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"SPACE DEBRIS" AND ENSURING ENVIRONMENTAL SECURITY

„DEŞEURILE SPAŢIALE" ŞI ASIGURAREA SECURITĂŢII ECOLOGICE

«КОСМИЧЕСКИЙ МУСОР» И ОБЕСПЕЧЕНИЕ ЭКОЛОГИЧЕСКОЙ БЕЗОПАСНОСТИ

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ABSTRACT:
"SPACE DEBRIS" AND ENSURING ENVIRONMENTAL SECURITY

The article analyzez the current state of near-Earth space regarding „space debris" and the legal aspects of regulating this problem, taking into account the need to maintain envioronmental safety.

The notion of "space debris" is applied to all man-made objects and fragments thereof in outer space, which have already failed, will never function again and will not be capable of serving any useful purpose, but are a dangerous factor as they can produce destructive effects on operated space vehicles, especially piloted ones.

The authors believe that space debris presents a growing danger to the international community and yhat it is necessary to broaden cooperation in this area, regardless of the disagreements between states on various issues that exist at the moment.

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Keywords: *space debris, outer space, environmental safety, Space control system, Missile attak warning system.*

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REZUMAT:
„DEŞEURILE SPAŢIALE" ŞI ASIGURAREA SECURITĂŢII ECOLOGICE

Articolul analizează starea actuală a spaţiului cosmic în ceea ce priveşte „deşeurile spaţiale" şi aspectele legale ale reglementării acestei probleme, ţinând cont de necesitatea menţinerii siguranţei mediului.

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Noțiunea de „deșeuri spațiale” se aplică tuturor obiectelor create de om și fragmentelor acestora din spațiul cosmic, care au eșuat deja, nu vor mai funcționa niciodată și nu vor fi capabile să servească niciun scop util, dar sunt un factor periculos, deoarece pot. produc efecte distructive asupra vehiculelor spațiale operate, în special asupra celor pilotate.

Autorii consideră că deşeurile spaţiale prezintă un pericol din ce în ce mai amre pentru comunitatea internaţională şi că este necesară lărgirea cooperării în acest domeniu, indiferent de neînţelegerile dintre stat pe diverse probleme care există în acest moment.

Cuvinte-cheie: *deşeuri spaţiale, spaţiul cosmic, siguranţa mediului, sistemul de control al spaţiului, sistemul de avertizare a atacurilor cu rachete.*

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РЕЗЮМЕ:
«КОСМИЧЕСКИЙ МУСОР» И ОБЕСПЕЧЕНИЕ ЭКОЛОГИЧЕСКОЙ БЕЗОПАСНОСТИ

В статье анализируется современное состояние околоземного космического пространства относительно "космического мусора" и правовые аспекты регулирования этой проблемы учитывая необходимость поддержания экологической безопасности.

Понятие «космический мусор» применяется ко всем искусственным обьектам и их фрагментам в космическом пространстве, которые уже вышли из строя, никогда больше не будут функционировать и не будут способны служить какой-либо полезной цели, но являются опасным фактором, поскольку могут оказывать разрушительное воздействие на эксплуатируемые космичкеские аппараты, особенно пилотируемые.

Авторы считают, что космический мусор представляет растущую опасность для международного сообщества и необходимо расширять сотрудничество в этой сфере, несмотря на существующие на данный момент разногласия между государствами по различным вопросам.

Ключевые слова: *космический мусор, космическое пространство, экологическая безопасность, Система контроля космического пространства, Система предупреждения о ракетном нападении.*

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Introduction

The problem of pollution of circumterrestrial outer space with various "space debris" emerged in theory immediately after the launch of Earth's first artificial satellites in the 1950s, but at the international level it only gained official status after the UN Secretary General on 10 December 1993 gave a speech entitled "The Impact of Space Activities on the Environment", in which he stressed the international and global nature of pollution and contamination of outer space with various debris[1].

At the present time, more than 300,000 different objects and fragments of technogenic origin with a mass of more than 5,000 tonnes are reported to be in low Earth orbit (up to 2,000 km)[2]. Only about 10% of them have been detected, monitored and catalogued by optical and radiolocation stations[3]. With current developments in telecomunication area, the most advanced

[1] To be seen: Космический мусор как угроза безопасности полета. // Космос-журнал.рф 15.06.2012. [On-line:] http://www.cosmos-journal.ru/articles/952/ (Vizited 01.02.2024).
[2] To be seen: ООН: Аппаратам на орбите угрожают 300 тыс обломков космического мусора. // РИА Наука, 02.10.2009. [On-line:] http://ria.ru/science/20091002/187328503.html (Vizited 01.02.2024).
[3] For example, the US Strategic Command Catalog in 2013 contained data on 16,600 pieces of space debris larger than 10 cm in diameter, and the Russian Cosmos Monitoring Catalog contained data on 15,800 pieces of space debris of various sizes.

broadband satellite internet that represents the world's largest satellite constellation using low Earth orbit (Starlink), accounts for over 5,400 operational satellites. According to projected deliverables, Starlink aimes to incease this number to 42,000 satellits in a megaconstellation[1]. As presented in the satellitemap, the constellation size increased over time from a total of 880 items in January 2021, out of which over 80 were inactive and almost 60 were burned, to a total of over 6100 units in April 2024, out of which over 900 are inactive and over 370 are burned[2]. Thus, it can be fairly stated that the amount of satellites launched in space grows at a fast pace (in 2024 we have more inactive units than total units registered in 2021), rising the question of space debris to a security order.

Characteristics of "space debris"

The notion of "space debris" is applied to all man-made objects and fragments thereof in outer space, which have already failed, will never function again and will not be capable of serving any useful purpose, but are a dangerous factor as they can produce destructive effects on operated space vehicles, especially piloted ones.

In some cases, excessively large fragments of 'debris' or cosmic objects containing hazardous materials (nuclear, toxic, etc.) can pose a direct threat to Earth's space, in the event of their uncontrolled descent from orbit, their incomplete burning as they pass through the Earth's atmosphere, and the related fallout of these cosmic objects on cities, industrial enterprises, communication and transport centres, etc.

Space debris resulted from satellite hardware is composed of various materials that can have different effects over the atmosphere: aluminium that is commonly used for structural elements and accounts the large amounts of the total mass for the vechicle it is used; carbon fibers or woven fabrics combined with epoxy; titanium used at engine components but also as a material for thermic isollation; cermaics; silican and copper[3]. Additional awarness of the space debris composition offers clarity upon the value of the debris itself, which allows its examination form the perspective of ecological security and rational usage.

There are various opinions on the danger posed by cosmic debris, the main categories of dangers being atmosphere pollition, collision in space, collision on Earth. It is certain that if the necessary measures are not taken as soon as possible, space activities may become impossible because of the 'cascade effect' which can be triggered by the collision of various fragments of 'space debris', multiplying the number of new fragments obtained as a result of such collisions (the Kessler effect) to infinity[4].

As an example, the collision of just two cosmic objects, the Russian military telecommunications satellite "Kosmos-2251", launched into orbit in 1993, and the American commercial telecommunications satellite "Iridium-33", launched into orbit in 1997, resulted in a considerable increase in the "cosmic debris" in the Earth's orbit: on 10 February 2009, these colliding cosmic objects completely destroyed each other, fragmenting into more than 600 new large fragments[5] and more than 1200 smaller fragments[6].

On 11 January 2007, the Chinese satellite "FenJun-1C" was destroyed by a Chinese rocket for anti-satellite weapons testing. As a result of this collision of two cosmic objects in outer space, more than 2800 new fragments of "space debris" have appeared, which obviously pose a

[1] To be seen: Starlink satellites. [On-line:] https://www.space.com/spacex-starlink-satellites.html (Visited 01.02.2024).

[2] To be seen: [On-line:] https://satellitemap.space/ (Visited 01.02.2024).

[3] Ratliff Laura. Space Debris Reentry: Inadvertent Geoengineering, 2022. [On-line:] https://bpb-us-e1.wpmucdn.com/blogs.gwu.edu/dist/7/314/files/2019/08/Ratliff-Debris-Reentry-Final-reformat.pdf (Visited 01.02.2024).

[4] D.J. Kessler and Burton G. Cour-Palais. Collision Frequency of Artificial Satellites: The Creation of a Debris Belt. In: Journal of Geophysical Research, June, 1, 1978, Vol. 83, No. A6. Paper number 8A0210, P. 2637-2646.

[5] To be seen: Над Сибирью столкнулись российский и американский спутники. - Lenta.ru. 12.02.2009. On-line: http://lenta.ru/news/2009/02/12/collision/ (Visited 01.02.2024).

[6] To be seen: Назаренко А.И. Моделирование космического мусора - М.: ИКИ РАН, 2013. 216 с. (Серия «Механика, управление и информатика»), ISBN 978-5-9903101-6-2, ISSN 2075-6839: с. 188-200.

danger to space exploration activities[1]. Further in 2013, the debris of Chinese anti-satellite weapon testing (ASAT) collided with a disabled Russian satellite[2].

Currently, experts assume that Starlink satellites represent the number one source of collision hazards in Earth's orbit. In the same time, SpaceX issued a statement of „Comitment to Space Sustainability" expressing the intention to deorbit older internet satellites with the purpose to reduce the danger imposed from spacecrafts in low Earth orbit[3].

At present there are no effective methods or technologies that could practically use or destroy "space debris" located in orbits above 600 km from Earth, where there is no natural destruction effect of such debris by the Earth's pull and braking force in the atmosphere, leading to its burning. The decommissioning that Starlink is using also implies steering old satellites into atmosphere to be burned up[4].

At the same time, various possibilities are being studied for using satellites that could destroy cosmic debris by laser, or by teleporting the debris to other cosmic orbits using ion cannons or ground lasers, which would brake the debris fragments by drawing them into the Earth's atmosphere, where they could burn up in the process[5].

The topicality of this problem is increasingly pressing and the need to ensure the continued safety of cosmic devices and objects in the face of the rapid growth of cosmic debris requires the states of the world to work together fruitfully in this field in order to solve it[6].

Space control system

There are many instruments for monitoring near-Earth orbits in order to search for objects in it. They can be categorized into radar and optical. Detection of orbital objects can also be an additional function of general-purpose space exploration instruments or defense systems. There are also a number of specialized instruments. The USSR and the USA have developed powerful space tracking instruments. A number of specialized instruments also exist in Europe and other countries. A number of national programs for tracking near-Earth objects and dealing with space debris are also in operation. *An Inter-Agency Space Debris Coordination Committee* has been established to coordinate their activities[7].

United States of America

In the USA there have been many programs for monitoring near-Earth space, both military and civil, such as *Project Space Track*[8], *National Space Defense Center*[1], *Space Detection and Tracking System*[2].

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[1] An Assessment of the Current LEO Debris Environment and the Need for Active Debris Removal // NASA, Liou - 2010 - slide 3 "Growth of the Historical Debris Populations". [On-line:] http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20100017146.pdf#page=4 (Visited 01.02.2024).

[2] Melissa Gray, 'Chinese space debris hits Russian satellite, scientists say', *CNN* (9 March 2013), [On-line:] www.cnn.com/2013/03/09/tech/satellite-hit. (Visited 22.04.2024)

[3] To be seen: Starlink satellites. [On-line:] https://www.space.com/spacex-starlink-satellites.html (Visited 01.02.2024).

[4] Ibid.

[5] To be seen: Буриан К. А. "Космический мусор" и экологическое право: реальность, тенденции, перспективы. In: Международная научно-практическая конференция "Евразийская интеграция: правовой и образовательный аспекты". ШКОЛА ИНТЕРЭКОПРАВА. Новосибирский государственный университет, 4-5 декабря 2014 г. (Burian K. A. "Kosmicheskij musor" i jekologicheskoe pravo: real'nost', tendencii, perspektivy. In: Mezhdunarodnaja nauchno-prakticheskaja konferencija "Evrazijskaja integracija: pravovoj i obrazovatel'nyj aspekty". SHKOLA INTERJEKOPRAVA. Novosibirskij gosudarstvennyj universitet, 4-5 dekabrja 2014 g.). [On-line:] http://iel2nd.ucoz.ru/NSUposter_K.A.Burian_C.pdf (Vizited 01.02.2024).

[6] To be seen: Мохаммад С.А. Международно-правовые аспекты борьбы с негативными экологическими последствиями космической деятельности. // Евразийский юридический журнал, № 7 (26) 2010. [On-line:] http://www.eurasialaw.ru/index.php?option=com_jcontentplus&view=article&id=1065:-7-26-2010-&catid=110:2010-06-17-10-27-36&Itemid=196 (Vizited 01.02.2024).

[7] Inter-Agency Space Debris Coordination Committee. [On-line:] https://iadc-home.org/what_iadc (Vizited 01.02.2024).

[8] Project Space Track. [On-line:] https://www.space-track.org/auth/login (Vizited 01.02.2024).

The closest to the topic of space debris is the *NASA Orbital Debris Program Office*[3]. As part of their work, many tools have been created, including specialized tools. For example, *NASA Orbital Debris Observatory*[4], *Large Zenith Telescope*[5] and others.

The United States Space Surveillance Network is an active service established to track the trajectories of objects in Earth orbit. Objects ranging from a few centimeters in diameter are tracked.

European Space Agency

A number of instruments for monitoring near-Earth space operate under the auspices of the European Space Agency. Such as the *ESA Space Debris Telescope*[6], *TIRA (System)*[7], *EISCAT*[8].

USSR and Russian Federation

The Soviet Union created the Space Control System, which still maintains a catalog of orbital objects based on data from SPRN systems (Missile Warning System)[9] and specialized near-Earth observation stations[10]. Space debris began to be dealt with in 1985 in the Ministry of Defense and the USSR Academy of Sciences. Already in 1990 the first practical estimates were obtained and a mathematical model of near-Earth space debris was developed. In 1992, for the first time in the country, a project of standard initial data (SID) was created to support the development of space orbital facilities.

Russia's Federal Space Program for 2016-2025 includes the creation of a "scavenger" of debris from geostationary orbits (which, as of 2014, contain up to 1,000 unexploited objects) by 2025. It is planned that within six months each "Liquidator" will transfer up to 10 objects to the disposal orbit.

As of 2015, according to the Russian hazard warning system, there are more than 17,000 space objects of artificial origin in near-Earth space. Of these, 1,336 are operational, the rest are space debris.

In addition to SPRN systems, the specialized radio-optical space object recognition complex Krona[11] is engaged in the search for and identification of orbital objects and the Arkhyz optical observation station[12], the Altai optical-laser station, and the Altai optical-laser station are also involved in the search for and identification of orbital objects The G. S. Titov Altai Optical and Laser Center[13], and the Okno optoelectronic complex[14].

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[1] National Space Defense Center. [On-line:] https://www.jtf-spacedefense.mil/About-Us/Fact-Sheets/Display/Article/3071003/national-space-defense-center/ (Vizited 01.02.2024).

[2] Space Detection and Tracking System. [On-line:] https://www.radartutorial.eu/02.basics/rp56.en.html (Vizited 01.02.2024).

[3] NASA Orbital Debris Program Office. [On-line:] https://orbitaldebris.jsc.nasa.gov/ (Vizited 01.02.2024).

[4] NASA Orbital Debris Observatory. [On-line:] https://orbitaldebris.jsc.nasa.gov/protection/ (Vizited 01.02.2024).

[5] Large Zenith Telescope. https://www.astro.ubc.ca/lmt/lzt/ (Vizited 01.02.2024).

[6] ESA Space Debris Telescope. [On-line:] https://www.esa.int/Space_Safety/Space_Debris/Scanning_and_observing2 (Vizited 01.02.2024).

[7] TIRA (System). [On-line:] https://www.fhr.fraunhofer.de/en/the-institute/technical-equipment/Space-observation-radar-TIRA.html (Vizited 01.02.2024).

[8] EISCAT. [On-line:] https://eiscat.se/ (Vizited 01.02.2024).

[9] To be seen: Система контроля космического пространства. . [On-line:] https://macvympel.ru/projects/skkp/ (Vizited 01.02.2024).

[10] To be seen: Система предупреждения о ракетном нападении). [On-line:] https://russianforces.org/rus/sprn/ (Vizited 01.02.2024).

[11] To be seen: Радиооптический комплекс распознавания космических объектов «Крона». [On-line:] https://vpk.name/library/f/krona-rokr.html (Vizited 01.02.2024).

[12] To be seen: Станция оптических наблюдений «Архыз». [On-line:] https://npk-spp.ru/branches/filial-son-arkhyz-ao-npk-spp/ (Vizited 01.02.2024).

[13] To be seen: Алтайский оптико-лазерный центр имени Г. С. Титова. [On-line:] https://npk-spp.ru/zemlya/aolc/ (Vizited 01.02.2024).

[14] To be seen: Оптико-электронный комплекс «Окно».[On-line:] https://vpk.name/library/f/okno-oek.html (Vizited 01.02.2024).

International cooperation

In general, the problem of space debris, like any complex and topical issue, has several dimensions: scientific, technical, legal, environmental and so on. Despite the fact that this subject attracts the attention of many national research centers and space agencies and is periodically discussed with varying degrees of depth at numerous committees and commissions of international organizations, such as the International Astronautical Federation (IAF)[1], the Committee on Space Research of the International Council of Scientific Unions (COSPAR)[2], The International Telecommunication Union (ITU)[3], the International Institute of Space Law (IISL)[4] and others, it seems that recently the joint coordinated activity of two international bodies in the "technical" and "political and legal" dimensions of this problem has brought its understanding to a qualitatively new level. These are the Inter-Agency Space Debris Coordination Committee (IADC)[5] and the Scientific and Technical Subcommittee of the UN Committee on the Peaceful Uses of Outer Space (STCS UN COPUOS)[6].

The Inter-Agency Space Debris Coordination Committee, (IADC) was established in 1993 and is an intergovernmental forum for coordinating research activities related to orbital debris. Its members include the space agencies of Italy, France, China, Canada, Germany, India, Japan, South Korea, USA, Russia, Ukraine, UK, and the European Space Agency. The main purpose of the committee is to exchange information between member space agencies on space debris research[7].

The priority directions for international cooperation in this area are:

- Ecological monitoring of circumterrestrial outer space, including geostationary orbit, tracking and monitoring of "space debris", their catalysis.
- Mathematical modelling of "space debris" and creation of international information systems for forecasting hazards to spacecraft and objects, and monitoring hazardous situations where fragments of "space debris" approach spacecraft and objects or descend uncontrolled into the atmosphere, available stallelite burnup, satellite trajectory reentry etc.
- Development of methods and mechanisms for protection of cosmic objects and devices against possible actions of cosmic supervoid dominant "space debris" fragments.
- Development and implementation of projects for cleaning the circumterrestrial outer space from "space debris".

From conceptual perspective, policy consideration on space debris tangentially touch upon additional subjects as the protection of ozon layer and geoengineering monitoring. Undoubtly, it is desirable to have clearer procedures within the existing frame to ensure the appropriate practical management of space debris. However, exposing the subject to a wider range of discussion is recommended in order to formulate a public discussion regarding the evolution of space technology management, which could lead in more space debris (as quantity) or with a more efficient approach (as quality).

Regrettably, international cooperation in this area has come to a standstill in the last two years due to the Russian-Ukrainian conflict.

The institution of liability in International law of outer space

[1] International Astronautical Federation (IAF). [On-line:] https://www.iafastro.org/ (Vizited 01.02.2024).

[2] Committee on Space Research of the International Council of Scientific Unions (COSPAR). [On-line:] https://cosparhq.cnes.fr/ (Vizited 01.02.2024).

[3] The International Telecommunication Union (ITU). [On-line:] https://www.itu.int/en/Pages/default.aspx (Vizited 01.02.2024).

[4] International Institute of Space Law (IISL). [On-line:] https://iisl.space (Vizited 01.02.2024).

[5] Inter-Agency Space Debris Coordination Committee (IADC). [On-line:] https://www.unoosa.org/oosa/en/ourwork/copuos/index.html (Vizited 01.02.2024).

[6] UN Committee on the Peaceful Uses of Outer Space (STCS UN COPUOS). [On-line:] https://www.unoosa.org/oosa/en/ourwork/copuos/index.html (Vizited 01.02.2024).

[7] Inter-Agency Space Debris Coordination Committee (IADC). [On-line:] https://www.unoosa.org/oosa/en/ourwork/copuos/index.html (Vizited 01.02.2024).

The legal regime of liability in law of outer space is dual in nature, absolute liability and liability for fault. Thus, for damage occurring on Earth or on an aircraft in flight, the liability of the launching state is absolute. However, if the damage occurs outside the Earth's surface, in a space object launched by another State, or to persons or property on board, the launching State is liable only for damage caused by its own fault, or that of the persons responsible[1].

Ambivalent liability applies both where the launch is carried out by a single State and where the launch is carried out by several States, in which case the latter are jointly and severally liable. As regards claims for compensation for damage, the Convention provides that they are to be submitted through diplomatic channels. By extending the responsibility of States for protecting victims of the effects of space activities, it can be said that the area of diplomatic protection takes on a new dimension[2].

The institution of liability in space law will need to be developed and updated, as the subjects carrying out space activities have expanded to include private companies, non-governmental organisations, even individuals. Lately, given the involvement of other fields such as transport, trade and tourism in space activities, liability for damage caused by these activities can be addressed as both civil and criminal liability[3].

Article VII of the 1967 Outer Space Treaty provides that States are internationally responsible for damage caused to another State or to natural or legal persons by objects launched into outer space by them or by their component parts, whether such damage occurs on the ground, in the air or in outer space[4].

The 1972 Convention on International Liability lays down detailed rules on liability for damage caused by objects launched into outer space[5]. In particular, the Convention introduces absolute strict liability of the launching State for damage caused by its space object on the ground or to aircraft in flight and fault-based liability for damage caused anywhere other than on the ground to a space object of a launching State or to persons or property on board a space object by a space object of another launching State[6].

In the context of studying the issue of liability for damage caused on the territory of another state, we mention the case of the Soviet satellite "Cosmos-954", which in 1978 disintegrated in space and parts of it (radioactive debris) fell on Canadian territory. The case was settled amicably in a diplomatic framework and the former USSR paid compensation to Canada of 3 million Canadian dollars for the damage caused in connection with the investigation to find the remains of the satellite, as well as for the decontamination of the area[7].

It should be noted that the content of the Canadian-Soviet negotiations for the settlement of this case has not been made public, but in the literature the discussion of the Cosmos-954 accident has focused on two issues: 1) whether or not the causal damage, since it was caused by

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[1] To be seen: Convenţia din 29 martie 1972 cu privire la răspunderea internaţională pentru daunele cauzate de obiecte lansate în spaţiul extraatmosferic. Publicat în Buletinul Oficial, Nr. 4 din 5 ianuarie 1980. [On-line:] http://www.monitoruljuridic.ro/act/conventie-din-29-martie-1972-cu-privire-la-raspunderea-internationala-pentru-daunele-cauzate-de-obiecte-lansate-in-spatiul-extraatmosferic-emitent-consiliul-de-stat-30815.html (Vizited 01.02.2024).

[2] To be seen: Neagu Corina. Evoluţia cadrului juridic al activităţilor spaţiale, cu privire specială la teledetecţia prin sateliţi. Teză de doctorat, Rezumat. Universitatea din Bucureşti, Facultatea de drept, Bucureşti, 2009. - 48 p. // [On-line:] http://www.unibuc.ro/studies/Doctorate2009Noiembrie/Neagu%20Corina%20-%20Evolutia%20Cadrului%20Juridic%20al%20Activitatilor%20Spatiale%20cu%20Privire%20Speciala%20la%20Teledetectia%20prin%20Sateliti/Teza%20doctorat%20-%20Rezumat.pdf. (Vizited 01.02.2024).

[3] Ibid.

[4] To be seen: Dumitra Popescu, Răspunderea internaţională în domeniul dreptului extraatmosferic, în „Studii de drept românesc”, nr. 3, 1996, p. 217-224.

[5] To be seen: Международное космическое право. Отв.ред. Г.П. Жуков, Ю.М. Колосов. – Москва, «Международные отношения», 1999. – 360 с.

[6] Cocca A.A.: *Consolidacion del Derecho Espacial,* Astrea, Buenos Aires, 1971; Ferrer M.A., *Derecho Espacial,* Plus Ultra, Buenos Aires, 1976.

[7] Burian Alexandru. Drept internaţional cosmic (spaţial). În: *Drept Internaţional public, Ed. a 4-a (revăz. şi adăugită).* Red.-coord.: A. BURIAN. Ch.: S. n., 2012 (Tipogr. “Elena-V.I.” SRL). – 636 p. (p. 393-407). ISBN 978-9975-106-99-3.

radioactive debris, falls under Art. 2) whether the case was settled on the basis of the Liability Convention or the 1967 Outer Space Treaty or on the basis of general principles of international law. Both negative and positive opinions were expressed on both issues. One of the positive opinions states that there can be no doubt about the applicability of the Convention to the resolution of the Soviet-Canadian incident[1].

The soaring amounts of "cosmic debris" and the danger that this debris poses to space activity as well as to the Earth and other celestial bodies, require new international legislation that would oblige states to comply with the Principle of Prohibition of Contamination of the Cosmos and Harmful Changes to the Earth's Environment[2]. In accordance with this principle of international cosmic law, States are obliged to avoid in their cosmic activities harmful contamination of outer space and other celestial bodies and harmful changes in the terrestrial environment as a result of the introduction of extraterrestrial substances (Article IX of the 1967 Outer Space Treaty)[3].

In 2007, the UN General Assembly adopted the Principles Governing Action to Prevent the Creation of "Space Debris" calling on all states to abide by these principles[4].

Ecology and “space debris”

It is believed that space debris does not fall to Earth, but this is not entirely true. Large spent satellites and cargo ships on Earth have their own graveyard in the Pacific Ocean, where they are buried because they do not burn up in the atmosphere. This place is located in the South Pacific Ocean near Nemo Point[5], the farthest place on Earth from land. No ships are allowed to fly or pass over this place. At the same time, it turns the problem of space debris into a problem of terrestrial debris. Between 1971 and 2016, at least 260 spacecraft were buried there.

Astrophysicists now face the challenge of how to get rid of debris in the geostationary orbit or Clark Belt. It is located directly above the Earth's equator at a distance of 35,786 kilometers. This orbit is very attractive for launching satellites, as it requires less fuel and covers much more of the Earth's surface than other orbits. However, the number of standing points for satellites in geostationary orbit is limited - there are about 180 of them. In addition to cleaning up the geostationary orbit, removing space debris in the vicinity of the ISS is important because the station is expensive and very vulnerable.

According to the Federal Communications Commission (FCC) website, in October 2023, US authorities fined the Dish television company $150,000 for moving its satellite to a lower orbit than agreed (120 km instead of the declared 300 km). The EchoStar-7 satellite had been in orbit since 2002, when it reached the end of its useful life, the company nailed it down and abandoned it where it ran out of fuel. This is the first ever fine issued to a company for failing to clean up space debris[6].

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[1] Ibid.

[2] To be seen: Резолюция Генеральной Ассамблеи ООН от 13 декабря 1963 г. N 1962 (XVIII) "Декларация правовых принципов, регулирующих деятельность государств по исследованию и использованию космического пространства". [On-line:] http://www.un.org/ru/documents/decl_conv/declarations/outerspace_principles.shtml (Vizited 01.02.2024).

[3] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, 27 January 1967. [On-line:] http://www.state.gov/www/global/arms/treaties/space1.html (Vizited 01.02.2024).

[4] To be seen: «Руководящие принципы Комитета по использованию космического пространства в мирных целях Организации Объединённых Наций по предупреждению образования космического мусора». Утверждены резолюцией Генеральной Ассамблеи ООН №A/RES/62/217, опубликованной 1 февраля 2008 г. [On-line:] http://www.un.org/en/ga/search/view_doc.asp?symbol=A/RES/62/217&referer=http://www.un.org/en/ga/62/resolutions.shtml&Lang=R (Vizited 01.02.2024).

[5] To be seen: Где находится «полюс недоступности» - точка Немо, и почему она самая чистая и самая грязная одновременно. // https://dzen.ru/a/XxHJzDWaYV5Dt6uq (Vizited 01.02.2024).

[6] To be seen: Впервые в истории компании выписали штраф за космический мусор. // https://habr.com/ru/news/765836/ (Vizited 01.02.2024).

Geoingineering is another subject that recieves attention in the scientific discussions that intersects ecology and space. Starting from the premise of adjusting the terrestrial habitat to the global warming by creating, a premise which can be separately debated, various scientists proposed to introduce in the space, a mean to reflect the sunlight back into the cosmos, filtering the amount of sunlight enters in the atmosphere. Geoengineering in itself represents a large-scale manipulation of the space environment that aims to reduce the consequences of premused anthropogenic climate change[1]. One can disagree that geoingineering can be atributed to the study of cosmis phenomena, as the ethymology of the term represents a contraction from „*geotechnical engineering*" – the science that studies the application of geology through the prism of engineering, prefix „*geo*-" originated from the Greek rooth „*ge*" meaning „*Earth*"[2]. Nevertheless, unlike industrial carbon mitigation, geengineering extends itself to a deliberate platenary management. Here, two conceptual nuances must be highligthed: (a) geoengineering implies active human intervention to counterbalance the effect of another mean of human activity as declared in the premise of its development, (b) geoegineering implies selecting the option of blocking a natural factor (sunlight) in repsonse to a human-induced cause (anthropogenic argument).

There are several types of approahces that embody categories of geoengineering technologies, which are mainly divied as: solar radiation management (SRM) and carbon dioxide removal (CDR)[3]. While CDR targets greenhouse gas emissions (GHG), SRM proposes to reduce radiatie force of the sun to decrease the amount of energy absorbed in the atmosphere (marine cloud brightening (MCB), stratospheric aerosol injection (SAI), space-based techniques). While SAI implies injection in the atmosphere of imense quantities of aerosols as sulphur dioxide, oxidized light-scattering sulphurate and others, the space-based techniques represent large-scale technical projects that, although yet theoretical, imply the launch of solid objects in the atmosphere. In this context, the developement of space-base techniques as part of SRM proposed in geoegineering projects, challenges in a dirrect manner our research question on space debris.

Some scientists have stated that a gigantic shield of mirrors installed in the space between Sun and Earth could hinder the solar radiation and lower temperatures on the surface of the Earth[4]. Alluminium particles in the satellite-generated space debris act by themselves as a schiled from sunlight, reflecting the radiation back out into space, reducing the overall amount of sunlight that reaches the surface of the Earth[5]. Although the SRM approach is yet visionary and theoretical, it gains more attention in both political and academic circles. In UNEP report on Atmosphere from february 2023, SRM is already presented as „the only option that could cool the planet within years"[6] and the academic literature holds sufficient analyses on the topic as the calulcations upon the optimal sunshade configurations of space-based geoengineering near Lagrange point (a position in space between Sun and Earth where gravitational forces produce regions of attraction and repulision and allow spacecfrats reduce their fuel consumtion

[1] Keith, D. W. Geoengineering the climate. In: The Ethics of Nanotetchnology, Geoengineering and Clean Energy, 2020, pp.207-246.

[2] Ibid.

[3] Heyward Clare. Situating and abandoning geoingineering: a typology of five responses to dangerous climate change. In: Political Science and Politics, 2013, 46.1:23-27.

[4] To be seen: A sun shield over Earth? Catch an Asteroid, and it might work. [On-line:] https://www.scientificamerican.com/article/a-sun-shield-over-earth-catch-an-asteroid-and-it-might-work/ (visited 21.04.2024)

[5] Ratliff Laura. Space Debris Reentry: Inadvertent Geoengineering, 2022. [On-line:] https://bpb-us-e1.wpmucdn.com/blogs.gwu.edu/dist/7/314/files/2019/08/Ratliff-Debris-Reentry-Final-reformat.pdf (Visited 01.02.2024).

[6] UNEP report. One Atmosphere: An Independent Expert Review on Solar Ratiation Modification Research and Deployement. February, 2023. [On-line:] https://wedocs.unep.org/handle/20.500.11822/41903 (Visited 21.04.2024)

necessary for position maintainance)[1]. The idea of proposing lightweight mirrors on satelites is not new, such hypothesis was brought to open scientific correspondence in 1989[2].

Examining the scientific correctness that fundaments the rationale of such interventions (global warming) exceeds the scope of this study, nevertheless, it might be appropriate to point that even in such discussions, we can find seemingly contradicting statements in the scientific literature. From one side, can be found conclusions that predict „*an accelerated surface temperature warming in this decade*"[3], and from another, researchers state that the Sun has entered a new proxy-magnetic field which might lead „*to a noticeable reduction of terrestrial temperature*"[4]. We still have an underdeveloped understanding upon the mechanism of solar dynamics[5], yet researching solar activity can be fairly prioritized if solar radiation is the factor that consolidates the human effors for developement and deployment of space-base technologies.

There are two important nuances regarding the initiatives for space-base technologies deployment: whether the counterweight used is (a) a set of new objects launced in space (which would increase the concentration of „space debris"), either it is (b) an object already floating in the air as space debris (which highlights the importance of strenghtening a legal framework for management of space debris). In the first scenario, the amount of space debris accumulation would generate high-risks for future uncontrolled Earth collissions, which correspondigly can only sharpen the dissagrement over the matter of international community. In the second scenario, consolidation of a common international understanding upon the principles and procedure for the re-use or re-cycling of the existing debris in space, oriented at ensuring the interest of small states included, is a mandatory condition for future development of Inernational Law.

Conclusions

We believe that cosmic debris presents a growing danger to the international community and that it is necessary to broaden cooperation in this area, regardless of the disagreements between states on various issues that exist at the moment. The US, Russia, China, Japan, India and the European Union, which are the "leading space powers" at the moment, need to join forces to tackle the problem of space debris. Additionaly, these international discussions must draw a parallel to geoengineering research and developement, with the purpose to analyse, monitor and reduce the consequences of from implementation of geoengineering projects.

At this stage it is necessary to conclude a multilateral agreement on the liability of states for damage caused by space debris and we support the idea that this agreement should be perfected as an additional protocol to the Convention of 29 March 1972 on International Liability for Damage Caused by Objects Launched into Outer Space.

At semantic debate, these distinctions are not of little relevance. The issue of solar dynamics will pose delicate questions in future if addressed incorrectly. For example, if the hypothesis that the sun enters a period of reduced solar activtity is proven while current policy documents interpret the climate data as warming and manage to canalize the geoengineering efforts into blocking the solar sunrays, the result might not only lead to a decrease of vegetation due to

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[1] Sánchez J-P, McInnes CR (2015) Optimal Sunshade Configurations for Space-Based Geoengineering near the Sun-Earth L_1 Point. PLoS ONE 10(8): e0136648. [On-line:] https://doi.org/10.1371/journal.pone.0136648 (Visited 01.02.2024).

[2] Seifritz, W. Mirrors to halt global warming? Nature, 1989. No. 340, 603. [On-line:] https://doi.org/10.1038/340603a0 (Visited 01.02.2024).

[3] Hodnebrog, Ø., Myhre, G., Jouan, C. *et al.* Recent reductions in aerosol emissions have increased Earth's energy imbalance. *Commun Earth Environ* **5**, 166 (2024). [On-line:] https://doi.org/10.1038/s43247-024-01324-8 (Visited 01.02.2024).

[4] Zharkova, V. (2020). Modern Grand Solar Minimum will lead to terrestrial cooling. *Temperature*, *7*(3), 217-222.

[5] Miyahara, H., Tokanai, F., Moriya, T. *et al.* Gradual onset of the Maunder Minimum revealed by high-precision carbon-14 analyses. *Sci Rep* **11**, 5482 (2021). [On-line:] https://doi.org/10.1038/s41598-021-84830-5 (Visited 01.02.2024).

duble factor of radiation reduction, but also launch reverberations of economic, geopolitical and serious social issues that can disturb previous systems established for the mangement space debris, causing situation of debris collisions on Earth incongruent for the technological advancement of the future.

Bibliography:

1. An Assessment of the Current LEO Debris Environment and the Need for Active Debris Removal // NASA, Liou - 2010 - slide 3 "Growth of the Historical Debris Populations". [On-line:] http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20100017146.pdf#page=4 (Vizited 01.02.2024).
2. Burian Alexandru. Drept internaţional cosmic (spaţial). În: *Drept Internaţional public, Ed. a 4-a (revăz. şi adăugită).* Red.-coord.: A. BURIAN. Ch.: S. n., 2012 (Tipogr. "Elena-V.I." SRL). – 636 p. (p. 393-407). ISBN 978-9975-106-99-3.
3. Burian, Alexandru ; Burian, Cristina. Drept internaţional cosmic (spaţial). Note de curs. : (Studii univ., ciclul 1) / Alexandru Burian, Cristina Burian ; Univ. de Studii Europene din Moldova, Fac. de Drept, Catedra Drept Public. – Chişinău.: Universitatea de Studii Europene din Moldova, 2016 (CEP USM). - 148 p. Bibliogr. p. 81-92 (82 tit.). ISBN 978-9975-71-861-5.
4. Burian, Cristina „Les débris spatiaux" et la responsabilité internationale pour les dommages causés par les objets spatiaux. In : Moldavian Journal of International Law and International Relations, 2016, Issue 4, Volume 11, Pages 609-616. ISSN 1857-1999 EISSN 2345-1963. [On-line:] https://rmdiri.md/assets/archive/2016-4.pdf (Vizited 01.02.2024).
5. Cocca A.A.: *Consolidacion del Derecho Espacial,* Astrea, Buenos Aires, 1971; Ferrer M.A., *Derecho Espacial*, Plus Ultra, Buenos Aires, 1976.
6. Committee on Space Research of the International Council of Scientific Unions (COSPAR). [On-line:] https://cosparhq.cnes.fr/ (Vizited 01.02.2024).
7. Convenţia din 29 martie 1972 cu privire la răspunderea internaţională pentru daunele cauzate de obiecte lansate în spaţiul extraatmosferic. Publicat în Buletinul Oficial, Nr. 4 din 5 ianuarie 1980. [On-line:] http://www.monitoruljuridic.ro/act/conventie-din-29-martie-1972-cu-privire-la-raspunderea-internationala-pentru-daunele-cauzate-de-obiecte-lansate-in-spatiul-extraatmosferic-emitent-consiliul-de-stat-30815.html (Vizited 01.02.2024).
8. ESA Space Debris Telescope. [On-line:] https://www.esa.int/Space_Safety/Space_Debris/Scanning_and_observing2 (Vizited 01.02.2024).
9. EISCAT. [On-line:] https://eiscat.se/ (Vizited 01.02.2024).
10. Heyward Clare. Situating and abandoning geoingineering: a typology of five responses to dangerous climate change. In: Political Science and Politics, 2013, 46.1:23-27.
11. Hodnebrog, Ø., Myhre, G., Jouan, C. *et al.* Recent reductions in aerosol emissions have increased Earth's energy imbalance. *Commun Earth Environ* **5**, 166 (2024). [On-line:] https://doi.org/10.1038/s43247-024-01324-8 (Vizited 01.02.2024).
12. International Astronautical Federation (IAF). [On-line:] https://www.iafastro.org/ (Vizited 01.02.2024).
13. Inter-Agency Space Debris Coordination Committee (IADC). [On-line:] https://www.unoosa.org/oosa/en/ourwork/copuos/index.html (Vizited 01.02.2024).
14. Inter-Agency Space Debris Coordination Committee. [On-line:] https://iadc-home.org/what_iadc (Vizited 01.02.2024).
15. International Institute of Space Law (IISL). [On-line:] https://iisl.space (Vizited 01.02.2024).
16. Kessler D.J. and Burton G. Cour-Palais. Collision Frequency of Artificial Satellites: The Creation of a Debris Belt. In: Journal of Geophysical Research, June, 1, 1978, Vol. 83, No. A6. Paper number 8A0210, P. 2637-2646.
17. Keith, D. W. Geoengineering the climate. In: The Ethics of Nanotetchnology, Geoengineering and Clean Energy, 2020, pp.207-246.
18. Large Zenith Telescope. [On-line:] https://www.astro.ubc.ca/lmt/lzt/ (Vizited 01.02.2024).
19. Melissa Gray, 'Chinese space debris hits Russian satellite, scientists say', *CNN* (9 March 2013) [On-line:] www.cnn.com/2013/03/09/tech/satellite-hit. (Visited 22.04.2024)
20. Miyahara, H., Tokanai, F., Moriya, T. *et al.* Gradual onset of the Maunder Minimum revealed by high-precision carbon-14 analyses. *Sci Rep* **11**, 5482 (2021). [On-line:] https://doi.org/10.1038/s41598-021-84830-5 (Visited 22.04.2024)

21. NASA Orbital Debris Program Office. [On-line:] https://orbitaldebris.jsc.nasa.gov/ (Vizited 01.02.2024).

22. NASA Orbital Debris Observatory. [On-line:] https://orbitaldebris.jsc.nasa.gov/protection/ (Vizited 01.02.2024).

23. National Space Defense Center. [On-line:] https://www.jtf-spacedefense.mil/About-Us/Fact-Sheets/Display/Article/3071003/national-space-defense-center/ (Vizited 01.02.2024).

24. Neagu Corina. Evoluţia cadrului juridic al activităţilor spaţiale, cu privire specială la teledetecţia prin sateliţi. Teză de doctorat, Rezumat. Universitatea din Bucureşti, Facultatea de drept, Bucureşti, 2009. - 48 p. // [On-line:] http://www.unibuc.ro/studies/Doctorate2009Noiembrie/Neagu%20Corina%20-%20Evolutia%20Cadrului%20Juridic%20al%20Activitatilor%20Spatiale%20cu%20Privire%20Speciala%20la%20Teledetectia%20prin%20Sateliti/Teza%20doctorat%20-%20Rezumat.pdf. (Vizited 01.02.2024).

25. Popescu Dumitra, Răspunderea internaţională în domeniul dreptului extraatmosferic, în „Studii de drept românesc”, nr. 3, 1996, p. 217-224.

26. Project Space Track. [On-line:] https://www.space-track.org/auth/login (Vizited 01.02.2024).

27. Ratliff Laura. Space Debris Reentry: Inadvertent Geoengineering, 2022. [On-line:] https://bpb-us-e1.wpmucdn.com/blogs.gwu.edu/dist/7/314/files/2019/08/Ratliff-Debris-Reentry-Final-reformat.pdf (Visited 01.04.2024).

28. Sánchez J-P, McInnes CR (2015) Optimal Sunshade Configurations for Space-Based Geoengineering near the Sun-Earth L_1 Point. PLoS ONE 10(8): e0136648. [On-line:] https://doi.org/10.1371/journal.pone.0136648 (Visited 01.04.2024).

29. Satellite map. [On-line:] https://satellitemap.space/ (Visited 01.02.2024).

30. Scientific American. A sun shield over Earth? Catch an Asteroid, and it might work. [On-line:] https://www.scientificamerican.com/article/a-sun-shield-over-earth-catch-an-asteroid-and-it-might-work/ (Visited 21.04.2024)

31. Seifritz, W. Mirrors to halt global warming? Nature, 1989. No. 340, 603. [On-line:] https://doi.org/10.1038/340603a0 (Visited 21.04.2024)

32. Space Detection and Tracking System. [On-line:] https://www.radartutorial.eu/02.basics/rp56.en.html (Vizited 01.02.2024).

33. Starlink satellites. [On-line:] https://www.space.com/spacex-starlink-satellites.html (Visited 01.02.2024).

34. Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, 27 January 1967. [On-line:] http://www.state.gov/www/global/arms/treaties/space1.html (Vizited 01.02.2024).

35. TIRA (System). [On-line:] https://www.fhr.fraunhofer.de/en/the-institute/technical-equipment/Space-observation-radar-TIRA.html (Vizited 01.02.2024).

36. The International Telecommunication Union (ITU). [On-line:] https://www.itu.int/en/Pages/default.aspx (Vizited 01.02.2024).

37. UN Committee on the Peaceful Uses of Outer Space (STCS UN COPUOS). [On-line:] https://www.unoosa.org/oosa/en/ourwork/copuos/index.html (Vizited 01.02.2024).

38. UNEP report. One Atmosphere: An Independent Expert Review on Solar Ratiation Modification Research and Deployement. February, 2023. [On-line:] https://wedocs.unep.org/handle/20.500.11822/41903 (Visited 21.04.2024).

39. Zharkova, V. (2020). Modern Grand Solar Minimum will lead to terrestrial cooling. *Temperature*, *7*(3), 217-222.

40. Алтайский оптико-лазерный центр имени Г. С. Титова. [On-line:] https://npk-spp.ru/zemlya/aolc/ (Vizited 01.02.2024).

41. Буриан К. А. “Космический мусор” и экологическое право: реальность, тенденции, перспективы. In: Международная научно-практическая конференция "Евразийская интеграция: правовой и образовательный аспекты". ШКОЛА ИНТЕРЭКОПРАВА. Новосибирский государственный университет, 4-5 декабря 2014 г. (Burian K. A. “Kosmicheskij musor” i jekologicheskoe pravo: real'nost', tendencii, perspektivy. In: Mezhdunarodnaja nauchno-prakticheskaja konferencija "Evrazijskaja integracija: pravovoj i obrazovatel'nyj aspekty". SHKOLA INTERJEKOPRAVA. Novosibirskij gosudarstvennyj universitet, 4-5 dekabrja 2014 g.). [On-line:] http://iel2nd.ucoz.ru/NSUposter_K.A.Burian_C.pdf (Vizited 01.02.2024).

42. Впервые в истории компании выписали штраф за космический мусор. [On-line:] https://habr.com/ru/news/765836/ (Vizited 01.02.2024).

43. Где находится «полюс недоступности» - точка Немо, и почему она самая чистая и самая грязная одновременно. [On-line:] https://dzen.ru/a/XxHJzDWaYV5Dt6uq (Vizited 01.02.2024).

44. Космический мусор как угроза безопасности полета. // Космос-журнал.рф 15.06.2012. [On-line:] http://www.cosmos-journal.ru/articles/952/ (Vizited 01.02.2024).

45. Международное космическое право. Отв.ред. Г.П. Жуков, Ю.М. Колосов. – Москва, «Международные отношения», 1999. – 360 с.

46. Мохаммад С.А. Международно-правовые аспекты борьбы с негативными экологическими последствиями космической деятельности. // Евразийский юридический журнал, № 7 (26) 2010. [On-line:] http://www.eurasialaw.ru/index.php?option=com_jcontentplus&view=article&id=1065:-7-26-2010-&catid=110:2010-06-17-10-27-36&Itemid=196 (Vizited 01.02.2024).

47. Над Сибирью столкнулись российский и американский спутники . - Lenta.ru. 12.02.2009. [On-line:] : http://lenta.ru/news/2009/02/12/collision/ (Vizited 01.02.2024).

48. Назаренко А.И. Моделирование космического мусора - М.: ИКИ РАН, 2013. 216 с. (Серия «Механика, управление и информатика»), ISBN 978-5-9903101-6-2, ISSN 2075-6839: с. 188-200.

49. ООН: Аппаратам на орбите угрожают 300 тыс обломков космического мусора. // РИА Наука, 02.10.2009. [On-line:] http://ria.ru/science/20091002/187328503.html (Vizited 01.02.2024).

50. Оптико-электронный комплекс «Окно».[On-line:] https://vpk.name/library/f/okno-oek.html (Vizited 01.02.2024).

51. Радиооптический комплекс распознавания космических объектов «Крона». [On-line:] https://vpk.name/library/f/krona-rokr.html (Vizited 01.02.2024).

52. Резолюция Генеральной Ассамблеи ООН от 13 декабря 1963 г. N 1962 (XVIII) "Декларация правовых принципов, регулирующих деятельность государств по исследованию и использованию космического пространства". [On-line:] http://www.un.org/ru/documents/decl_conv/declarations/outerspace_principles.shtml (Vizited 01.02.2024).

53. «Руководящие принципы Комитета по использованию космического пространства в мирных целях Организации Объединённых Наций по предупреждению образования космического мусора». Утверждены резолюцией Генеральной Ассамблеи ООН №A/RES/62/217, опубликованной 1 февраля 2008 г. [On-line:] http://www.un.org/en/ga/search/view_doc.asp?symbol=A/RES/62/217&referer=http://www.un.org/en/ga/62/resolutions.shtml&Lang=R (Vizited 01.02.2024).

54. Система контроля космического пространства. . [On-line:] https://macvympel.ru/projects/skkp/ (Vizited 01.02.2024).

55. Система предупреждения о ракетном нападении. [On-line:] https://russianforces.org/rus/sprn/ (Vizited 01.02.2024).

56. Станция оптических наблюдений «Архыз». [On-line:] https://npk-spp.ru/branches/filial-son-arkhyz-ao-npk-spp/ (Vizited 01.02.2024).

Bibliography (Transliteration):

1. An Assessment of the Current LEO Debris Environment and the Need for Active Debris Removal // NASA, Liou - 2010 - slide 3 "Growth of the Historical Debris Populations". [On-line:] http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20100017146.pdf#page=4 (Vizited 01.02.2024).

2. Burian Alexandru. Drept internaţional cosmic (spaţial). În: Drept Internaţional public, Ed. a 4-a (revăz. şi adăugită). Red.-coord.: A. BURIAN. Ch.: S. n., 2012 (Tipogr. "Elena-V.I." SRL). – 636 p. (p. 393-407). ISBN 978-9975-106-99-3.

3. Burian, Alexandru ; Burian, Cristina. Drept internaţional cosmic (spaţial). Note de curs. : (Studii univ., ciclul 1) / Alexandru Burian, Cristina Burian ; Univ. de Studii Europene din Moldova, Fac. de Drept, Catedra Drept Public. – Chişinău.: Universitatea de Studii Europene din Moldova, 2016 (CEP USM). - 148 p. Bibliogr. p. 81-92 (82 tit.). ISBN 978-9975-71-861-5.

4. Burian, Cristina „Les débris spatiaux" et la responsabilité internationale pour les dommages causés par les objets spatiaux. In : Moldavian Journal of International Law and International Relations, 2016, Issue 4, Volume 11, Pages 609-616. ISSN 1857-1999 EISSN 2345-1963. [On-line:] https://rmdiri.md/assets/archive/2016-4.pdf (Vizited 01.02.2024).

5. Cocca A.A.: Consolidacion del Derecho Espacial, Astrea, Buenos Aires, 1971; Ferrer M.A., Derecho Espacial, Plus Ultra, Buenos Aires, 1976.

6. Committee on Space Research of the International Council of Scientific Unions (COSPAR). [On-line:] https://cosparhq.cnes.fr/ (Vizited 01.02.2024).
7. Convenţia din 29 martie 1972 cu privire la răspunderea internaţională pentru daunele cauzate de obiecte lansate în spaţiul extraatmosferic. Publicat în Buletinul Oficial, Nr. 4 din 5 ianuarie 1980. [On-line:] http://www.monitoruljuridic.ro/act/conventie-din-29-martie-1972-cu-privire-la-raspunderea-internationala-pentru-daunele-cauzate-de-obiecte-lansate-in-spatiul-extraatmosferic-emitent-consiliul-de-stat-30815.html (Vizited 01.02.2024).
8. ESA Space Debris Telescope. [On-line:] https://www.esa.int/Space_Safety/Space_Debris/Scanning_and_observing2 (Vizited 01.02.2024).
9. EISCAT. [On-line:] https://eiscat.se/ (Vizited 01.02.2024).
10. Heyward Clare. Situating and abandoning geoingineering: a typology of five responses to dangerous climate change. In: Political Science and Politics, 2013, 46.1:23-27.
11. Hodnebrog, Ø., Myhre, G., Jouan, C. et al. Recent reductions in aerosol emissions have increased Earth's energy imbalance. Commun Earth Environ 5, 166 (2024). [On-line:] https://doi.org/10.1038/s43247-024-01324-8 (Vizited 01.02.2024).
12. International Astronautical Federation (IAF). [On-line:] https://www.iafastro.org/ (Vizited 01.02.2024).
13. Inter-Agency Space Debris Coordination Committee (IADC). [On-line:] https://www.unoosa.org/oosa/en/ourwork/copuos/index.html (Vizited 01.02.2024).
14. Inter-Agency Space Debris Coordination Committee. [On-line:] https://iadc-home.org/what_iadc (Vizited 01.02.2024).
15. International Institute of Space Law (IISL). [On-line:] https://iisl.space (Vizited 01.02.2024).
16. Kessler D.J. and Burton G. Cour-Palais. Collision Frequency of Artificial Satellites: The Creation of a Debris Belt. In: Journal of Geophysical Research, June, 1, 1978, Vol. 83, No. A6. Paper number 8A0210, P. 2637-2646.
17. Keith, D. W. Geoengineering the climate. In: The Ethics of Nanotetchnology, Geoengineering and Clean Energy, 2020, pp.207-246.
18. Large Zenith Telescope. [On-line:] . https://www.astro.ubc.ca/lmt/lzt/ (Vizited 01.02.2024).
19. Melissa Gray, 'Chinese space debris hits Russian satellite, scientists say', CNN (9 March 2013) [On-line:] www.cnn.com/2013/03/09/tech/satellite-hit. (Visited 22.04.2024)
20. Miyahara, H., Tokanai, F., Moriya, T. et al. Gradual onset of the Maunder Minimum revealed by high-precision carbon-14 analyses. Sci Rep 11, 5482 (2021). [On-line:] https://doi.org/10.1038/s41598-021-84830-5 (Visited 22.04.2024)
21. NASA Orbital Debris Program Office. [On-line:] https://orbitaldebris.jsc.nasa.gov/ (Vizited 01.02.2024).
22. NASA Orbital Debris Observatory. [On-line:] https://orbitaldebris.jsc.nasa.gov/protection/ (Vizited 01.02.2024).
23. National Space Defense Center. [On-line:] https://www.jtf-spacedefense.mil/About-Us/Fact-Sheets/Display/Article/3071003/national-space-defense-center/ (Vizited 01.02.2024).
24. Neagu Corina. Evoluţia cadrului juridic al activităţilor spaţiale, cu privire specială la teledetecţia prin sateliţi. Teză de doctorat, Rezumat. Universitatea din Bucureşti, Facultatea de drept, Bucureşti, 2009. - 48 p. // [On-line:] http://www.unibuc.ro/studies/Doctorate2009Noiembrie/Neagu%20Corina%20-%20Evolutia%20Cadrului%20Juridic%20al%20Activitatilor%20Spatiale%20cu%20Privire%20Speciala%20la%20Teledetectia%20prin%20Sateliti/Teza%20doctorat%20-%20Rezumat.pdf. (Vizited 01.02.2024).
25. Popescu Dumitra, Răspunderea internaţională în domeniul dreptului extraatmosferic, în „Studii de drept românesc”, nr. 3, 1996, p. 217-224.
26. Project Space Track. [On-line:] https://www.space-track.org/auth/login (Vizited 01.02.2024).
27. Ratliff Laura. Space Debris Reentry: Inadvertent Geoengineering, 2022. [On-line:] https://bpb-us-e1.wpmucdn.com/blogs.gwu.edu/dist/7/314/files/2019/08/Ratliff-Debris-Reentry-Final-reformat.pdf (Visited 01.04.2024).
28. Sánchez J-P, McInnes CR (2015) Optimal Sunshade Configurations for Space-Based Geoengineering near the Sun-Earth L1 Point. PLoS ONE 10(8): e0136648. [On-line:] https://doi.org/10.1371/journal.pone.0136648 (Visited 01.04.2024).
29. Satellite map. [On-line:] https://satellitemap.space/ (Visited 01.02.2024).

30. Scientific American. A sun shield over Earth? Catch an Asteroid, and it might work. [On-line:] https://www.scientificamerican.com/article/a-sun-shield-over-earth-catch-an-asteroid-and-it-might-work/ (Visited 21.04.2024)

31. Seifritz, W. Mirrors to halt global warming? Nature, 1989. No. 340, 603. [On-line:] https://doi.org/10.1038/340603a0 (Visited 21.04.2024)

32. Space Detection and Tracking System. [On-line:] https://www.radartutorial.eu/02.basics/rp56.en.html (Vizited 01.02.2024).

33. Starlink satellites. [On-line:] https://www.space.com/spacex-starlink-satellites.html (Visited 01.02.2024).

34. Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, 27 January 1967. [On-line:] http://www.state.gov/www/global/arms/treaties/space1.html (Vizited 01.02.2024).

35. TIRA (System). [On-line:] https://www.fhr.fraunhofer.de/en/the-institute/technical-equipment/Space-observation-radar-TIRA.html (Vizited 01.02.2024).

36. The International Telecommunication Union (ITU). [On-line:] https://www.itu.int/en/Pages/default.aspx (Vizited 01.02.2024).

37. UN Committee on the Peaceful Uses of Outer Space (STCS UN COPUOS). [On-line:] https://www.unoosa.org/oosa/en/ourwork/copuos/index.html (Vizited 01.02.2024).

38. UNEP report. One Atmosphere: An Independent Expert Review on Solar Ratiation Modification Research and Deployement. February, 2023. [On-line:] https://wedocs.unep.org/handle/20.500.11822/41903 (Visited 21.04.2024).

39. Zharkova, V. (2020). Modern Grand Solar Minimum will lead to terrestrial cooling. Temperature, 7(3), 217-222.

40. Altajskij optiko-lazernyj centr imeni G. S. Titova. [On-line:] https://npk-spp.ru/zemlya/aolc/ (Vizited 01.02.2024).

41. Burian K. A. “Kosmicheskij musor” i jekologicheskoe pravo: real'nost', tendencii, perspektivy. In: Mezhdunarodnaja nauchno-prakticheskaja konferencija "Evrazijskaja integracija: pravovoj i obrazovatel'nyj aspekty". ShKOLA INTERJeKOPRAVA. Novosibirskij gosudarstvennyj universitet, 4-5 dekabrja 2014 g. (Burian K. A. “Kosmicheskij musor” i jekologicheskoe pravo: real'nost', tendencii, perspektivy. In: Mezhdunarodnaja nauchno-prakticheskaja konferencija "Evrazijskaja integracija: pravovoj i obrazovatel'nyj aspekty". SHKOLA INTERJEKOPRAVA. Novosibirskij gosudarstvennyj universitet, 4-5 dekabrja 2014 g.). [On-line:] http://iel2nd.ucoz.ru/NSUposter_K.A.Burian_C.pdf (Vizited 01.02.2024).

42. Vpervye v istorii kompanii vypisali shtraf za kosmicheskij musor. [On-line:] https://habr.com/ru/news/765836/ (Vizited 01.02.2024).

43. Gde nahoditsja «poljus nedostupnosti» - tochka Nemo, i pochemu ona samaja chistaja i samaja grjaznaja odnovremenno. [On-line:] https://dzen.ru/a/XxHJzDWaYV5Dt6uq (Vizited 01.02.2024).

44. Kosmicheskij musor kak ugroza bezopasnosti poleta. // Kosmos-zhurnal.rf 15.06.2012. [On-line:] http://www.cosmos-journal.ru/articles/952/ (Vizited 01.02.2024).

45. Mezhdunarodnoe kosmicheskoe pravo. Otv.red. G.P. Zhukov, Ju.M. Kolosov. – Moskva, «Mezhdunarodnye otnoshenija», 1999. – 360 s.

46. Mohammad S.A. Mezhdunarodno-pravovye aspekty bor'by s negativnymi jekologicheskimi posledstvijami kosmicheskoj dejatel'nosti. // Evrazijskij juridicheskij zhurnal, # 7 (26) 2010. [On-line:] http://www.eurasialaw.ru/index.php?option=com_jcontentplus&view=article&id=1065:-7-26-2010-&catid=110:2010-06-17-10-27-36&Itemid=196 (Vizited 01.02.2024).

47. Nad Sibir'ju stolknulis' rossijskij i amerikanskij sputniki . - Lenta.ru. 12.02.2009. [On-line:] : http://lenta.ru/news/2009/02/12/collision/ (Vizited 01.02.2024).

48. Nazarenko A.I. Modelirovanie kosmicheskogo musora - M.: IKI RAN, 2013. 216 s. (Serija «Mehanika, upravlenie i informatika»), ISBN 978-5-9903101-6-2, ISSN 2075-6839: c. 188-200.

49. OON: Apparatam na orbite ugrozhajut 300 tys oblomkov kosmicheskogo musora. // RIA Nauka, 02.10.2009. [On-line:] http://ria.ru/science/20091002/187328503.html (Vizited 01.02.2024).

50. Optiko-jelektronnyj kompleks «Okno».[On-line:] https://vpk.name/library/f/okno-oek.html (Vizited 01.02.2024).

51. Radiooptičeskij kompleks raspoznavanija kosmicheskih ob"ektov «Krona». [On-line:] https://vpk.name/library/f/krona-rokr.html (Vizited 01.02.2024).

52. Rezoljucija General'noj Assamblei OON ot 13 dekabrja 1963 g. N 1962 (XVIII) "Deklaracija pravovyh principov, regulirujushhih dejatel'nost' gosudarstv po issledovaniju i ispol'zovaniju kosmicheskogo prostranstva". [On-line:]

http://www.un.org/ru/documents/decl_conv/declarations/outerspace_principles.shtml (Vizited 01.02.2024).

53. «Rukovodjashhie principy Komiteta po ispol'zovaniju kosmicheskogo prostranstva v mirnyh celjah Organizacii Ob"edinjonnyh Nacij po preduprezhdeniju obrazovanija kosmicheskogo musora». Utverzhdeny rezoljuciej General'noj Assamblei OON #A/RES/62/217, opublikovannoj 1 fevralja 2008 g. [On-line:] http://www.un.org/en/ga/search/view_doc.asp?symbol=A/RES/62/217&referer=http://www.un.org/en/ga/62/resolutions.shtml&Lang=R (Vizited 01.02.2024).

54. Sistema kontrolja kosmicheskogo prostranstva. . [On-line:] https://macvympel.ru/projects/skkp/ (Vizited 01.02.2024).

55. Sistema preduprezhdenija o raketnom napadenii. [On-line:] https://russianforces.org/rus/sprn/ (Vizited 01.02.2024).

56. Stancija opticheskih nabljudenij «Arhyz». [On-line:] https://npk-spp.ru/branches/filial-son-arkhyz-ao-npk-spp/ (Vizited 01.02.2024).

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