Beldav & Rokytsky, 2024).

Thus, ensuring management stability and developing a long-term strategy are crucial steps that will allow Ukraine to effectively utilize its scientific and technical potential and strengthen

its position in the global market for space services. The full-scale armed aggression against Ukraine has created new challenges for the space sector, which has become a critically important element of national security and defense. Space technologies play a key role in providing strategic surveillance, reconnaissance, navigation, and communications for military and civilian structures. In these conditions, the development of space infrastructure and the expansion of Earth remote sensing capabilities acquire special significance for effectively managing defense operations and monitoring battlefield conditions.

Space activities in wartime: challenges and issues

The full-scale invasion of Ukraine by Russia in 2022 created unprecedented challenges for the aerospace sector, jeopardizing not only existing programs but also the very scientific and technological base of the country. The destruction of infrastructure, relocation of enterprises, loss of personnel, and constraints on funding for strategic projects have critically impacted Ukraine's ability to implement long-term space initiatives. Preserving scientific and technical potential requires not only state support but also active engagement of international partners and investors (Beldav & Rokytsky, 2024). In this context, coordinating efforts among state institutions, the private sector, and international organizations is crucial to enhancing the competitiveness of Ukraine's aerospace sector and its integration into global defense and research programs.

Today, Ukraine's aerospace sector faces a number of systemic issues that significantly affect its development and efficacy:

1. Lack of a Unified Space Activity Development Strategy. Despite the ambitious goals set in the National Space Program for 2021–2025, the absence of a comprehensive strategy that accounts for new wartime challenges remains a significant obstacle to industry development. Frequent shifts in priorities and the lack of stable funding greatly complicate the implementation of both national and international projects. For example, after the expiration of the previous program in 2017, a new program was not adopted in time, which disrupted the coordination between state and private sector entities in the industry (Vavilova, 2023).
2. Inefficiency in State Administration. The State Space Agency of Ukraine (SSAU) faces numerous administrative challenges. A key issue is the insufficient coordination among executive bodies. The subordination of the SSAU to the Ministry of Strategic Industries in 2020 (Certain, 2020) introduced an additional bureaucratic barrier that reduced the agility in making crucial decisions. The lack of autonomy in funding and management complicates the strategic planning process and increases dependence on political circumstances.
3. Absence of an Effective Public-Private Partnership Model. Despite significant potential for private sector engagement, the legal framework for public-private partnerships in Ukraine's space sector remains underdeveloped. The Law of Ukraine "On Space Activities" (On Space, 1996) partially regulates these relationships but does not create incentives for active participation by private companies. The lack of tax incentives, grant support, and state funding for startups and small enterprises inhibits the development of innovative projects. This situation contrasts with practices in the EU and the USA, where the space sector is actively developing through private investments and state support. Collaboration between government bodies and space enterprises is identified as a key element in forming an effective space policy for any country. However, several main areas can be distinguished:

4. Policy Development and Regulation. Government bodies define strategic policy and develop regulatory norms for space activities, incorporating contributions from space enterprises. Such collaboration helps to create policies that meet industry needs and contribute to achieving national goals.
5. Funding and Investment Support. The state provides funding and offers investment incentives to support innovation, scientific research, development, and the implementation of space programs. This approach stimulates technological development and enhances the industry's competitiveness.
6. Public-Private Partnership (PPP). Government bodies and private space companies join efforts in public-private partnerships. This allows optimal use of resources, distribution of risks, and the creation of joint ventures for the effective execution of space projects.
7. Research and Development (R&D). Joint participation by the state and enterprises in scientific research enables the development of cutting-edge technologies, expands industry capabilities, and addresses common challenges. Such collaboration stimulates innovation and enhances the competitiveness of the space sector.
8. Provision of Infrastructure and Facilities. Government bodies provide access to critical infrastructure objects, such as launch complexes, testing grounds, or communication networks, essential for the implementation of space missions and commercial activities.
9. Facilitating Dialogue and Supporting the Regulatory Environment. Continuous dialogue between the state and space enterprises helps maintain a regulatory environment conducive to industry development, innovation growth, and increased competitiveness (Karpenko, 2023).

1. ***Personnel challenges in the Ukrainian space industry***

The Ukrainian aerospace sector is experiencing a significant brain drain as highly qualified professionals migrate abroad, substantially weakening the country's human resource base. The lack of targeted programs to support young scientists and engineers, insufficient attention to training students in space-related specialties, and the decreasing prestige of working in the industry threaten the future of the aerospace sector. The primary issues are the aging of the scientific and technical workforce and the lack of motivation among young professionals (Koshova, 2022a).

According to the proceedings of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III), a key factor in further progress in space exploration and enhancing the effectiveness of space technologies for addressing global challenges is the targeted training of specialists and fostering youth interest in space science and technology. The conference documents emphasize the critical role of the United Nations as a leading organization in space activities, highlighting the need to engage young people in space projects. This includes participation in the development of space technologies, the popularization of scientific and technological achievements, and facilitating the transformation of promising plans into real projects (Koshova, 2022b).

The importance of developing educational programs and stimulating youth to study in the space field through support for STEM education and the creation of innovative centers, such as

the O.M. Makarov National Aerospace Educational Center for Youth, is also emphasized in the Development Strategies 2023 (Recommendations, 2024).

This comprehensive academic analysis highlights the critical challenges in human resources within Ukraine's aerospace sector. It emphasizes the need for strategic interventions to reverse the trends of workforce aging and brain drain, enhancing the sector's capacity to contribute effectively to both national and global space initiatives. The creation of supportive educational environments and the active involvement of youth in space-related activities are deemed essential for revitalizing the sector and securing its future.

*2. **Challenges in funding and investment in the Ukrainian space sector***

The funding of the space sector from the Ukrainian state budget remains limited, especially during war times when priorities shift towards the defense sector. The development program for space activities for 2021-2025 was prepared before the onset of the full-scale invasion, necessitating its review and adaptation to current challenges. During the second reading of the program, amendments were made to accommodate new priorities and timelines that meet the needs of national security and defense of Ukraine. The total funding for the space program from 2021 to 2025 is projected to be 40.78 billion UAH, with 15.76 billion UAH expected from the state budget. The main expenditure directions include:

- Development of rocket and space technology – 7.6 billion UAH;
- Earth observation systems – 3.96 billion UAH (Draft, 2021).

These areas have become particularly significant in the context of increasing demand for satellite reconnaissance, which ensures the country's defense capabilities and situational control at the front. In 2022-2023, funding was maximized due to the need for space technologies for conducting combat operations and planning (Draft, 2021).

The main source of funding is the state budget, however, additional lawful sources such as investments and private contributions are critically important. The coordination of program execution is carried out by the State Space Agency of Ukraine in cooperation with the Ministry of Strategic Industries. A portion of the resources is directed towards fundamental and applied research (3.3 billion UAH), which stimulates innovation and strengthens Ukraine's position in the international space market.

The key strategic priorities highlighted in the recommendations from the joint meeting "Space in Times of War and Peace" emphasize the need for:

- Implementing a new model of space activities that aligns with wartime conditions and national priorities, with a special focus on using space technologies for national security and defense.
- Integrating Ukraine into the European space market through active cooperation with the European Space Agency (ESA) and the implementation of joint projects.
- Optimizing costs by involving the private sector in executing space projects and implementing public-private partnership mechanisms.
- Developing national systems for space situation monitoring and satellite communication, which are critically important for defense and post-war recovery (Recommendations, 2024).

The investment climate and barriers remain a significant challenge, with insufficient levels of investment in the space sector being a key factor. The absence of effective mechanisms for attracting private capital and imperfect legislation that does not stimulate investors is a concern.

A priority is the systematic modernization of legislation and the implementation of incentives for the private sector, including tax breaks and grants.

3. ***Challenges and imperfections in the regulatory framework of Ukraine's space sector***

The legislative framework governing space activities in Ukraine requires modernization to align with current global trends. The existing state of Ukrainian legislation in the space sector does not meet contemporary challenges. The lack of a systematic approach to updating legal norms and integrating international standards into the national legal system significantly limits the industry's capabilities. A crucial task now is the reform of the legal framework considering global trends, focusing on simplifying the processes for licensing and regulating private space activities. Consequently, the current Law of Ukraine "On Space Activities" from 1996 and its associated subordinate legislation require modernization. The legislative framework reveals several critical gaps, including:

- The absence of mechanisms for implementing international standards in space activities, complicating Ukraine's integration into the global space market.
- Outdated licensing procedures that do not reflect the dynamics of the private sector and the concept of "New Space."
- Insufficiently regulated issues of public-private partnerships, hindering the attraction of investments and the creation of innovative startups.

The updated draft of the Strategy for the Development of Space Activities in Ukraine until 2033 emphasizes the need to adopt a new Law of Ukraine "On Space Activities" that will include stimulating norms for investments and development of the private sector, particularly through public-private partnerships (Recommendations, 2024).

Role of the National Targeted Scientific and Technical Space Program

The National Targeted Scientific and Technical Space Program (the Program) is a crucial tool for strategic planning in the space sector. It is developed based on the Law of Ukraine "On Space Activities" and approved by the Verkhovna Rada of Ukraine following a decision by the Cabinet of Ministers of Ukraine. The formation of the program is conducted in collaboration with the State Space Agency of Ukraine (SSAU), research institutions, executive authorities, and the National Academy of Sciences of Ukraine.

In wartime conditions, the Program is vital for ensuring national security and defense, as space technologies facilitate the monitoring of combat operations, missile threat forecasting, and communication under challenging conditions. As noted by Koshova, S.P., the war has underscored the importance of space technologies not only for development but also for the survival of the country (Koshova, 2022a).

Key Directions for Reform:

- Modernization of Licensing: Programs of the European Space Agency (ESA) highlight the importance of creating a transparent and adaptive licensing system to attract the private sector and stimulate innovation. Introducing simplified procedures for new market participants will enable more active involvement of startups and investors in the sector (Recommendations, 2024).
- Implementation of International Standards: Adapting to European Union standards, as outlined in the Strategy until 2033, will create conditions for harmonizing Ukrainian projects with European initiatives such as the Artemis and Horizon Europe programs.

This will open new opportunities for international cooperation (Recommendations, 2024).

- Development of Public-Private Partnerships: The Strategy identifies public-private partnership as a key tool for the development of the space sector. Introducing mechanisms for co-financing, grants, and tax incentives will attract private capital and facilitate the creation of new high-tech products (Karpenko, 2023).

4. *Challenges of operational response to military threats in the Ukrainian space sector*

Satellite technologies play a decisive role in modern military conflicts by providing intelligence, navigation, and communication capabilities. For Ukraine, which is countering Russian aggression, having its own satellite resources is crucial for autonomous decision-making and effective conduct of combat operations. However, limitations in national space capabilities and dependence on data from international partners pose significant challenges for the country's defense capabilities (Borisikhina, 2022).

Limitations of National Satellite Resources Currently, Ukraine possesses a limited number of its own satellites for Earth remote sensing. The launch of the "Sich-2-30" satellite in 2022 was a significant step forward, yet its technical capabilities do not fully meet the military's need for high-precision data (The Ukrainian, 2021).

Dependence on International Partners Due to the limited capabilities of Ukrainian satellite systems, Ukraine must rely on data from international partners and private companies. A notable example is the collaboration with the Finnish company ICEYE, which provides Ukraine with access to satellite images using Synthetic Aperture Radar (SAR). This was made possible through a crowdfunding campaign led by Sergiy Prytula, which raised approximately 16.3 million euros for purchasing satellite images and a contract for using the ICEYE satellite (The People's, 2023).

The dependence on ICEYE satellites, while beneficial, does not provide full autonomy. Risks include potential access restrictions or delays in critical information if conflicts escalate or if there are disruptions in partner operations.

For instance, satellite images from MAXAR Technologies have been crucial in assessing damages in Bakhmut and other hotspots, demonstrating the importance of foreign assistance but also highlighting vulnerabilities due to the lack of own resources (The Obliteration, 2023).

Although international support offers significant advantages, it comes with risks of limited control over data and potential delays in processing. According to research by Groundstation, the effectiveness of operations often depends on external commercial structures, complicating immediate responses to changing situations (Veritas, 2023).

Successful Use of Satellite Data A key case was the destruction of Russian ammunition depots and equipment facilitated by images from ICEYE satellites. Within six months of acquiring the satellite, Ukrainian intelligence inflicted billions of dollars in damages on enemy military assets, enabled by the satellites' ability to operate independently of weather conditions and time of day (The People's, 2023).

Impact on Decision-Making Speed Satellite data are critical in planning military operations. Having accurate and timely data from space reduces risks to military units, increases the effectiveness of strikes, and minimizes the likelihood of errors. However, dependence on international partners carries the risk of delays in image delivery and possible restrictions on certain areas or strategic assets. For example, companies may refuse to provide images of certain

regions or impose restrictions on the frequency of information updates, significantly reducing command responsiveness.

Other countries' experiences underscore the importance of developing national space capabilities for national security. For example, Finland actively cooperates with Ukraine in the field of satellite technologies, providing access to its resources and helping to develop national capabilities (How, 2023).

This highlights the importance of international cooperation but also points to the need for investment in own technologies. Essential development directions include:

- Developing a national space program: Investing in creating and launching own satellites to ensure independence in intelligence gathering.
- Strengthening cooperation with international partners: Continuing collaboration with companies like ICEYE to access advanced technologies and share expertise.
- Developing ground infrastructure: Creating modern centers for processing and analyzing satellite data to improve the speed and accuracy of decision-making.

The limitations of own satellite resources and dependence on international partners significantly affect Ukraine's defense capabilities. Developing national space capabilities is a strategic step towards ensuring autonomy in decision-making and enhancing the effectiveness of military operations.

Administrative and legal pathways for modernizing space activity management

Effective normative and legal regulation is essential for the development of Ukraine's space sector. It determines the main directions of management, allowing for a systematic and long-term approach to the implementation of state policy in this area. As noted in recent studies, the effectiveness of regulation largely depends on the refinement of national legislation and a thorough analysis of international legal documents that form the legal basis for space activities (Koshova, 2022b).

The legal framework for space activity in Ukraine consists of a combination of laws, presidential decrees, and regulatory acts of the Cabinet of Ministers. For instance, the primary document, the Law of Ukraine "On Space Activity" dated November 15, 1996, No. 502/96-VR, establishes general principles, directions of state management, rules of activity in the space sphere, and specifics of forming national programs. Other important acts like the Law of Ukraine "On State Support for Space Activity" dated March 16, 2000, No. 1559-III, regulate financing and development of the technological and export potential of the industry.

Presidential decrees play a crucial role, for example, "On the Establishment of the National Space Agency of Ukraine" dated February 29, 1992, No. 117, which defined the legal status and tasks of this institution, and "On the National Center for the Control and Testing of Space Means" dated August 12, 1996, No. 698/96, which establishes procedures for rapid response to potential threats to national security. Regulatory acts of the Cabinet of Ministers, such as the "Regulation on the State Space Agency of Ukraine," approved by the resolution dated May 14, 2015, No. 281, ensure the implementation of state policy in the space sector.

However, as highlighted during the recent joint meeting "Space in Times of War and Peace. Strategic Orientations and Priorities," there is a significant need for modernization of the management system of space activities. Participants noted that space technologies are critically important for ensuring security, defense, and sustainable development of Ukraine. They are an

integral part of digitalization systems for the economy and national security. The priority lies in developing national ground monitoring systems, satellite communications, and navigation (Recommendations, 2024).

There is an urgent need to develop a new Space Strategy for Ukraine, which would include measures to reform the space industry, define key directions for international cooperation, and create a coordinating body at the level of the Cabinet of Ministers of Ukraine. A special emphasis is placed on implementing public-private partnerships to stimulate the development of the "New Space" sector, which would allow private business to engage in prospective space projects (Recommendations, 2024).

The discussion of "administrative-legal regulation" in the context of public-private partnership in Ukraine's space sector emphasizes its application not just as a means for managing administrative service fees but as a broader regulatory mechanism. This term, when used in this specialized governance context, signifies the actions of governmental entities concerning their authoritative powers aimed at ensuring public interests. This shift toward a more expansive approach to "administrative-legal regulation" is apparent in its detailed inclusion in legislative texts, such as the Tax Code of Ukraine, which outlines the administration of taxes, duties, customs payments, and social security contributions as comprehensive actions and procedures by regulatory bodies.

The notion of "administrative-legal regulation" in public-private partnerships within the space sector could be more effectively characterized by establishing clearer definitions and norms. Such a redefinition would help clarify the roles and responsibilities of public and private sectors in managing space activities, thereby fostering a more transparent and structured approach to governance. This, in turn, could lead to more efficient management and implementation of space projects and policies, crucial for enhancing the country's defense, security, and sustainable development capabilities (Karpenko, 2023a).

Future efforts should focus on refining the theoretical framework around this term to achieve doctrinal clarity, which would facilitate its formal integration into the legal system. As this term has varying interpretations, achieving consensus on its definition could streamline regulatory practices and enhance the efficacy of public administration in Ukraine's space sector. Thus, the modernization of administrative-legal regulation in this field should be seen as an ongoing priority, essential for aligning national governance strategies with contemporary space industry challenges and opportunities.

Yet, as of 2023, the need for modernization of space activity management was actively discussed in Ukraine, defining it as one of the key directions of state policy in the areas of security and technological development. The draft Strategy for the Development of Space Activities in Ukraine up to 2033 was presented to the Cabinet of Ministers, emphasizing the critical importance of space technologies for defense capability, sustainable development, and the digitalization of the economy. In particular, the document stated that the full-scale military aggression of the Russian Federation brought to the fore the need to use space technologies for controlling state borders, monitoring military groupings, planning defense operations, and managing emergency situations (Draft, 2023).

The Strategy envisaged radical changes in approaches to space activities, aimed at creating new jobs, increasing the level of national security, and integrating Ukraine into the European space market. The document emphasized the necessity of developing a new edition of the Law of Ukraine "On Space Activity," corporatizing state enterprises, creating a "space holding," and engaging the private sector in the development of the "New Space" sector. It also planned

to restore scientific and production capacities and create new technological chains capable of producing competitive space technology. A special focus was placed on integrating Ukraine into the European Space Agency (ESA) and participating in international projects such as "Artemis" and "Moon Village." Meanwhile, it was emphasized the need to activate Ukraine's activities in international organizations related to the use of space (Draft, 2023).

Despite the ambitiousness and relevance of the Space Activity Development Strategy for Ukraine, its non-adoption at the state level by the end of 2023 indicates the presence of deep systemic problems in the field of strategic planning, management, and coordination among state authorities. One of the key obstacles remains the lack of an integrated approach to developing the space sector, reflecting the fragmentation of the legal base, insufficient inter-agency cooperation, and weak interaction with the private sector.

An important aspect is that in the context of current geopolitical challenges, space activity is considered a critically important component for ensuring defense capability and national security. In 2023, the Organisation for Economic Co-operation and Development (OECD) highlighted the significance of space technologies for monitoring military threats, which has become particularly relevant in the context of the war in Ukraine. According to OECD data, the use of space apparatuses for tracking military equipment movements and coordinating defense operations is a strategic tool in the fight for territorial integrity (How, 2023).

However, the lack of adequate state funding for the space sector leads to the stagnation of many promising projects. Regular delays in the allocation of budget funds and the imperfection of public-private partnership procedures significantly reduce Ukraine's competitiveness on the international arena. As noted in an analytical report by New York Post, the successes of companies such as SpaceX have been made possible by close collaboration with NASA and significant investments from the US government (Tapscott, 2024). In contrast, in Ukraine, cooperation between the state and private business remains at a conceptual level, which prevents the rapid implementation of space initiatives and the commercialization of the industry. Additionally, significant technological dependence on foreign partners, particularly until 2014 from the Russian Federation, creates additional barriers to the development of domestic production of space technology. The lack of large-scale import substitution programs and limited access to modern technologies lead to the loss of competitive positions in the global market. This is exacerbated by a personnel shortage and the emigration of specialists abroad, which makes it impossible to implement large engineering projects in a short time (How, 2023).

A significant factor in stagnation is also insufficient coordination among state bodies, which creates a legal vacuum and limits the opportunities for the development of the private sector. The imperfection in the legal regulation of space activity is manifested in the fragmentation of the legislative base and the absence of a single coordination center (Semenyaka, 2021).

In light of the above, the absence of an adopted Strategy for the Development of Space Activities is a critical factor that slows down Ukraine's integration into European and global space projects. To address this issue, it is necessary to:

- Develop an effective public-private partnership mechanism, taking into account the experience of ESA and NASA.
- Introduce clear financial incentives for private sector investment in the space industry.
- Activate efforts on import substitution and the development of own technologies.
- Create a single coordination center that will provide comprehensive management and coordination of inter-agency space projects.

Thus, the acceleration of the adoption of the Strategy and its further implementation will allow Ukraine to reach a qualitatively new level of space activity and ensure its integration into the international space community.

Conclusions

This study has focused on exploring the impact of the state of war on the functioning of the space sector. It was found that space technologies play a crucial role in ensuring national security, strategic defense, and territorial monitoring. However, infrastructure destruction, limited funding, and the emigration of highly skilled personnel significantly complicate the implementation of national space programs. The analysis highlights Ukraine's critical dependency on international partners for satellite reconnaissance, communications, and navigation, which introduces additional risk factors in a wartime context.

A set of administrative and legal measures aimed at overcoming the identified challenges and creating favorable conditions for the modernization of the space sector is proposed. The necessity of adopting a new version of the Law of Ukraine "On Space Activity" is emphasized, along with the development and implementation of a National Space Program that meets current challenges and priorities. Special emphasis is placed on creating a single coordination center capable of providing integrated management of space projects and enhancing the efficiency of collaboration between the public and private sectors.

The research underscores the importance of harmonizing national legislation with European and international standards in space law. A priority direction is identified as enhancing cooperation with the European Space Agency (ESA), NASA, and other leading space agencies, which will allow Ukraine to consolidate its position on the international stage and facilitate the attraction of investments into the space sector. Ultimately, the implementation of the outlined measures will promote the development of national space infrastructure, strengthen defense capabilities, and integrate Ukraine into the global space community.

🕮 References

Artemis Accords (2020) NASA. Available online: https://www.nasa.gov/specials/artemis-accords/index.html

Beldav, Widwood and Yevhen Rokytsky (2024) Integration of the Ukrainian Aerospace Sector into Europe. Space Ukraine. Available online: https://space.com.ua/2024/02/24/integratsiya-ukrayinskoyi-aerokosmichnoyi-galuzi-v-yevropu/

Borisikhina, Kira (2022) How Starlink and Other Satellite Companies Help Ukraine in the War Against Russia. Available online: https://techno.nv.ua/ukr/innovations/yak-starlink-ta-inshi-suputnikovi-kompaniji-dopomagayut-ukrajini-u-viyni-z-rosiyeyu-50222327.html

Certain Issues of the Ministry of Strategic Industries of Ukraine (2020) Resolution of Cabinet of Ministers of Ukraine from September 7, 2020, No. 819. Available online: https://zakononline.com.ua/documents/show/488162___771396

Draft Law on the Approval of the National Targeted Scientific and Technical Space Program for 2021-2025, No. 6129 dated October 4, 2021 (2021) Verkhovna Rada of Ukraine. Available online: https://itd.rada.gov.ua/billInfo/Bills/CardByRn?regNum=6129&conv=9

Draft Strategy for the Development of Space Activities in Ukraine until 2033 (2023) Aerospace Ukraine. Available online: https://a-kosmos.com.ua/wp-content/uploads/2023/08/проєкт%20Стратегії_2023.pdf

History (2024) National Space Agency of Ukraine. Available online: https://www.nkau.gov.ua/ua/dka-ukrainy/istoriia

Horbulin, V. P., Shevtsov, A. I., & Shekhovtsov, V. S. (2000) The International Space Services Market: Ukraine's Position and Perspectives. *Space Science and Technology*, 6(1), 64-71. https://doi.org/10.15407/knit2000.01.064

How the war in Ukraine is affecting space activities (2023) OECD iLibrary. Available online: https://www.oecd-ilibrary.org/science-and-technology/how-the-war-in-ukraine-is-affecting-space-activities_ab27ba94-en

Karpenko, S. R. (2023a) Analysis of certain aspects of the administrative-legal regulation process of public-private partnership relations in the space sector of Ukraine. *Kyiv Law Journal*, 2, 153-160. https://doi.org/10.32782/klj/2023.2.21

Karpenko, S. R. (2023b) On the Criteria for the Classification of Subjects of Administrative-Legal Regulation of Public-Private Partnerships in the Space Sector of Ukraine. Proceedings of the International Scientific Internet Conference. Ternopil.

Koshova, S. P. (2022a) Features of the Development of the Space Sector in Ukraine's Post-War Period. *Investments: Practice and Experience*, 9-10, 96-102. https://doi.org/10.32702/2306-6814.2022.9-10.96

Koshova, S. P. (2022b) Normative-Legal Provision of the Space Sector of Ukraine. *Efficiency of State Management*, 9-10, 96-105. https://doi.org/10.32702/2306-6814.2022.9-10.96

Kotsur, V. (2023) Challenges and threats to the collective security of Europe in the context of the Russian-Ukrainian war. *Strategic Defense Challenges*, 18, 151-162. Available online: https://sdc-journal.com.ua/web/uploads/journals_pdf/SDC_2023_18.pdf#page=151

Kuznetsov, E. I. (2022) Thirty Years in Orbit: Celebrating the 30th Anniversary of the Establishment of the State Space Agency of Ukraine. Kyiv: Space-Info.

National Data Center of the State Space Surveillance System of Ukraine (2024) Main Special Control Center. Available online: https://gcsk.gov.ua

On Space Activities (1996) Law of Ukraine from November 15, 1996. No. 502/96-VR. Verkhovna Rada of Ukraine. Available online: https://zakon.rada.gov.ua/laws/show/502/96-вр

On the Signing of the Agreement between the Government of Ukraine and the European Space Agency Regarding the Extension of the Cooperation in the Peaceful Uses of Outer Space of January 25, 2008 (2008) Cabinet of Ministers of Ukraine. Available online: https://www.kmu.gov.ua/npas/pro-pidpisannya-ugodi-u-formi-obminu-listami-mizh-uryadom-ukrayini-ta-yevropejskim –

Recommendations of the joint workshop "Space in Times of War and Peace: Strategic Guidelines and Priorities" (2024) Committee of the Verkhovna Rada of Ukraine on Economic Development, Council for Space Research of the National Academy of Sciences of Ukraine, and Ukrainian Association of High-Tech Enterprises and Organizations "COSMOS" (April 11–12, 2024, Kyiv). Kyiv: State Space Agency of Ukraine. Available online: https://files.nas.gov.ua/PublicMessages/Documents/0/2024/05/240508113030417-4848.pdf

Semenyaka, V. (2021) Current Trends and Problems in Legal Regulation of Space Policy Formation in Ukraine. *Advanced Space Law*, 8, 96-103. https://doi.org/10.29202/asl/8/9

Tapscott, Alex (2024). How Elon Musk's SpaceX Began a New 'Space Race' Unlike Any Other [Electronic resource]. Available at: https://nypost.com/2024/09/21/tech/elon-musks-spacex-began-a-new-space-race

The Head of State Signed the Law on the Regulation of Space Activities (2019) Office of the President of Ukraine. Available online: https://www.president.gov.ua/news/glava-derzhavi-pidpisav-zakon-shodo-regulyuvannya-kosmichnoy-58089

The Obliteration of Bakhmut: New Satellite Photos Reveal a City of Smoldering Ruins (2023) RFE/RL, MAXAR Technologies. Available online: https://www.rferl.org/a/bakhmut-ukraine-satellite-images-maxar-destruction/32416025.html

The People's Satellite: Ukrainian Crowdfunding Campaign Acquires ICEYE SAR Satellite for Military Use (2023) Defence Intelligence of Ukraine. Available online: https://defence-ua.com/news/the_defense_intelligence_reveals_ukraines_strategic_use_of_the_iceye_satellite-10971.html

The Ukrainian Satellite Constellation: Known Facts and Perspectives (2021) Defense Express. Available online: https://defence-ua.com/minds_and_ideas/kosmichne_ugrupuvannja_suputnikiv_ukrajini_scho_vidomo_ta_jaki_perspektivi-5409.html.

Vavilova, I. K. (2023) Ukrainian Space Innovations: Challenges and Perspectives. *Space Science and Technology*, 29(1), 63-74. Available online: https://www.mao.kiev.ua/biblio/jscans/knit/2023-29/knit-2023-29-1-07-vavilova.pdf

Veritas, Vincet (2023) Space for Ukraine: The Impact of Satellite Data on Ukraine's Defence Efforts. Groundstation. Available online: https://www.groundstation.space/defence/ukraine/space-for-ukraine-the-impact-of-the-satellite-data-on-ukraines-defence-efforts/

Artificial Intelligence as an Object of Global Digital Governance

Diana Levchenko

Ph.D. in Law, Researcher, Information Analysis Center for Aerospace Law (Kyiv, Ukraine)
E-mail: diana.levchenko5@gmail.com
https://orcid.org/0000-0001-8343-2260

Levchenko, Diana (2024) Artificial Intelligence as an Object of Global Digital Governance. *Advanced Space Law*, Volume 14, 45-52. https://doi.org/10.29202/asl/14/4.

The article offers the author's understanding of the essence of artificial intelligence as a phenomenon of the digital society. The features of artificial intelligence as conditions for the transformation of global digital governance are determined. The relevance of the adoption of the Global Digital Agreement within the framework of the UN as a normative step in the creation of a worldwide system of principles and mechanisms for the transparent and accountable use of artificial intelligence is highlighted. The ethical challenges of introducing artificial intelligence into global digital governance are revealed. Attention is focused on ensuring access to digital technologies and resources (including artificial intelligence) for developing countries as a direction for the development of global digital governance. It is summarized that artificial intelligence is the driving force of changes in global governance. The important role of international cooperation in the development of uniform standards, ethical principles and inclusive models of management, which should become the basis for a harmonious combination of technical progress with humanitarian values, is determined.

Keywords: governance, global cooperation, global administration, space activities, space, development, artificial intelligence.

Received: 04 December 2024 / Accepted: 18 December 2024 / Published: 30 December 2024

Introduction

The rapid development of artificial intelligence and the intensification of the implementation of artificial intelligence (hereinafter – AI) in various spheres of society (for example, autonomous vehicles, lethal weapons systems, robotics, etc.) create serious challenges for legal regulation, which should manage the scale and speed of socio-technical transitions that are happening New applications of artificial intelligence offer opportunities to improve economic efficiency and quality of life, but they also generate unexpected and unanticipated consequences and create new forms of risk that must be addressed. To maximize the benefits of AI and minimize the downside risks, governments around the world need to better understand

the scale and depth of the emerging risks and put in place quality governance processes and structures to address these challenges (Taeihagh, 2021).

Many researchers also argue that artificial intelligence is rapidly becoming an important component of both digital communications and (most importantly) military applications of nations around the world. However, less is known about how states use artificial intelligence in their information warfare and influence operations. Major countries (notably the United States, China, etc.) are incorporating AI into their national security strategies, which has important implications for international security (Hunter et al., 2024).

In the conditions of complex security challenges, and in general, for the development of human benefits, the use of artificial intelligence is a complex process from the point of view of legal regulation. The relevant challenges in this area generate both regulatory gaps and further issues in the practical implementation of people's rights, freedoms and legitimate interests.

The essence of artificial intelligence as a phenomenon of digital society

There are still serious disputes about the definition of artificial intelligence. Controversy over the definition begins in computer science (Russell & Norvig, 2020), where the term was first introduced in a 1955 grant application. McCarthy (McCarthy et al., 1955) actually did not define this term, but only emphasized that "artificial intelligence" research must proceed on the basis of the assumption that every aspect of learning or any other feature of intelligence can in principle be so accurately described that a machine can be made to imitate it (Büthe et al., 2022).

Tim Büthe understands artificial intelligence as systems that combine means of collecting input data from the external environment with technologies for processing this input data and algorithmically linking it to previously stored data, which allows such systems to perform a wide range of tasks with some degree of autonomy, that is, without simultaneous continuous human intervention. Their ability to learn allows AI systems to solve problems and thus support, imitate or even improve human decision-making – although (at least at this stage of technological development) not holistically, but only with respect to well-defined, albeit perhaps quite complex, tasks (Büthe et al., 2022).

At the same time, vagueness due to lack of definition is costly. Many policy instruments use only partial or preliminary definitions – or refrain from providing a definition at all – creating uncertainty and encouraging conflict, including costly litigation, over the applicability of any particular measure (Büthe et al., 2022).

In our opinion, artificial intelligence as a phenomenon of the digital society is a complex digital-technological system capable of autonomously or with minimal human intervention, analyzing, algorithmically processing and adaptively using data and information in order to fulfil various tasks and goals.

Artificial intelligence, as a phenomenon of the digital society, is formed at the intersection of innovative technologies and societal challenges, contributing to the development of digital infrastructure, but at the same time generating new regulatory, ethical and legal issues that require careful analysis and management.

Artificial intelligence as a condition for the transformation of global digital governance

Now more than ever, artificial intelligence is impacting our society and lives on personal and professional levels. Although initial work on artificial intelligence began as far back as the 1950s, the year 2023 marked the AI revolution, with the technology advancing at an unprecedented pace, requiring governments, international organizations, regulators, the private sector, and all decision makers to recognize this powerful and revolutionary technology and adapt accordingly. Significant technical, legal and ethical implications affect virtually every sector, with no framework to guide and regulate decision-making processes. In this environment characterized by variability, uncertainty, complexity and ambiguity, it is imperative to build a truly effective and secure AI management model (Artificial, 2024).

Recent developments in the field of artificial intelligence show that this new technology will have a deterministic and potentially transformative impact on global governance, military power, strategic competition, and world politics in general. If left unchecked, the uncertainties and vulnerabilities created by the rapid proliferation and spread of artificial intelligence could become a major potential source of instability and great power strategic rivalry (Johnson, 2019).

At the same time, the main goal of managing artificial intelligence is not to manage the development of technology as such, but to avoid bad and achieve better results or consequences of a particular use of AI. For example, health-related data is considered particularly sensitive in many countries. AI-based analysis of such data can be used to assess personalized risk profiles, which can then be used to deny employment, health insurance or other benefits to high-risk individuals. Consequently, health and medical data are generally subject to some of the most stringent data privacy and security requirements. The collection of such data, its combination with other data and the analysis of health and medical data are strictly limited or even prohibited in many countries. However, such regulation of technology also inhibits progress in personalized medicine, delays progress in finding treatments for rare diseases, and hinders early detection and effective policy responses to public health risks and threats, such as epidemics and pandemics. Therefore, it may be much better in the public interest to relax restrictions on data and tools for analyzing it and instead focus on prohibiting denial of health insurance coverage (perhaps supplemented by government subsidies for high-risk insured individuals). Employment discrimination based on health status and other abuses – and strict enforcement of such prohibitions (Büthe et al., 2022).

International AI governance requires a flexible and multi-stakeholder approach. At the same time, artificial intelligence and other applications based on artificial intelligence are being integrated into international governance approaches. The last decade has seen the growth of AI-based applications that extend the management function (Budhwar et al., 2022).

Appropriate integration of artificial intelligence into international governance opens up new horizons for the efficiency of global processes (Global, 2024). However, such a tool cannot remain without the normative attention of the international community, because it is a direct object of influence on the model of global digital governance.

Such a normative direction was the adoption and agreement in 2024 at the level of the United Nations of the Global Digital Compact as part of the Pact for the Future, which addresses such urgent international issues as sustainable development, international peace, future generations, technology and innovation, as well as digital cooperation. The Global Digital Compact sets out

goals, principles, commitments and actions to develop an open, free and secure digital future for all, based on the benefits that digital technologies bring to humanity (The United, 2024).

The provisions of the Global Digital Compact include initiatives related to artificial intelligence. The main direction in the field of artificial intelligence is determined by the Global Digital Compact to improve the international management of artificial intelligence for the benefit of humanity (Global, 2024).

The signatories of the Global Digital Compact recognize the need for a balanced, inclusive and risk-based approach to the governance of artificial intelligence with full and equal representation of all countries, and especially developing countries. At the level of the international community, the enormous potential of artificial intelligence systems to accelerate progress on all Sustainable Development Goals has been identified (The 17, 2024). At the same time, the international community is trying to build a model of managing artificial intelligence in the public interest and ensure that the application of artificial intelligence contributes to the development of diverse cultures and languages and supports local data for the benefit of the development of countries and communities. Which includes, in particular, international cooperation to support developing countries in building the capacity of artificial intelligence, as well as efforts to address the potential negative impact of new digital technologies on work and employment and on the environment (Global, 2024).

In light of the Global Digital Compact's recognition of the need for a global, balanced and inclusive approach to AI governance, it is clear that the international community must not only recognize the potential of AI to achieve the Sustainable Development Goals, but also make efforts to build effective governance models that meet these challenges.

At the same time, given the speed, scale and uncertainty of the development of artificial intelligence, no existing AI management model is ideal. Instead, the international community should use several models of governance, forming a unified approach. This pragmatic yet optimistic path will allow humanity to maximize the benefits of AI programs and spread them as widely as possible, while minimizing harm and mitigating risks as efficiently as possible (Sepasspour, 2023).

The formation of effective AI management mechanisms should be based on a combination of a pragmatic approach, focused on achieving specific results, with inclusive cooperation at the international level. This means that, on the one hand, it is necessary to support developing countries in building their AI potential, and on the other hand, to test innovative management models that correspond to geopolitical reality and allow reducing risks from the use of new technologies. Such an approach will help not only to minimize the negative impact of AI on work, employment and the environment, but also to maximize its benefits through effective solutions to global problems within the framework of regional and multilateral groupings.

If we continue to analyze the modern model of global governance, then, in particular, the main directions of advancing international governance of artificial intelligence, defined by the provisions of the Global Digital Compact, are: assessment of future directions and consequences of artificial intelligence systems and promotion of scientific understanding; supporting interoperability and interoperability of AI management approaches by sharing best practices and promoting common understanding; helping to build capacity, especially in developing countries, to access, develop, use and manage artificial intelligence systems and channel them towards sustainable development; promoting transparency, accountability and robust human oversight of artificial intelligence systems in accordance with international law (Global, 2024).

It is artificial intelligence that currently plays a key role in the transformation of global digital governance, acting as a powerful driver of change and a condition for regulatory attention. Its integration into international governance processes opens wide opportunities for achieving the Sustainable Development Goals, contributing to solving global challenges such as the fight against poverty, climate change, and improving access to education and health care. However, the rapid development of AI requires the formation of complex legal cooperation capable of ensuring a balance between stimulating innovation and minimizing potential risks.

Therefore, as an additional form of international cooperation, states within the United Nations have committed to establish a multidisciplinary, independent international scientific commission on artificial intelligence with balanced geographic representation to promote scientific understanding through evidence-based assessments of impacts, risks and opportunities, based on to existing national, regional and international initiatives and research networks. Also in the immediate plans is the initiation within the framework of the United Nations Global Dialogue on the Management of Artificial Intelligence with the involvement of governments and all relevant stakeholders, which will take place in the fields of existing relevant UN conferences and meetings (Global, 2024).

Today, the development of international and intergovernmental partnerships to build the capacity of artificial intelligence for the development of educational and training programs, expanding access to resources, including open models and systems of artificial intelligence, open educational data and computation, facilitating training and development of artificial intelligence models, and promoting participation micro, small and medium enterprises in the digital economy. Also, the international community emphasizes the importance of increased investment, especially from the private sector and philanthropy, to increase the scale of building the potential of artificial intelligence for sustainable development (Global, 2024).

In general, the adoption of the Global Digital Compact within the framework of the UN is an important step in creating a worldwide system of principles and mechanisms for the transparent and accountable use of artificial intelligence. International cooperation should become the mainstay for the successful management of artificial intelligence. Coordinated actions of governments, international organizations, scientific institutions and the private sector will allow the exchange of best practices, the formation of joint platforms for the development of AI and the harmonization of approaches to its regulation. Given the speed and uncertainty of technology development, the implementation of multi-level and dynamic management is critically important. The use of different models and adaptive strategies will ensure an effective response to today's challenges and at the same time will allow building strategies for the future.

Ethical challenges of implementing artificial intelligence in global digital governance

In 2024, the signatories of the Global Digital Compact recognized the obligation to promote fair and inclusive approaches to harnessing the benefits of artificial intelligence and mitigating risks, fully respecting international law, including international human rights law, and taking into account other relevant frameworks, such as the Recommendations on ethics of artificial intelligence United Nations Educational, Scientific and Cultural Organization (Global, 2024; Recommendation, 2024).

Indeed, as AI technologies are proliferating around the world, international debate is increasingly focused on their implications for democracy, human rights, fundamental freedoms, security, and economic and social development. In this context, the UNESCO Recommendation on the Ethics of Artificial Intelligence, adopted in November 2021, became the first global regulatory framework for the development and implementation of AI. Tense negotiations over every detail of the document have caused numerous disputes among UNESCO member states. Drawing on a unique set of primary sources, including written positions and recorded discussions, this article explains the achievement of a global compromise on the regulation of artificial intelligence despite the multiple positions of UNESCO member states representing a variety of liberal and sovereign preferences (Natorski, 2024).

Thus, artificial intelligence is not just a technological tool, but an important element in the formation of the future digital ecosystem. Its potential to achieve sustainable development can only be realized if balanced, inclusive and adaptive models of global governance are implemented, which will meet the challenges of today and the needs of future generations.

AI as an object of global governance must be developed in compliance with ethical principles, transparency and preservation of human control. This will help prevent abuse and ensure its use is solely for the benefit of humanity. Special attention should be paid to education, which will help prepare society for effective interaction with the latest technologies, as well as promote the development of innovative ecosystems and participation in the digital economy. At the same time, it is extremely important to ensure access to technologies and resources for developing countries, to stimulate the preservation of local languages and cultures, and to create conditions for their equal participation in the global digital environment.

Possibilities of artificial intelligence for managing space activities

Artificial Intelligence provides unlimited opportunities for various spheres of society, space is no exception. Indeed, there are various possibilities of artificial intelligence for space activities, for example, the robotics of space missions. Effective robotic exploration, especially deep space, optimally requires advanced artificial intelligence. This creates ethical and social problems in interaction with people. Human exploration of deep space ideally requires the physiological improvement of future astronauts. Meanwhile, advances in space medicine, countermeasures to cosmic radiation, and artificial gravity also offer solutions for human spaceflight. Deep space mission planners must consider both advanced robotic artificial intelligence and human physiological enhancement (Szocik & Tachibana, 2019). Trends in the use of artificial intelligence for space also affect legal regulation, in particular, as some scientists pay attention to the adoption of a new European space law, which will establish common standards and rules for the national legislation of EU member states and the Community as a whole (Soroka & Danylenko, 2024).

Artificial intelligence is opening new horizons for managing space activities, promoting efficiency, safety and innovation in space exploration. Its implementation makes it possible to automate complex operations, optimize resource management and ensure accuracy in decision-making even in deep space, where human intervention is limited. At the same time, the use of AI raises the issue of ethical responsibility, the distribution of powers between autonomous systems and people, as well as the legal regulation of the interaction of these technologies with traditional management methods. The integration of AI into the governance of space activities requires the development of legal standards that will guarantee transparency, security and

compliance with the interests of all subjects of space law. This approach will contribute to the harmonious combination of technical progress with humanitarian values, ensuring sustainable development in the field of space exploration and development.

Conclusions

Artificial Intelligence is a strategic element of the modern digital society, which fundamentally affects global governance, providing new opportunities for development and solving key challenges of humanity. Thanks to its ability to autonomously analyze, process large volumes of data and perform complex tasks, AI plays an important role in achieving sustainable development, increasing the efficiency of management processes and transforming traditional approaches to global cooperation. However, its rapid development gives rise to a number of challenges, including legal, ethical and social ones, which require careful regulation and adaptive management.

Artificial Intelligence is not only a technological tool, but also an object of legal regulation, which should ensure a balance between stimulating innovation and minimizing potential risks. It is necessary to guarantee transparency in the use of AI, preservation of human control over autonomous systems, compliance with ethical principles and protection of people's rights and freedoms in the digital environment. The lack of uniform approaches at the international level can cause gaps in legal regulation and create risks for global stability.

The potential of AI in achieving the Sustainable Development Goals is unprecedented. This technology has the potential to contribute to the fight against poverty, climate change, increased access to education and health care, while preserving cultural and linguistic diversity. Ensuring equal access to technology, especially for developing countries, is a key element in creating an inclusive digital environment that will contribute to the harmonious development of society.

Overall, AI is driving change in global governance, but its effective use requires a balanced and adaptive approach. International cooperation, aimed at the development of uniform standards, ethical principles and inclusive management models, will become the basis for a harmonious combination of technical progress with humanitarian values. This approach will ensure that the benefits of AI for humanity are maximized while maintaining sustainability, transparency and responsibility in its use.

🕮 References

Artificial Intelligence and international affairs (2024) UNITAR. Available online: https://unitar.org/sustainable-development-goals/multilateral-diplomacy/our-portfolio/artificial-intelligence-and-international-affairs

Budhwar, P., Malik, A., De Silva, M. T. T., & Thevisuthan, P. (2022) Artificial Intelligence – challenges and opportunities for international HRM: a review and research agenda. *The International Journal of Human Resource Management*, 33(6), 1065-1097. https://doi.org/10.1080/09585192.2022.2035161

Büthe, T., Djeffal, C., Lütge, C., Maasen, S., & Ingersleben-Seip, N. von. (2022) Governing AI – attempting to herd cats? Introduction to the special issue on the Governance of Artificial Intelligence. *Journal of European Public Policy*, 29(11), 1721-1752. https://doi.org/10.1080/13501763.2022.2126515

Global Digital Compact (2024) United Nations. Available online: https://www.un.org/global-digital-compact/en

Hunter, L. Y., Albert, C. D., Rutland, J., Topping, K., & Hennigan, C. (2024). Artificial intelligence and information warfare in major power states: how the US, China, and Russia are using artificial intelligence in their information warfare and influence operations. *Defense & Security Analysis*, 40(2), 235-269. https://doi.org/10.1080/14751798.2024.2321736

Johnson, J. (2019) Artificial intelligence & future warfare: implications for international security. *Defense & Security Analysis*, 35(2), 147-169. https://doi.org/10.1080/14751798.2019.1600800

McCarthy, J., Minsky, M. L., Rochester, N., & Shannon, C. E. (1955) A proposal for the Dartmouth summer research project on artificial intelligence. Retrieved March 31, 2017. http://www-formal.stanford.edu/jmc/history/dartmouth/dartmouth.html

Natorski, M. (2024) Compromise in multilateral negotiations and the global regulation of artificial intelligence. *Democratization*, 31(5), 1091-1116. https://doi.org/10.1080/13510347.2024.2351583

Recommendation on the Ethics of Artificial Intelligence of the United Nations Educational, Scientific and Cultural Organization (2024) UNESCO. Available online: https://www.unesco.org/en/articles/recommendation-ethics-artificial-intelligence

Russell, S. J., & Norvig, P. (2020) Artificial intelligence: A modern approach (4th ed.). Pearson.

Sepasspour, R. (2023) A reality check and a way forward for the global governance of artificial intelligence. *Bulletin of the Atomic Scientists*, 79(5), 304-315. https://doi.org/10.1080/00963402.2023.2245249

Soroka, Larysa and Anna Danylenko (2024) EU Space Doctrine – Sustainable Development or a New Arms Race. *Advanced Space Law*, Volume 13, 43-50. https://doi.org/10.29202/asl/13/4

Szocik, K., & Tachibana, K. (2019) Research Viewpoint: Human Enhancement and Artificial Intelligence for Space Missions. *Astropolitics*, 17(3), 208-219. https://doi.org/10.1080/14777622.2019.1672509

Taeihagh, A. (2021) Governance of artificial intelligence. *Policy and Society*, 40(2), 137-157. https://doi.org/10.1080/14494035.2021.1928377

The 17 Goals (2024) United Nations. Available online: https://sdgs.un.org/goals

The United Nations members adopted a Global Digital Compact shaping a safe and sustainable digital future for all (2024) United Nations. Available online: https://digital-strategy.ec.europa.eu/en/news/united-nations-members-adopted-global-digital-compact-shaping-safe-and-sustainable-digital-future

The Intersections of General International Law and Space Law: Critical Approach to Article III of the Outer Space Treaty

Boudour Mefteh

Ph.D. Candidate in Space Law at The University of Debrecen,
Géza Marton Doctoral School of Legal Studies. Researcher at the Institute of Space Law and Policy, Ludovika (Budapest, Hungary)
https://orcid.org/0009-0001-5255-6874
Email: boudourspace@gmail.com

Mefteh, Boudour (2024) The Intersections of General International Law and Space Law: Critical Approach to Article III of the Outer Space Treaty. *Advanced Space Law*, Volume 14, 53-65. https://doi.org/10.29202/asl/14/5.

Article III of the Outer Space Treaty contains an important principle in which state parties shall consider international law, including the Charter of the United Nations while conducting space activities. This approach was based on the belief that space law, specifically the OST, was insufficient to address all potential issues in the space sector and that international law could provide a solution by filling the gaps. International law continues to play a crucial role in covering gaps in space law, also the intersection between both laws is clear. However, Article III must be criticized because it is so wide and contains no restrictions when applying international law, which was mainly made for Earth and not for space. The absence of such limitation can blur the uniqueness of outer space especially since not all international law principles can be applied in this area. This analysis explores the intersections between general international law and space law, further, it will critique Article III, offer suggestions for improvement, and examine whether international law has adequately addressed space governance challenges.

Keywords: *General international law, Space law, Article III of the outer space treaty, Intersection of International and Space Law.*

Received: 05 October, 2024 / Accepted: 10 December, 2024 / Published: 30 December 2024

Introduction

The Outer Space Treaty (OST) is a typical example of international law from the 20th century. It was the product of the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) in the General Assembly via a multilateral process. It aspires to universal membership, which until now it has largely achieved with 112 parties, including all space-faring nations (OST, supra note 2, art. IV). It binds all signatories to basic principles, and it

has been described as the "*Magna Carta*" and a "*Constitution*" for space activity. The Outer Space Treaty succeeds at what most framework agreements from the 20th century excel at doing: establishing broad principles and guidelines to guide future multilateral collaboration in the space sector. What it doesn't do is provide more detailed regulatory guidance, and that typically is the function of successive protocols to those framework conventions (Popova, 2019, 90). In light of this, article III of the OST deserves to be analyzed, and why not criticize it? It is worth mentioning that the need for this evaluation arises because of its vital linking role between international law and space law; however, the general wording and indefinable limits of this article turn it into a hardly applicable tool for Earth-based laws to outer space.

Precisely, Article III stipulates that "*States Parties to the Treaty shall carry on activities in the exploration and use of outer space, including the moon and other celestial bodies, in accordance with international law, including the Charter of the United Nations, in the interest of maintaining international peace and security and promoting international co-operation and understanding*." For a deeper understanding, let us first start with the historical background; Before the OST was signed, many scholars continued to voice and argue that there was just no place for public international law concerning extraterrestrial activities for the longest time. (Schick, 1944; Mankiewicz, 1964).

During the negotiations, which were ultimately crowned by the OST, for instance, the French delegate, Mr Lemaitre, and the representative of Brazil, Mr. de Carvalho Silos, apparently considered international law and the United Nations Charter as anachronisms for the space sector. (See particularly Mr. Lemaitre A/AC.105/C.2/SR.70, p. 14, and Mr. de Carvalho Silos A/C.1/SR.1492, p. 15.) Nevertheless, the various principles and rules intrinsic to general international law apply automatically "*ipso iure*" to outer space; therefore, there is no need to indicate it by the OST (Popova, 2019, 90).

What is more noticeable within Article III is the usage of its obligatory terminologies; The term "*shall*" in legal context means strongly binding or imperatively, which means that state parties are obliged to follow what is required of them by the said article legally. That is stronger than terms like "may" or "should," which are advisory or suggestive (Cocca 1981, 13-20). This, therefore, serves to confirm that compliance with international law as it connects to the conduct of outer space activities is a binding obligation on the concerned states and not an option.

The motivation behind the article mentioned above is rooted in the fact that OST is not enough to cover all the issues that humanity might face in space activities. This is partly because the treaty was drafted at a time when technological advancements limited the ability to foresee many space scenarios (Lau et al., 2018). In other words, the OST lays down the basic principles as well as basic guidelines for space law. Logically, it should follow that other international laws must fill in the details and complement these principles where the OST has left out. We shall also discuss two other reasons, where there is a lack of specific regulation either in space law or a consensus on how to conduct a certain space activity, other branches of international law fill the gaps (Cepelka & Gilmour 1970, 30-49). By these, outer space activities are ensured of conformation to internationally accepted norms and principles. Other applicable international law that supports the principles and is inextricably linked to the OST should not be overlooked in carrying out the application and interpretation of the OST, which may lead to incomplete and/or inaccurate understandings of the space law.

This paper adopts a comparative approach across various sections of general international law to show not only their interactions with space law but also their disconnections. Along with

the qualitative methodology to analyze and evaluate these legal texts, in order to highlight the shortcomings of Article III. It will be primarily divided into two major parts in order to analyze and further criticize Article III of the OST. The first part will focus on the intersections between general international law and international space law, with particular attention to the principles of the UN charter, public international law, international customary law, and diplomacy **(I).** Later, the emphasis will be on the critical approach to Article III of the Outer Space Treaty, which aims to show that not all areas of international law can be cohesive with the principles of space law while also considering the principles of peaceful use, non-appropriation, and common heritage **(II)**. This study extends further than analysis and criticism and gives recommendations, continuing the broader discussion of it. It will finally and thoroughly answer the most paramount question of whether international law proved insufficient in covering all interests and issues concerning space activities. This will be elaborated on in the final sections to have a full view of this issue.

I. The Intersections between General International Law (GIL) and International Space Law

The commonalities between these two legal systems are numerous, with the principles of the UN Charter playing a significant role in shaping the foundation of space law. As an emerging branch of public international law, space law must necessarily interact with other branches within the broader international legal framework.

1. The intersection with the UN Charter Principles

1.1 Res Nellies and Common Heritage

To gain a clear understanding of this concept and how it can be related to the space realm, it is important to give an idea about its historical origins. International law took the concept of res communis from Roman law and applied it to different areas of Earth. Traditionally, this applies to unowned resources or territories that are available for appropriation. However, this principle has limited application in space law. Since outer space and celestial bodies are subject to *ajus humanitatis*, they are also considered a *res communis humanitatis*. The Latin term "*humanitatis*" is ambivalent and as already stated means of and for. We are accordingly dealing with things in the legal sense of the word-belonging to and for humanity (Cocca 1981, 13-20). It is, however, necessary to add the most important provision contained in the Outer Space Treaty, Article II: "*Outer Space, including the moon and other celestial bodies, is not subject to national appropriation by claims of sovereignty, by means of use or occupation, or by any other means.*" Thus, if no national occupation on the part of States is possible, it is something common to all Humankind, considered as a whole. Moreover, they are open for peaceful use and exploration by all countries as reinforced further by (Treaty, 1967).

Additionally, the principle of the common heritage of mankind further ensures that outer space is not to be exploited as a resource by any one nation or entity; This principle sets space as part of the global commons, purposed to be utilized towards the benefit of humanity, which completely disallows any single party from claiming ownership or having exclusive rights over the resources of outer space. This was first articulated in the 1979 Moon Agreement, most specifically in Article XI, which states: "*The Moon and its natural resources are the common heritage of mankind, which means that their exploration and use shall be carried out for the benefit of all peoples, irrespective of the degree of economic or scientific development of the*

nations involved." Even though this has only been ratified by a few states, the underlying idea of the common heritage of mankind has played an influential role in the space law discourse. This notion has spread much further than into the Moon and vastly influences the manner in which we approach the idea of space resource exploitation. It promotes the notion that space and its resources belong to all of humanity and not just individual nations. This challenges common concepts of national control and adds shared responsibility and fair access as a basic layer in multi-space policies. It has implications for emerging discussions about how space activities may be regulated in the future and how resources in space may be used (Cocca 1981, 13-20). In light of this, the above-mentioned principle borrows from broader principles of General International Law aimed at managing global commons like the high seas, atmosphere, and Antarctica in order to ensure that their use serves the collective interest of humanity as a whole.

1.2 The Peaceful Use of Outer Space and The Peaceful Dispute Resolution

It is clear that the fundamental principles of international law, some of which are preserved in Article 33 of the UN Charter, have a strong connection to space law and, in particular, to the OST. This underlines that space should be used for peaceful purposes, that there is a need for international cooperation, and the willingness to settle international disputes through discussion and the process of justice. These sets of laws ensure international stability and cooperation even in this strange and intricate world of outer space. While Article I of the OST provides the basic principle that exploration and use of outer space, including the moon and other celestial bodies, shall be conducted for the benefit of all countries, irrespective of the stage of development, in the broader context it is international cooperation, as mentioned in the UN Charter itself, whereby outer space is to be used for peaceful purposes; Article I of the OST stipulates: *"The exploration and use of outer space, including the Moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind"* (Charter, 1945). This concept of peaceful exploration resembles Article 1 of the UN Charter in its aim to maintain world peace and security and promote cooperation in the peaceful settlement of international disputes. Article 33 of the UN Charter deals with the peaceful settlement of disputes and enumerates the various instruments that governments may employ to prevent war. The provision reads as follows: *"The parties to any dispute, the continuance of which is likely to endanger the maintenance of international peace and security, shall, first of all, seek a solution by negotiation, enquiry, mediation, conciliation, arbitration, judicial settlement, resort to regional agencies or arrangements, or other peaceful means of their own choice"* (Charter, 1945). On this note, Article 33 says that disputes between nations should be settled through peaceful means and dialogue. From this principle, required under the UN Charter, naturally flows that disputes are to be resolved without force. The same principles are relevant to space law, especially as opportunities for conflict have grown with the increasing competition over access to space exploration, satellite usage, and resource extraction. The more states and private actors become involved in such activities, the more likely disputes over those activities are to arise. Space law, developing the principles enshrined in Article 33, could assist in taming these new challenges by facilitating a path toward regimes of peaceful cooperation, rules for resource sharing, and procedures for resolving disputes involving both states and private operators.

1.3 Non-Interference and Non-Discrimination

Other principles that deserve our attention when analyzing the several connections between international law and space law are the principles of non-interference and non-discrimination which represent cornerstones of international law and the emerging legal regime relating to outer space, each based on recognition of equal rights, and sovereignty, and access to states. These stand at the heart of the international order of things, precarious in any balance in the name of fairness, in a constantly changing frontier such as outer space, wherein technological developments carry within them the potential for wide imbalances in power. The Outer Space Treaty (OST) emphasizes these principles, much like key instruments of general international law, such as the UN Charter, the Universal Declaration of Human Rights, and the International Covenant on Civil and Political Rights (ICCPR). The principle of non-interference forbids one state from actions calculated to unjustly interfere in the internal affairs or sovereignty of another. This is reflected in Article 2(7) of the UN Charter, which provides that: *"Nothing contained in the present Charter shall authorize the United Nations to intervene in matters which are essentially within the domestic jurisdiction of any state..."* (UN Charter).

In the context of space law, this principle goes beyond territorial confines; in this respect, the Outer Space Treaty provides that no nation should monopolize space operations at the expense of another. According to Article I of the OST, every state may explore and use space freely, and no state is allowed to impede or otherwise interfere with the efforts of another state in the peaceful exploration of outer space. This, in fact, further helps solidify the perspective that space is part of the global commons like the high seas and shall not be susceptible to appropriation or interference from any single nation (Cocca 1981, 13-20). Moreover, the principle of non-interference also in practical form in Article IX of the OST, calls upon states to avoid those actions that may cause harmful contamination or adverse changes in the space environment, and oblige them to respect the activities of other spacefaring nations. This provision reflects the broader principle of state sovereignty and nonintervention to ensure that space activities do not harmfully affect other states. (Cocca 1981, 13-20).

2. The Intersections with The Public International Law branches (PIL)

2.1 International Environmental Law (IEL)

The international environmental law is also progressively relevant under the banner of sustainability and responsible use of outer space for peaceful purposes. Although the UN space treaties are quiet on what sustainability may mean, in actuality the principle of sustainability finds a sympathetic resonance with the predominant goals of the treaties when the latter are harnessed toward responsible behavior, the mitigation of risk, and the capability for long-term use of space. With increasing investment, the related environmental impacts, in particular space debris and contamination of celestial body environments, are receiving high attention. The principles and frameworks of IEL maintain great relevance in dealing with these issues, in particular in those cases when space law lacks support by binding enforcement mechanisms (López et al., 2024, 37-43).

Even though the word "sustainability" is not explicitly mentioned, in the UN space treaties, it would appear from their general tone that space sustainability is inherently concerned with long-term use. As a result, there are some basic clauses relating to sustainability and environmental preservation in the Outer Space Treaty. For example, Article IX of the OST imposes on States an obligation to avoid harmful contamination of space and celestial bodies. It stipulates: *"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." This article reflects, therefore, that the principle of environmental responsibility is central not only to space law but also to international environmental law. The OST does not use the language of sustainability; however, it imbues the vision that activities in outer space must be conducted without causing irreversible damage to space and Earth's environments.

1.2 International Criminal Law (ICL)

International Criminal Law holds an actor criminally responsible for acts committed on space missions further to the conventions of space law such as the Liability Convention. Since damages caused by the objects give rise to questions of liability, the legal consequences arising from the commission of crimes, in particular by and against astronauts on space missions, are far from being satisfactorily provided for under that convention.

It is in this respect that ICL principles are involved, creating liability based on serious crimes-causing activities such as piracy, terrorism, resource theft, and any other activities accompanied by wellful intention (López et al., 2024, 37-43). The following section expounds the gaps within the Liability Convention and examines the standby ICL as regards the serious crimes of outer space.

Limitation of Liability Convention in Cases of Crimes Accordingly, the 1972 Liability Convention becomes the only true legally binding instrument within the institutional framework of international space law as far as issues of liability against damage peculiar to space objects are concerned. However, it cannot be applied when it comes to criminal acts in outer space for two major reasons: the first is that Article II refers to the "*damage caused by space objects*" (Convention, 1972), 1972) and Article III refers to the "*fault-based Liability*" while other serious futuristic crimes in outer space can be done not only with a space object, and with an intention to do so, which make the ICL important as long as there's is no document regulating the liability of serious criminal actions in outer space.

1.3 International Humanitarian Law (IHL)

International humanitarian law, or the law of armed conflict, contains rules on the conduct of hostilities and provides for the protection of combatants and non-combatants, or civilians, from the dangers of war. To the extent that the armed conflict does spread to outer space, the rules of IHL would automatically apply since, by clear implication of Article III of the OST, activities carried out in outer space are required to be done in conformity with international law, including the UN Charter, of which IHL is part.

This means that the rules of IHL are binding universally, even for states that have not signed onto particular treaties, as those principles have evolved into customary international law. Essentially, what this means is that the underlying concepts, such as the protection of civilians, the protection against the safeguarding of non-military property, and the conduct in warfare, should also apply to outer space. The problem is that translating IHL to space will not be easy. Space activities involve highly sophisticated technologies, and many of the implements used in space can be said to be both military and civilian in nature, drawing legally ambiguous areas. Further, the special environment of space itself, in which an action in one area might affect very large areas, does raise some questions about the suitability of traditional laws for protection and accountability. This further underlines the need for more specific and

detailed directives with regard to how IHL can, in fact, be effectively applied in space and space combat.

3. Customary International Law

It refers to the norms and practices not taken in by conventions but adhered to by states just because there lies a sense of obligation under law. Such norms become binding as a result of consistent practice and *opinio juris*, which is to say – belief – that a particular behavior is called upon by law (Ocoa 2007, 119). While most of the basic principles of space law are taken from the treaties, the development of customary rules is a constant process, that changes the practices and behaviors of states.

Critics argue that space law has developed few of its own customary principles because many space activities have not yet been repeated consistently enough to establish norms. According to Article III of the Outer Space Treaty, which integrates border general international law, actions in space are subject to established international laws, including customary principles. A typical example is the principle of using outer space mainly for peaceful purposes, one of the cornerstones of international law (Vecchio, 2017, 491).

The remaining parts of the space law have either recently attained customary status or are still awaiting it. Also, the Karman line could become a standard for defining airspace and outer space. Finally, the possibility of private companies and persons appropriating and using space resources could become a customary rule with further practices (López et al., 2024, 37–43).

4. Diplomacy and Space Conflicts

While there are various ways through which international relations can be maintained, one effective way is diplomacy; it is also known as the "*Art of negotiation*" and the "*Art of tactics and communication*" in managing international relations. An international law method that proved its efficiency in the space sector when it comes to solving conflicts. In particular, a well-known application of diplomacy took place in 1978 when a Soviet satellite fell on Canadian territory. This indeed was considered to fall under the issues of the Liability Convention, but this was solved with diplomacy (Cohent, 1985). That is why, with its essential flexibility, diplomacy can still play a vital role in dynamic complex issues that may arise in space. In contrast with other rigid legal frameworks, i.e., the Liability Convention, which normally takes some time before adjusting to any changes either in technology or special circumstances, diplomacy opens the avenue for immediately offering solutions tailored to the situation. That is particularly valued in space, where unexpected incidents such as the collision of satellites, and debris-related issues, can overnight emerge and call for fast action in order to evade further complications or delays. These situations often have to be resolved in a very short time to prevent further deterioration or operational failure. In that case, could diplomacy serve as a primary tool for resolving future incidents in space, circumventing the complexities and limitations of formal legal mechanisms?

Thus, diplomacy in outer space as mentioned above, could be truly efficient in dealing with space conflicts in the future. We should not neglect the importance of creating more adaptable binding rules that go beyond the Liability Convention by using flexible and easier solutions.

II: A Critical Approach to Article III of the Outer Space Treaty

As we said before, it is essential to acknowledge the importance of GIL and all its intersections with, at least, space law in order to fill the gap. However, this does not mean that GIL is not far from receiving criticisms either. This is because Article III of the OST does not indicate limitations on International Law in the exploration of outer space. While international law can define, for example, what parts of international law bind space activities, Article III does no such thing. The basic prohibition is only that all activities are to be carried out "*in accordance with international law*." For instance, in overall terms, Article III provides that activities in space shall be carried out in conformity with international law, including the UN Charter, but it fails to explain what laws or principles are relevant and how they apply in outer space. That absence has given rise to differences between space law and international law, because the principles governing the two laws are different, as the nature of outer space is very unique. It would be impossible to have an adequate estimate without certain specific limitations or guidelines on how those international laws designed for terrestrial scenarios should be adapted to the peculiar environment of outer space.

1. Sovereignty VS National Appropriation

The idea of a nation serves as the foundation for international law (Wallace, 2002). Simultaneously, the notion of sovereignty, which represents the authority of the state as a lawful actor, serves as the foundation for the acknowledgment of a state (Locke, 1689). Eli Lauterpacht, meanwhile, claims that: *"…it is necessary to distinguish between the two principal meaning attributed to the word 'sovereignty'. It is used, in one sense, to describe the right of ownership which a State may have in any particular portion of territory. This may be called 'the legal sovereignty' …[t]his kind of sovereignty may be likened to the residual title of the owner of freehold land which is let out on a long lease. The word 'sovereignty' is, however, more commonly used, in its second meaning, to describe the jurisdiction and control which a State may exercise over territory, regardless of the question of where ultimate title to the territory may lie*" (Wilde, 2008). This leads to conclude that sovereignty is a layered concept that contains both the legal and the jurisdictional aspects, that are essential for a state to exercise its governance and control over its territory, which is practically not the case in the sphere of outer space. In international law, the idea of a state's exclusive sovereignty over its territory is essential (Gardiner, 1976). Since it is generally understood that interfering in the internal affairs of others is forbidden, the creation of a state is strongly connected to the ownership of its territory (Polter, 1976) and the jurisdiction and control that it may exercise over its territory, which is still impossible in outer space (Lau et al., 2018).

What about extending the state's sovereignty over its airspace, reaching the earth's orbits and the outer space area above its territory? Could we talk then about sovereignty in outer space? Scientifically, we can't talk about extending a state's sovereignty to reach space above its territory simply because the earth is not stable, and its rotation around the sun makes this sovereignty unconstant for the smallest conceivable fraction of time. Legally speaking, the concept of sovereignty does not apply in outer space, which brings under the spotlight the criticisms of the application of international law to the space sector; Article II of the OST clearly stipulates that: "*Outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by*

any other means". Despite the different interpretations of "*non-appropriation"* it is generally understood to mean that the ownership, jurisdiction, and exercise of sovereignty by any state in outer space is forbidden. This principle ensures that outer space belongs to everyone and is free from claims, but it raises questions about how practically to make such a rule in a fast-changing environment of exploration and utilization of space.

2. Use of Force: Peaceful Uses VS Jus Ad Bellum

Article IV has been interpreted by different member states in different ways (Jasentuliyana, 1999). In order for the member nations to reach a consensus, the restriction itself must incorporate a compromise element (Markoff, 1976). Consequently, this has led to varied interpretations of the term "*peaceful*" highlighted in the OST (Morgan, 1994). The majority of developed countries have interpreted "*peaceful*" as not being entirely opposed to the banning of armed action. In essence, it indicates a "non-aggressive" rather than "non-military" (Bogomolov, 1992). As a result, military operations conducted for self-defense are permitted in outer space (Maogoto & Freeland, 2007–2008). This applies also to all non-aggressive military operations, just as they are under the laws governing airspace and the sea (Bourbonniere, 2005). If one interprets "*peaceful*" as prohibiting all armed action, then self-defense would not be considered legitimate. The use of nuclear weapons in space is the only area where they are prohibited. The United States Senate Committee on Foreign Relations has confirmed this interpretation (Markoff, 1976).

However, "*peaceful*" in developing countries refers to an absolute ban on military action (Cheng, 1998). The 1959 Antarctic Treaty's Article I, which stresses a complete ceasefire, uses the same phrase. Since Article I of the 1959 Antarctic Treaty is widely accepted, it implicitly forbids engaging in any armed action, even self-defense. It is obvious that no military action should be taken in this regard so as to serve the interests of all governments. The vagueness of Article IV has led to the potential military actions in space camouflaged as an act of self-defense, which is permitted by Article 51 of the UN Charter, which permits the use of force only in self-defense or in pursuance of a UN mandate. The application of this idea to space is complicated, especially in light of the advancements in anti-satellite and space-based weapons. It is intended for strategic military purposes: disrupting or destroying satellites. Satellites are becoming critical contributors in modern military operations for communications, navigation, and intelligence gathering. If an ASAT disables or destroys these satellites, adversaries would not be able to utilize them. Most troubling of all, however, is the developmental and deployable aspects of the ASATs, which raise concern for the arms race in space and its long-term implications for the security and stability of space assets (Adams, 2023). The use of force principle can be applied in an unclear manner even though the OST stresses peaceful use because it lacks specific and strong restrictions (Lau et al., 2018). With these risks in mind, it is increasingly important to reach a clearer understanding of how "*peaceful*" space operations should be clearly defined and enforced.

3. Common Heritage VS the Right of People to Self-Determination

While international law is very clear when it comes to various jurisdictions and ownership rights over the resources on Earth, whether found within national borders or in international waters, international law concerning space, particularly the OST and the Moon Agreement, treats the resources found in space as the "*common heritage of mankind*." The principle of "*common heritage*" forbids national appropriation of celestial bodies. The lack of any clarifying

direction makes property rights in space legally uncertain. The arguments on this basis have been that private firms and states could not invest fully in resource-extracting industries due to a lack of knowledge of ownership rights. When there is no specific regulation concerning ownership and management of resources, space mining will be retarded, which, in turn, will slow down investment and innovation in this industry (Lau et al., 2018).

III. Suggestions and Discussion

While the theoretical discussions on the application of international law to space activities are valuable, it is relevant to consider that international law does not always have a straightforward relevance or sufficiency for addressing the issues in the space sector. In that case, it could be preferable to add "*in accordance with international law when there is a lack of regulation*" to Article III to make it more practical to consider the unique characteristics of this dimension.

As this paper explains, international law and space law are based on distinct concepts, hence this lack of precision may cause dispute restrictions (Lau et al., 2018). It will need thorough analysis to understand and reconcile these differences, and perhaps the need to develop more specific regulations or supplemental agreements that explain how international laws apply to space activities. Other branches of PIL need to be adapted to the space's unique environment to be applied efficiently. This is due to the fact that the other areas of general international law are intended to be applied on Earth, not in space. Consequently, modifications are required; for instance, the lack of sovereignty rights in space precludes the complete application of IEL principles.

All things considered, no conventional law governed by Article 38 of the ICJ Statute has been approved or accepted in the field of space law more than 50 years after the last space treaty. This reality has prompted space lawyers, organizations, and researchers, in general, to examine the application of other PIL branches to outer space law through Article III OST in cases when a treaty's terms are ambiguous or there is disagreement about the best way to conduct a space activity (López et al., 2024, 37–43). Nonetheless, International Space Law is currently moving in a different path, guided by international non-legally binding instruments, except for the resuscitation of CIL in space law. This normative growth is represented in United Nations General Assembly declarations (UNGA), such as the Nuclear Principles Declaration, Benefit Sharing, Space Debris Mitigation Guidelines, and Guidelines for Long-Term Sustainability.

Did international law fail to cover all the aspects of space activities?

While the OST and other space law components provided a valuable base for conducting space activities. Thus, commercial-private space activities fall outside the scope of space treaties adopted in the 1960s and 1970s. Article VI of the OST requires states parties to the Treaty only *"international responsibility for national activities in outer space, including the Moon and other celestial bodies, whether such activities are carried on by governmental agencies or by non-governmental entities, and for assuring that national activities are carried out in conformity with the provisions outlined in the present Treaty."*

Nothing has been said about the essence, scope, boundaries, and requirements for private space activities. However, the same Article VI also prescribes that states shall authorize and continuously supervise non-governmental space operations, the proper control regimes for private space activities have to be established at the national level (Volynskaya, 2016). Accordingly, international law fails to answer the most important question posed by the

conditions of commercialization of space: how to provide a balance between the public and commercial interests?

On one side, there is the support and promotion of projects aiming for commercial gain, while on the other side, there is a commitment to strictly following the fundamental principles and standards of international space law. These principles include those related to the exploration and utilization of outer space for the benefit and the interest of all mankind, for peaceful purposes, based on equality and international cooperation, as well as the new principle of LTS.

At this point, we cannot deny the effectiveness that national space legislation can bring as a tool in the solution of the commercial aspects of the problem where the public law aspect should be treated as paramount on the supra-national level.

Conclusion

This paper examines and analyzes Article III of the Outer Space Treaty in relation to the points of intersection between general international law and space law, with particular emphasis on the principles of the UN Charter, public international law, and international customary law. It also deals with the need for a critical approach to Article III by underlining that international law cannot have all its aspects cohesive with space law principles on the use of force, the principle of non-appropriation, and the common heritage. The paper recommends the addition of "in accordance with international law when there is a lack of regulation" in Article III and the necessity for further detailed regulations or supplemental agreements to clarify the application of international laws concerning space activities. It also underlines the fact that international law fails to cover all aspects of space activities, as commercial-private space activities fall outside the scope of space treaties adopted in the 1960s and 1970s. At this point, we cannot deny the effectiveness that national space legislation can bring as a tool in the solution of the commercial aspects.

🕮 References

Adams, Alexander (2023) Anti-Satellite Weapons and the Emerging Space Arms Race. *Harvard International Review*. Available online: https://hir.harvard.edu/anti-satellite-weapons-and-the-emerging-space-arms-race/.

Bogomolov, Vladimir (1992) "Prevention of an Arms Race in Outer Space: Developments in the Conference on Disarmament in 1992." *Journal of Space Law*, 20, 137.

Bourbonniere, Michel (2005) National security law in outer space: The interface of exploration and security. *Journal of Air Law and Commerce*, 70, 16.

Cepelka, Cestmir, and Jamie H.C. Gilmour (1970) The application of general international law in outer space. *Journal of Air Law and Commerce*, 36(1), 30-49.

Charter of the United Nations (1945) San Francisco, done 26 June 1945, entered into force 24 October 1945; USTS 993; 24 UST 2225; 59 Stat. 1031; 145 UKTS 805; UKTS 1946 No. 67; Cmd. 6666 & 6711; CTS 1945 No. 7; ATS 1945 No. 1.

Cheng, Chia-Jm, and Pablo Mendes de Leon, eds. (1992) *The Highways of Air and Outer Space over Asia.* Dordrecht: Nijhoff.

Cocca, Aldo Amando (1981). The advances in international law through the law of outer space. *Journal of Space Law*, 9(1-2), 13-20.

Cohent, Alexander F. (1985) Note on the Military Use of Outer Space. *Yale Journal of International Law,* 10(1), 78-93. Available online: https://openyls.law.yale.edu/bitstream/handle/20.500.13051/6129/10_10YaleJIntlL78_1984_1985_.pdf?sequence=2&isAllowed=y

Convention on International Liability for Damage Caused by Space Objects (1972) London/Moscow/Washington, done 29 March 1972, entered into force 1 September 1972; 961 UNTS 187; TIAS 7762; 24 UST 2389; UKTS 1974 No. 16; Cmnd. 5068; ATS 1975 No. 5; 10 ILM 965 (1971).

Gardiner, Stephen (1976) *International Law.* London: Weidenfeld & Nicolson.

Jasentuliyana, Nandasiri (1999) *International Space Law and the United Nations* (p. 103). Kluwer Law International.

Lau, Hoe, Ing. Roslan, Umar. & Mohd Khairul Amir, Kamarudin (2018). Article III of the 1967 Outer Space Treaty: A critical analysis. International Journal of Academic Research in Business and Social Sciences. Available online: https://hrmars.com/papers_submitted/4106/article-iii-of-the-1967-outer-space-treaty-a-critical-analysis.pdf

Locke, John (1689) *Two Treatises of Government.* Edited by Peter Laslett. Cambridge: Cambridge University Press, 1988.

López, Marcos, Leonardo Alberto. & Moro Aguilar, Raúl (2024) Some comments on the current state of international space law: An open window for the future development of space law. *Boletín del Observatorio Jurídico Aeroespacial*, 14. Asociación Española de Derecho Aeronáutico y Espacial. Available online: https://aedae-aeroespacial.org/wp-content/uploads/2024/04/Boletin-no-14-OJA.-Marzo-2024.DEF_.pdf.

Mankiewicz, Julius (1964) Some Thoughts on Law and Public Order in Space, 2 *Canadian Yearbook of International Law*, 260.

Maogoto, J. N., and Freeland, S. (2007) The Final Frontier: The Laws of Armed Conflict and Space Warfare. *Connecticut Journal of International Law*, 23, 169.

Markoff, George (1976) Disarmament and "peaceful purposes" provisions in the 1967 Outer Space Treaty. *Journal of Space Law*, 4(1), 6.

Morgan, William (1994) The Interpretation of 'Peaceful Purposes' in the Outer Space Treaty. *Journal of Space Law*, 22(1), 45-67.

Ocoa, Christina (2007) The individual and customary international law formation. *Virginia Journal of International Law*, 48(1), 119.

Polter, David M. (1976) Remote sensing and state sovereignty. *Journal of Space Law*, 4, 99.

Popova, Maria (2019) Governing the final frontier: A comparative analysis of global space governance and legal frameworks. *University of Pennsylvania Journal of Law and Innovation*, 1(1), 85-136.

Schick Problems of a Space Law in the United Nations (1944) 13 *International & Comparative Law Quarterly*, 977.

Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (1967) London/Moscow/Washington, done 27 January 1967, entered into force 10 October 1967; 610 UNTS 205; TIAS 6347; 18 UST 2410; UKTS 1968 No. 10; Cmnd. 3198; ATS 1967 No. 24; 6 ILM 386 (1967).

Vecchio, Valentina (2017) Customary international law in the Outer Space Treaty: Space law as a laboratory for the evolution of public international law. *Zeitschrift für Luft – und Weltraumrecht*, 66, 491.

Volynskaya, Olga (2016) *Future Space Is Challenge for International Law.* Available online: https://room.eu.com/article/future-space-is-challenge-for-international-law.

Wallace, Rebecca M. M. (2002) *International Law.* 4th edition. London: Sweet & Maxwell. Available online: https://books.google.hu/books/about/International_Law.html?id=vh4ZMQAACAAJ&redir_esc=y.

Wilde, R. (2008) The idea of international territorial sovereignty. In *International Territorial Administration: How Trusteeship and the Civilizing Mission Never Went Away* (p. 99). Oxford University Press.

Legal and Ethical Challenges of the Use of Nuclear Technologies in Space: Risks and Opportunities

Larysa Soroka

Professor, Doctor of Law, Scientific Institute of Public Law
(Kyiv, Ukraine)
E-mail: lsoroka_kw@ukr.net
https://orcid.org/0000-0002-6979-6049

Anna Danylenko

Ph.D. in Law, Researcher, Information Analysis Center for Aerospace Law
(Kyiv, Ukraine)
E-mail: a_danilenko07@ukr.net
https://orcid.org/0000-0001-8263-1364

Maksym Sokiran

Ph.D. in Law, Lawyer, Scientific and Research Institute of Public Law
(Kyiv, Ukraine)
E-mail: maxim.sokiran@gmail.com
https://orcid.org/0000-0002-1682-2012

Soroka, Larysa, Anna Danylenko, and Maksym Sokiran (2024) Legal and Ethical Challenges of the Use of Nuclear Technologies in Space: Risks and Opportunities. *Advanced Space Law*, Volume 14, 66-73. https://doi.org/10.29202/asl/14/6

The article examines the concept of threats and risks of using nuclear technologies in the space sphere. In particular, it has been stated that the presence of a nuclear arsenal can act as a deterrent, forcing potential aggressors to reevaluate their actions. At the same time, the countries that do not possess nuclear weapons but are under threat of armed aggression often face limited assistance due to the unwillingness of partner states to scale up conflict or be engaged in direct confrontation. The example of Israel demonstrates how the presence of a potential nuclear arsenal and the geopolitical importance of the region contribute to increased military and political support from the United States and other countries. In the case of Ukraine, which renounced nuclear weapons after the signing of the Budapest Memorandum, selective military support limited to efforts to avoid direct confrontation with Russia is

observed. The article emphasizes the interdependence between a country's status as a nuclear or non-nuclear one, the level of international aid, and the threats associated with the use of nuclear technologies for military and space purposes. Despite the economic advantages of using nuclear energy sources in space activities, the need to activate initiatives aimed at strengthening commitments to the complete abandonment of nuclear weapons both on Earth and in space.

Keywords: nuclear energy sources, space activity, space security, non-proliferation of nuclear weapons, war, international rules and principles, risk, danger, legal regulation.

Received: 04 December 2024 / Accepted: 18 December 2024 / Published: 30 December 2024

Introduction

On August 06, 1945 at 08:15 local time, in accordance with the ultimatum of the Potsdam Declaration of July 26, 1945 and Japan's refusal to fulfill the terms of this ultimatum, the Enola Gay, the American B-29 Superfortress bomber, piloted by Paul Tibbets and bombardier Thomas Ferebee, dropped the first atomic bomb called "Malysh" ("Little Boy") on Hiroshima. Consequently, the first atomic bomb in the history of mankind was dropped on the Japanese city of Hiroshima (Hiroshima, 2024).

The first article of the UN Charter (United, 1945), which established that ensuring peace and international security is the main goal and principle of the creation of this organization, was adopted right after this accident. This postulate (in which economic development, access to clean and renewable energy, as well as reducing inequality are part of the 17 Sustainable Development Goals) is continued in the 2030 Agenda (The 17 Goals, 2015), which was supported by all UN Member States in 2015.

Consequently, after the end of the "Cold War" and the long arms race started by the USA and the USSR, the world has chosen a path towards disarmament, nuclear proliferation control and prohibition of their use in outer space.

But after the successful launch of the lunar probe Chang-e 1 in October 2007 (China's, 2009), China has intensified the debate on the use of space nuclear power sources, using the UN platform for this purpose (Discussion, 2012: 2). Considering the above, and the importance of minimizing the safety risks associated with such power sources both on Earth and in space, the United Nations Office for Outer Space Affairs (OOSA) and the International Atomic Energy Agency (IAEA) have jointly published Framework for the Safety of Nuclear Power Sources in Space (Safety, 2009). The document provides guidance for the international community on the safe use of nuclear power sources (NPS) in outer space and contains administrative and technical recommendations for countries to safely advance their initiatives regarding these sources in outer space.

Currently, the main sources of energy that can be used in spacecraft are chemical, solar and nuclear energy. The main types of nuclear energy used for electricity production are radioisotopes and nuclear reactors (Discussion, 2012). It is worth noting that requirements for nuclear safety and procedures for the use of nuclear technologies or components are established for all stages of nuclear programs on design, production, transportation and testing (Voss, 2020). The only case where nuclear material can be outside of direct physical control and security measures is when operating in remote space, on the surface of a planet, or due to an emergency when a spacecraft with nuclear technology or components is launched or returned.

At first glance, it seems that everything is under control and there is a consensus among the countries regarding the use of nuclear energy sources and an agreement to prohibit the use of nuclear weapons in space. But what has changed in nuclear doctrines in recent years, taking into account the numerous military conflicts raging in different parts of the world, including in Ukraine?

In this regard, for example, CIA Director Bill Burns stated the following: "There was a moment in the fall [autumn] of 2022 when I think there was a genuine risk of potential use of tactical nuclear weapons by Russia in Ukraine", Burns said, but he believed such concerns should not be taken too seriously. "I never thought ... we should be unnecessarily intimidated by that," he added (Sabbagh, 2024). Therefore, it is the presence of nuclear weapons in Russia and Israel that forms different approaches and reactions of the world to the wars between Russia and Ukraine and Israel and Hamas. This means that the US, Europe and even some Arab countries are keen to ensure that Israel is never provoked enough to use it, or even use any serious conventional weapons against Iran. Therefore, European countries and the USA jointly protect Israel's airspace from Iranian missiles and drones. The Ukrainian sky, on the other hand, is protected by the Ukrainians themselves (Applebaum, 2024).

In addition to the above, the worsening of the situation in Russia's war against Ukraine has led to US President Joe Biden lifted the ban on strikes by ATACMS ballistic missiles on Russian territory. In response, Russia changed its nuclear doctrine and amended the Basic State Policy of the Russian Federation in the Field of Nuclear Deterrence (Putin, 2024). Russia, in turn, has changed its nuclear doctrine and amended the Basic State Policy of the Russian Federation in the Field of Nuclear Deterrence (Fundamentals, 2024). The category of states and military alliances, in respect of which nuclear deterrence is implemented, was expanded. The list of military threats that require such actions to neutralize them has been supplemented. The doctrine also states that the Russian Federation may use nuclear weapons in case of "critical threat" to the sovereignty and territorial integrity of itself and Belarus. The "launch of ballistic missiles" on the territory of Russia is among the conditions for the use of nuclear weapons by Russia. According to the doctrine, the decision to use nuclear weapons must be made by the Kremlin leader himself. The document expresses confidence that "the readiness and determination of the Russian Federation to use nuclear weapons will ensure nuclear deterrence."

There is concern that nuclear weapons or materials may be stolen or transferred to terrorist organizations, thereby necessitating the consolidation of efforts by a number of countries to improve overall nuclear safety and reduce the availability of nuclear materials for weapons.

In connection with the above, there was a need to study the existing risks and possibilities of using new nuclear technologies in outer space, as well as the role of legal frameworks in policies to contain nuclear proliferation both on Earth and in space.

The concept of threats and risks in the space sphere

Threat is interpreted as: "rude, bold promise to cause some evil, trouble; threats, praise" (Threat, 2023); "a variety of contradictions creating danger for the security system, the life support of its system-forming elements"; "danger of the transition from possibility to reality" (Dictionary, 2008). The authors of theoretical and methodological studies on security theory are unanimous in their opinion that threat is a category close in essence to the concept of "danger", but its distinctive feature is more specific form by the level of exposure to the object

of action (Romanchik, 2020). That is, the authors believe that first there is a danger, and then a specific threat.

But there are also completely opposite opinions. For example, O. Arefieva and T. Kuzenko understands threat as "a set of conditions, processes, factors preventing the implementation of national economic interests or creating danger for the latter and economic activity actors" (Aref'eva & Kuzenko, 2005: 30). That is, the author puts a threat at the beginning, after which danger arises.

Besides, the terms "risk" and "threat" are often equated. Thus, V. Lipkan defines threat as the risk that began to materialize on an undesirable option, or a adverse scenario beyond the notion of normal uncertainty in business conditions known in advance (Lipkan, 2006). O. Liashenko suggests that "threat" and "risk" reflect some current events, while "danger" indicates probable, that is, such events that may not happen (Lyashenko, 2015). At the same time, L. Kalinichenko emphasizes that risk and threat are forms of danger, which reduce the level of security only by their presence (Kalinichenko, 2014). We agree with the latter statement, as both risk and threat are factors preventing objects or entities from being safe.

Recognizing the critical importance of space assets and services in the face of evolving geopolitical dynamics and increased threats, a number of countries, including the US and the EU, have strategically identified space as a priority area of protection and action. For example, on March 24, 2022, the EU approved the Strategic Compass of the European Union (A Strategic, 2022), which sets out proactive measures to ensure the security of its space assets and mitigate potential threats.

As for modern risks and threats in the space sphere, the authors include the following: cyber-attacks (Van Camp & Peeters, 2021; European, 2023) the use of radio-electronic warfare, covering electronic and electromagnetic interference with the ability to disrupt or disable communication between ground bases and space means (Pinker & Smith, 1999; Reis, 2024); growing amount of space debris or micrometeorites (Polkowska, 2020); anti-satellite weapons on ground or space platforms (Way, 2019), the use of uncontrolled nuclear technologies (Henriquet, 2023; Cesari, 2024) and so-called "hybrid threats" (Reis, 2024).

It should be noted that on January 10, 2023, the EU and NATO signed the Joint Declaration on EU-NATO Cooperation (Joint, 2023), in which countering hybrid and cyber threats is defined as a priority for their cooperation at the current stage, along with issues of stability and space protection.

Regulatory framework and evolution of space nuclear security threats

Since the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) entered into force in 1970 Treaty on the Non-Proliferation (Treaty, 1968), the countries of the world were divided into those that are official owners of nuclear weapons and others. At the current stage, there are a total of five official owners: Great Britain, China, the Russian Federation, the USA and France. Most of the countries have voluntarily agreed to renounce the possession of nuclear weapons in accordance with the NPT. Such countries that have international recognition and are members of the UN (193 full members and two observers) are now 186 out of 195. A number of countries – India, Pakistan, Israel and North Korea – are the owners of limited arsenals of nuclear weapons outside the NPT (India, Pakistan and Israel did not join the Treaty;

the DPRK was a member of it as a non-nuclear state, but withdrew from the Treaty in 2003). Several countries are not parties to the NPT, but are de facto non-nuclear (Izhak, 2022).

A global regime of nuclear non-proliferation is impossible without the obligations of official nuclear states towards non-nuclear ones. The text of the NPT does not contain obligations of nuclear countries regarding the specific conditions for the use of nuclear weapons. However, it lays down the very philosophy of the non-proliferation regime. Article VI of the Treaty states that "each of the Parties to the Treaty undertakes to pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament, and on a treaty on general and complete disarmament under strict and effective international control" (Treaty, 1968).

Activities related to the use of nuclear energy sources in outer space are carried out in accordance with international law, including, in particular, the Charter of the United Nations and the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and other Celestial Bodies. But the only official international policy for the use of SBS for space energy is the UN Resolution 47/68 "Principles relevant to the Use of Nuclear Power Sources in Outer Space," which states that "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" (Principles, 1992). Besides, this document allows the use of nuclear energy sources (radioisotope/reactor).

Further, the Resolution specifies that "nuclear reactors may be operate: 1) on interplanetary missions; 2) in sufficiently high orbits; 3) in low-Earth orbits if they are stored in sufficiently high orbits after the operational part of their mission" (Article 2a) (Principles, 1992).

However, geopolitical conditions have significantly changed since the signing of the NPT. Nowadays, the Global Non-Proliferation Regime faces two key threats:

1. China is actively expanding its nuclear arsenal and increasing its technological level. The State avoids participation in arms control negotiations and has just recently started using satellites for missile warning and tracking.
2. Changes in China's nuclear doctrine and Russia's actions, which also includes the potential placement of nuclear weapons in space, create additional risks for strategic stability.

Given these challenges, existing deterrence mechanisms need to be modernized to meet new threats and provide an effective response to possible scenarios of limited nuclear use.

Thus, according to the Treaty on the Prohibition of Nuclear Weapons (NPT) (Treaty, 2017), which entered into force in 2021, its participants are non-nuclear countries. They have not withdrawn from the NPT, but by participating in the new treaty they declared that the commitment to universal renunciation of nuclear weapons should be more specific than the text of Article VI of the NPT (Izhak, 2022). This initiative is quite relevant, because as the Russia's war against Ukraine has indicated, the countries with a nuclear arsenal can act in a position of force towards the countries without it, disregarding international rules and principles enshrined in the Treaty on the Non-Proliferation of Nuclear Weapons. This poses serious risks to global security and calls into question the effectiveness of the existing nuclear deterrence system. Therefore, initiatives aimed at strengthening commitments to the complete abandonment of nuclear weapons are important steps towards strengthening the international legal order and ensuring equality in the security sphere.

If we talk about the economic benefit of using nuclear energy sources in space activities, the use, in particular, of highly enriched uranium (HEU), will allow to minimize the mass of power systems in spacecraft. This reduces the cost of launching and transporting cargo, which is a key factor in reducing the overall cost of missions. For the exploration of the Moon, Mars and other planets, a reliable energy supply is essential for establishing long-term bases and infrastructure. Nuclear technologies can guarantee a stable and uninterrupted power supply in environments where solar energy is limited.

In addition, access to nuclear energy sources may become an impetus for innovation in spacecraft design and new technology development, which contributes to strengthening scientific and technical potential of the country. Thanks to the high energy intensity of nuclear sources, countries can significantly reduce the costs of long-term missions, because the need for refueling or servicing of spacecraft is reduced.

Conclusion

Having summarized the material, we can claim that:

1. Lack of objectivity in the identification of the category "critical threat" causes an unprecedented situation, in which a "nuclear country", in particular, the well-known aggressor – Russia – gets the opportunity to use nuclear weapons without hindrance, contrary to all established general nuclear security rules;
2. Russia's potential use of nuclear weapons as a weapon of war in Ukraine should be considered as a critical threat to the collective security and stability from the standpoint of the EU and NATO, in particular the protection of outer space, which requires an immediate reaction from these organizations in the form of proactive actions – joint protection of air space of Ukraine;
3. Currently, it is extremely urgent to put on the agenda the issue of updating the official obligations of nuclear states in relation to non-nuclear ones in the aspect of providing the latter with security guarantees and support in case of actualization of nuclear threats. Moreover, China's practice of avoiding participation in arms control negotiations should be brought under control in the form of economic sanctions.

Thus, the use of nuclear technologies in space has significant advantages, but their importance is leveled by the awareness of risks and threats to the international legal order and ensuring equality in the field of security. As long as the world is not united, and each element of its structure will allow disregard for norms and principles enshrined in the UN Charter, there is no point in developing and implementing authorization rules for the use of nuclear technologies in space. Strict regulation of the specified legal relations should be an inviolable postulate, confirmation of the relevance of which we already have in today's conditions.

🕮 References

A Strategic Compass for Security and Defence (2022) European Union. Available online: https://www.eeas.europa.eu/sites/default/files/documents/strategic_compass_en3_web.pdf

Applebaum, Anne (2024) Why Did U.S. Planes Defend Israel but Not Ukraine? Atlantic. Available online: https://www.theatlantic.com/politics/archive/2024/04/ukraine-israel-war-comparison/678077/

Aref'eva, O.V., and Kuzenko T. B (2005) *Planning the economic security of enterprises.* European University Publishing House.

Cesari, Laetitia (2024) Buzzword or real threat? How concerns over nuclear capabilities in outer space can trigger the extension of space security discussions. *Note de la FRS*. No 09. Available online: https://www.frstrategie.org/en/publications/notes/buzzword-or-real-threat-how-concerns-over-nuclear-capabilities-outer-space-can-trigger-extension-space-security-discussions-2024

China's lunar probe Chang'e-1 impacts moon (2009) China National Space Administration. Available online: https://www.cnsa.gov.cn/english/n6465652/n6465653/c6478763/content.html

Dictionary of terms and definitions of the non-state security system of Ukraine (2008) Compiled by V. V. Krutov, P. Ya. Prygunov, O. I. Zakharov, V. A. Lipkan and others. Kyiv.

Discussion on the safety of space nuclear power sources. A/AC.105/C.1/2012/CRP.5 (2012) Committee on the Peaceful Uses of Outer Space Scientific and Technical Subcommittee. Available online: https://www.unoosa.org/pdf/limited/c1/AC105_C1_2012_CRP05E.pdf

European Union External Action, "Securing the future of Europe in space. Josep Borrell, High Representative of the European Union for Foreign Affairs and Security Policy (2023) Vice-President of the European Commission. Available online: https://www.eeas.europa.eu/eeas/securing-future-europe-space_en

Fundamentals of State Policy of the Russian Federation on Nuclear Deterrence (2024) Executive Order of the President of the Russian Federation No.991 of November 19, 2024. Available online: https://mid.ru/en/foreign_policy/international_safety/regprla/1434131/

Hiroshima and "Little Boy": A Historical Perspective (2024) Designed with WordPress. Available online: https://dirkdeklein.net/tag/little-boy/

Henriquet, Pierre (2023) The use of nuclear power in deep space exploration. Polytechnique-insights. Available online: https://www.polytechnique-insights.com/en/columns/space/the-use-of-nuclear-power-in-deep-space-exploration/

Izhak, Oleksii (2022) Nuclear deterrence and nuclear intimidation in russia's policy. *Strategic panorama*. Special Issue 2022: 111-122. Available online: https://niss-panorama.com/index.php/journal/article/view/138/138

Joint Declaration on EU-NATO Cooperation (2023) European Council. Available online: https://www.consilium.europa.eu/en/press/press-releases/2023/01/10/eu-nato-joint-declaration-10-january-2023/

Kalinichenko, L. L. (2014) Personnel security as a leading component in ensuring the economic security of an enterprise. *Economic security in the context of globalization of the world economy*. "FOP Drobyazko S.I." Vol. 2.

Lipkan, V.A. (2006) National Security of Ukraine. Condor.

Lyashenko, O. M. (2015) *Conceptualization of enterprise economic security management*. NISD.

Pinker, A, and C. Smith (1999) Vulnerability of the GPS signal to jamming. *GPS Solutions*. Volume 3: 19-27. https://doi.org/10.1007/PL00012788

Polkowska, Małgorzata (2020) Space situational awareness (SSA) for providing safety and security in outer space: implementation challenges for Europe. *Space Policy*. Volume 51. https://doi.org/10.1016/j.spacepol.2019.101347

Principles relevant to the Use of Nuclear Power Sources in Outer Space (1992) UN. General Assembly. Available online: https://digitallibrary.un.org/record/159141?v=pdf

Putin Approves Updated Russian Nuclear Doctrine After Biden's Missile Decision (2024) BBS NEWS. Available online: https://www.bbc.com/russian/articles/cx2l4wzkl0lo

Reis, João (2024) European union defense and security strategy for space and ground-based systems against hybrid threats. *Acta Astronautica*.Volume 225: 55-66. Available online: https://www.sciencedirect.com/science/article/pii/S0094576524004995#bib1

Romanchik T.V. (2020) Danger, threat, risk: analysis of the terminological apparatus of the theory of economic security. *Economic Bulletin of National Technical University of Ukraine " Kyiv Polytechnic Institute"* :257-267.

Sabbagh, Dan (2024) CIA boss says west should not be intimidated by Russia's nuclear threats. Guardian News. Available online: https://www.theguardian.com/world/article/2024/sep/07/cia-west-russia-nuclear-threats-putin

Safety Framework for Nuclear Power Source Applications in Outer Space (2009) United Nations Committee on the Peaceful Uses of Outer Space Scientific and Technical Subcommittee. Available online: https://www.unoosa.org/pdf/publications/iaea-nps-sfrmwrkE.pdf

The 17 Goals (2015) United Nations. Available online: https://sdgs.un.org/goals

Threat (2023) Online Dictionary. Available online: http://sum.in.ua/s/zaghroza

Treaty on the Non-Proliferation (1968) United Nations. Available online: https://disarmament.unoda.org/wmd/nuclear/npt/#:~:text=The%20NPT%20is%20a%20landmark,and%20general%20and%20complete%20disarmament.

Treaty on the prohibition of nuclear weapons (2017) United Nations. Available online: https://treaties.un.org/doc/Treaties/2017/07/20170707%2003-42%20PM/Ch_XXVI_9.pdf

United Nations Charter (1945) United Nations. Available online: https://www.un.org/en/about-us/un-charter

Van Camp, Charlotte, and Walter Peeters (2021) A World without Satellite Data as a Result of a Global Cyber-Attack. *Space Policy*. Volume 59: 101458. https://doi.org/10.1016/j.spacepol.2021.101458

Voss, Susan S. (2020) Nuclear Security Considerations for Space Nuclear Power: A Review of Past Programs with Recommendations for Future Criteria. *Nuclear Technology*. Volume 206, Issue 8: 1097-1108. https://doi.org/10.1080/00295450.2019.1706378

Way, Tyler (2019) Counterspace Weapons 101. Center for Strategic and International Studies. Available online: https://aerospace.csis.org/aerospace101/counterspace-weapons-101/

AUTHORS

Anna Danylenko is a Ph.D. in Law, a Lecturer at the Research Institute of Public Law and Information Analysis Center for Aerospace law, and the author of about 20 scientific papers. Her research interests are national and global governance, space legal relations and space law, the status of a global space administrator, and the impact of digital and space technologies on human rights and freedoms. She has published on topical issues of space law, the development of space relations, as well as tendencies in digital governance in the field of space activities. Kyiv (Ukraine).
E-mail: danilenko07@bigmir.net
https//orcid.org/0000-0001-8263-1364

Elham Farahani is a Ph.D. in Law, the Academy of Air, Space Policy and Law, The School of Law, Beijing Institute of Technology (BIT), China. Her research interests include the legal aspects of Space Traffic Management, Long-Term Sustainability of Outer Space, and Commercialization of Outer Space. She holds two masters degrees in "Public International Law" and "Space Law and Policy." Beijing (China).
E-mail: elham@bit.edu.cn
https://orcid.org/0009-0000-5717-5387

Jean Michel Haziza is a Ph.D. in Law, specializing in air and space criminal law, a researcher at the Institute of Criminal Sciences and Justice in Bordeaux, and a member of the SIRIUS Chair since June 2024. My area of research covers private law, from civil contract and liability law to personal criminal law, as well as transport law (maritime, air and space). I am the author of two scientific works. Bordeaux (France).
E-mail: jean-michel.haziza@hotmail.com

Inessa Kostenko is a Ph.D. in Law, Associate Professor. Sphere of science interests: administrative policy in various spheres, administrative legal status of subjects of public administration, European administrative law. She is the author of more than 40 scientific works. Currently the Fellow at the Center for European Love and Internationalization (CELE) and Leicester Love Shul. Leicester (United Kingdom).
E-mail: inessakostenko2014@gmail.com
https//orcid.org/0000-0002-8784-5422

Diana Levchenko is a Ph.D. in Law and researcher at the Information Analysis Center for Aerospace Law. The sphere of scientific interests is an administrative policy in various spheres, the administrative legal status of subjects of public administration, and global administrative law. She is the author of more than 15 scientific works. Kyiv (Ukraine).
E-mail: diana.levchenko5@gmail.com
https//orcid.org/0000-0001-8343-2260

Shouping Li is a lecturer at the School of Law, Beijing Institute of Technology. Beijing (China).
E-mail: lishouping@bit.edu.cn

Sami Mehmeti is a Ph.D. in Law, Associate Professor of Legal History and Comparative Law, South East European University – Faculty of Law. The sphere of scientific interest includes legal history and comparative law. He is the author of more than 22 scientific works. Tetovo (North Macedonia).
E-mail: s.memeti@seeu.edu.mk
https://orcid.org/0000-0002-4212-9975

Maksym Sokiran is a Ph.D. in Law, candidate for a doctor's degree Scientific and Research Institute of Public Law. The major research interests include space law, administrative policy in various spheres, the administrative and legal status of subjects of public administration, and European administrative law. He has written over 30 scientific works. Kyiv (Ukraine).
E-mail: maxim.sokiran@gmail.com
https://orcid.org/0000-0002-1682-2012

Larysa Soroka is a Doctor of Law, Professor. Sphere of science interests: formation and development of space doctrines, legal and criminal liability for space crimes, legal regulation of the use of space technologies and artificial intelligence in law enforcement, human rights, global space administration of the space sphere. She is the author of more than 120 scientific works. Currently, she works as the Deputy Director of Research at the Scientific Institute of Public Law and President of Analysis Center of Air and Space Law. Kyiv (Ukraine).
E-mail: lsoroka_kw@ukr.net
https://orcid.org/0000-0002-6979-6049

Information for Authors

- ✓ The articles that are submitted to the *Advanced Space Law* follow a double blind peer-review procedure.
- ✓ Submitted papers must be clearly written in English. The mixture of American and British usage of English is not allowed whereas the both usages of English are accepted.
- ✓ The preferred mode of submission is as MS Word (.doc, docx) by e-mail attachment to info@asljournal.org
- ✓ The target length for an article is 5,000-7,000 words. If your article is longer than this, please contact the editorial office.
- ✓ The style (e.g. fonts, font size, spaces, margins, etc.) is adjusted by editors.
- ✓ It is suggested that figures, tables and formulae should be displayed with features of your software package (e.g. MS Word tools).
- ✓ The list of References (Bibliography) should appear at the end of the main text, and be listed in alphabetical order by author's name.
- ✓ References to publications within the text should be as follows: (Zsizsek, 2002: 26), (Encyclopaedia of Philosophy, 1983: 220), (Zsizsek, 2008a: 26), (Zsizsek, 2008b: 75). There must be a strict one-to-one correspondence between the names and years in the text and those in the list of references.
- ✓ Footnotes should be kept to a minimum and indicated by consecutive superscript numbers.
- ✓ Information about the author should include: author name, honorary or other degree(s) (if any); affiliation. Provide also the full postal address, including the country name, e-mail address and, if available, phone numbers (with country and area code). Contact details must be kept up to date by the corresponding author.
- ✓ The abstract should state briefly the purpose of the research, the principal results and major conclusions. The abstract should not be less than 250 words.
- ✓ The abstract should also contain a short list of carefully chosen Keywords or content indicators (5-10 words).
- ✓ Acceptance of manuscripts is based on originality and importance to the field as assessed by the Editors. Manuscripts are reviewed by the Editorial Board with ad hoc assistance of external reviewers (blind peer review). Publication decisions are made by the Editorial Board. Based on editorial judgment, some submissions are rejected initially without external review.

Review procedure

Advanced Space Law considers for publication the articles on conditions that the articles are your own original works and are not copies of any other previously published works, including your own previously published work. The article has been given only for *Advanced Space Law*. The article should not be under consideration or peer-review or accepted for publication elsewhere. All articles should be presented in accordance with the journal's publication guidelines. Articles not adhering strictly to journal guidelines will be returned to authors without scientific evaluation within a month. Submitted articles adhering to the journal's guidelines are reviewed by the Chief Editor or the Editor, who will assign them to reviewers. The articles that are published in *Advanced Space Law* follow a double blind reviewing procedure.

The article does not contain anything that is disrespectful, demeaning, libellous, obscene, fraudulent, or illegal. The use of general descriptive names, trade names, trademarks, and so forth in the publication, even if not specifically identified, does not imply that these names are not protected by the relevant laws and regulations.

Please note that *Advanced Space Law* uses text-matching software UNPLAG and some web-services to check your articles for plagiarism. By submitting your articles to the journal, you agree that your articles are checked for originality and have to undergo the peer-review and publication procedures. If the reviewers suspect plagiarism, fabricated data, conflict of interest, redundant (duplicate) publication etc., they follow the COPE Flowcharts for resolving such cases.

We aim to complete the review process, from submission date to decision date, within ten weeks. If this process takes longer than the given period, the authors will be informed additionally about the reasons of the timeline changes. The Chief Editor prepares a decision letter according to the reviewers' comments, which is sent to the author of article. If necessary, the author should edit your article according to the reviewers' recommendations within two weeks.

Advanced Space Law, **Volume 14, 2024**

Academic Journal

Advanced Space Law, **Том 14, 2024**

Науковий журнал

Коректура – Лариса Сорока
Комп'ютерне верстання – Неля Панченко
Макет обкладинки – Неля Панченко