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Legal Instruments Supporting Sustainable Development Of Space Exploration

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Abstract

The future of space exploration depends not only on technological and economic measures but also on the appropriate legislation undertaken to achieve sustainable development of space activities. The current state of space debris, which are the result of an increasing number of collisions or direct-ascent anti-satellite (DA-ASAT) tests [1] has prompted the international community to engage in extensive actions involving the protection of the outer space environment. In addition to *Corpus Iuris Spatialis*, there are several standardization activities, which, although staying beyond the strictly regulatory aspect, contribute to the gradual uniformity process of space activities, at least on a technical level. The question therefore arises as to whether these mechanisms at the current stage are effective enough *"to meet the needs of the present generations while preserving the outer space environment for future generations*" [2]. Due to the lack of consistent regulations and heterogeneous guidelines, states decide to adopt preventive and mitigation measures at national level, which in consequence leads to the visible differentiation of requirements on a global scale, even if they are based on international recommendations. In addition to provided standards various initiatives are being taken to address this challenge. These activities aim to provide technical, managerial as well as legal support in order to achieve sustainability in the space sector. Besides the mechanisms designed to prevent creation of space debris, there are instruments intended for the remediation of the existing ones. One of these, by the way of example, is Active Debris Removal (ADR). Nevertheless, in addition to technical and economical obstacles that stand in the way of the development of ADR, legal aspects are a significant barrier. From the perspective of harmonization of space environment regulations, the consensus in the form of an international treaty appears to be impossible to achieve, and soft law mechanisms are not necessarily effective enough in the case of a possible dispute. Thus, in the interest of all space stakeholders should be the adoption of coherent measures to reduce the risk of collisions and avoidance fault-based liability as far as possible. To propose a potential solution, it becomes important to point out the differences emerging from already existing internationally recognized standards. The aim of the authors is furthermore to identify the inadequacies in the current international space environmental liability regime as well as indicate the actual legislative needs associated with the increasing commercialization of outer space in the field of sustainable development.

Keywords: Sustainable development, space debris, outer space environment, liability regime, space exploration, national space legislation

Acronyms/Abbreviations
Active Debris Removal (ADR)
Direct Anti Satellite Test (DA-ASAT)
Low Earth orbit (LEO)
Medium Earth orbit (MEO)
Non-Geostationary orbit (NGSO)

1. Introduction

According to the latest market estimates, the average number of satellites launched into space each year is expected to be more than 2,500, which gives approximately 7 satellites per day. Among the most vulnerable areas is the LEO and MEO, as it is expected that 83% of all satellites launched between 2022 and 2031 will be satellites of the NGSO constellation [3]. The current canon of international space law is insufficient to meet the challenges of

increasing problem of space debris in orbit around the Earth and as a consequence shrinking electromagnetic spectrum due to new business models such us mega constellations. The frequency of launching space objects into outer space increases the probability of collisions, thus threatening the sustainable access to space exploration [4]. Composed in the second half of the 20th century, international space law as *"hard law"* was dedicated to several government space programmes [5]. In order to facilitate the supervision of the growing number of activities of non-governmental stakeholders in outer space, *"soft law"* instruments are becoming widely used by national governments. The question arises as to what mechanisms are needed to ensure that voluntary recommendations will be both applicable as well as enforceable and whether it is possible to harmonize their application on a global scale. For a better understanding of the nature of the soft law mechanism *"It is vital to distinguish the effects of soft law from its interpretation, the control function it plays, and the sanction that might result from noncompliance with it. The effects of soft law are always objective. Interpretation and control are often subjective. Sanctions are not effects of soft law, but rather the repercussions of failure to comply"* [6]. Soft law regime in the space sector is intended to guide the best practices and behaviour of space actors through the influential role of a number of international resolutions and documents as a reflection of general interests and international will [7]. In currently existing practices related to space activities there is a diverse cross-section of standards, guidelines and recommendations. Their implementation is one of the methods of managing the space activities, in particular within the context of the growth of space debris. Due to the lack of enforceability and the non-binding nature of the standards, their effectiveness is still not satisfactory enough. From the other side, there is a noticeable increase in the application of appropriate mechanisms regarding the management of space debris mitigation, especially at the domestic level, considering that about 30 countries have already implemented national space legislation into their legal systems.

2. *Corpus Iuris Spatialis* – Insufficient Liability Regime

The concept of Long-Term Sustainability of outer space activities was included in the Guidelines for Long Term Sustainability of Outer Space Activities from 2019 of the Committee on the Peaceful Uses of Outer Space (LTS Guidelines) according to which it is defined as *"the ability to maintain the conduct of space activities indefinitely into the future in a manner that realizes the objectives of equitable access to the benefits of the exploration and use of outer space for peaceful purposes, in order to meet the needs of the present generations while preserving the outer space environment for future generations."* In the course of the Cold War period, the sustainable development was not the main focus during the creation of international space law. Due to the nature of the space stakeholders, which in the second half of the 20th century, only included states, this concept did not attract lots of attention. The current space ecosystem increasingly consisting of non-governmental entities inevitably requires action to reduce threats to the outer space environment by more decisive legal actions. International space treaties, due to the background of their formation, have a legal gap in this regard. The existence of minimum binding regulations and, in certain aspects, total absence of rules implies more and more questions and difficulties in determining the appropriate direction for the development of space activities. The consequence of this state of affairs is legal uncertainty and high risk, not only for states, but also for private actors, which must comply with the relevant requirements in order to conduct space activities. Taking into account the canon of international space regulations, several treaties deserve to be considered in the context of sustainability namely: Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (The Outer Space Treaty), Convention on International Liability for Damage Caused by Space Objects (The Liability Convention) and Convention on Registration of Objects Launched into Outer Space (The Registration Convention). Article VI of Outer Space Treaty contains the basic principle obliging states to *"bear 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."* Further, according to article VII the launching state is liable for damage caused by space object or its components parts on the Earth, in air or in outer space, including the Moon and other celestial bodies. The basis for the adoption of appropriate measures for space debris mitigation can be found in Article IX which says that "*States Parties to the Treaty shall pursue studies of outer space, including the moon and other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose.*" Based on Article II and III, the Liability Convention distinguishes between two types of liability for damages caused by space objects – in addition to absolute liability (in the case of damage on the surface of the earth or to aircraft in flight), the Convention attributes fault-based liability to damage caused in outer space. However it is important to emphasise that it does not refer to liability caused to the space environment but only to damage to persons or property. The obligation to register a space object in the Registration Convention is intended to ensure the effectiveness of the regulations contained in the

two aforementioned treaties. It aims to recognize control, jurisdiction and thus easier identification of space objects in the event of potential liability for damage caused by this space object. One of the unresolved issues regarding the Liability Convention is the attribution of liability for damage caused solely by a space object. With the currently broad spectrum of space activities despite their early stage of development (for example on-orbit servicing or space mining), such a narrow interpretation of the regulations may have far-reaching consequences in enforcing international liability. Similarly, this problem affects the Registration Convention which requires registration of space objects only[8].

3. Protection of Space Environment – Dual Perspective

This section of the paper shall be devoted to the analysis of the legal and technical options regarding the sustainability of space sector. Due to the current status of the space legislation, the considerations will be substantially limited to the space debris problem, i.e. remediation of space debris and mitigation the risk of damage caused by space debris in the future.

3.1. Remediation

Referring to the NASA's study conducted in 2018, in the absence of globally binding disposal methods of space objects after completing the space mission, the debris population in LEO will grow rapidly, causing an approximately 330 percent increase in the next 200 years [9]. Various instruments aimed at responding to the existing problem can be divided into two categories: those of a preventive nature and those aimed at remediation. Mitigation guidelines as well as standards only consider the issues of preventing the formation of space debris to the minimal extent [10]. However, the problem seems to be a bit more complex. Again, in accordance with recent NASA statement, there is currently a critical point with regard to the mass of space debris [11]. This state of affairs may lead to the emergence of so-called Kessler's syndrome according to which, even in the absence of further space objects being launched, more and more space debris is created as a result of numerous collisions. Therefore, in addition to measures aimed at limiting the formation of new space debris as much as possible, there are also attempts to introduce mechanisms designed to eliminate the existing ones. Active Debris Removal is one of the proposals to remediating existing debris, however, despite both economic and technical barriers, it faces also legal difficulties [12]. Why? The main legal challenge is the question of granting consent for the removal of inactive space objects. According to already mentioned article VII of the Outer Space Treaty the State that launches or procures the launching of an object into outer space are bearing the liability for damage caused by such object. Further, the Liability Convention in addition to damage caused in earth surface or to aircraft in flight, impose fault-based liability for damage caused in outer space [13]. Registration Convention in article II indicates the obligation to register space object by launching state and finally, based on article VIII of Outer Space Treaty *"State Party to the Treaty on whose registry an object launched into outer space is carried shall retain jurisdiction and control over such object […]."* In many cases it is not possible to attribute ownership of space debris to a particular state especially when it comes to small fragments, detached from released space objects [14]. Due to the huge amount of space debris, currently about 32290 tracked by Space Surveillance Networks [15], it is therefore extremely difficult to determine their origin. Redefining and reinterpreting existing international treaties is not an adequate solution. The provisions of national space legislations are also based on liability regime resulting from the Outer Space Treaty and Liability Convention as well as the obligation under the Registration Convention. Following the principle of good faith and the framework of international law, it is up to the State to acknowledge that it has caused the potential threat by recognizing ownership of these objects [16]. In practice, however, this can be very difficult to achieve. For instance, the recent DA-ASAT test conducted by Russia in November 2021 created a huge amount of debris. Nevertheless the activity of destroying one's own non-functioning satellite is not in itself illegal under international law. The international response appeared in the form of United Nations General Assembly draft Resolution calling on member states "*to not conduct destructive direct-ascent anti-satellite missile tests"* thereby acknowledging *"such a commitment to be an urgent, initial measure aimed at preventing damage to the outer space environment, while also contributing to the development of further measures for the prevention of an arms race in outer space"* [17]. The property rights of the space objects, as one of the many legal aspects, pose a difficulty in terms of ADR development. From the legal perspective, one solution that could contribute to facilitating the identification of space debris and thus avoiding conflicts over property rights, is to harmonize the definition of space debris at international level. It should be noted

that space debris is defined in some of the existing recommendations [18] and also appears in several definitions contained in national space legislations [19]. However, due to the slight differences between the definitions of space debris, issues of dispute may arise in terms of their appropriate interpretation.

3.2 Mitigation

The second method aimed at managing the space industry in a sustainable manner is mitigation of the risk before it materializes. This issue obviously is related at first to space debris, though in long-term perspective should be considered in a broader way, taking into account other prerequisites of the sustainable development. The mitigation measures result mostly from the soft law instruments, as no Space Treaty refers directly to this issues. The current range of international guidelines focusing on mitigation of space debris is substantial. Among the most common and used in practice are Long Term Sustainable Guidelines, International Organization for Standarization (ISO) Standards and Technical Reports, Committee on the Peaceful Uses of Outer Space, Space Debris Mitigation Guidelines (COPUOS SDMG), Inter-Agnecy Space Debris Coordination Committee (IADAC) Space Debris Mitigation Guidelines and International Telecommunications Union (ITU) Recommendations [20]. In relation to COPUOS SDMG, application of the guidelines should take place in all phases of the space activity (from planning and design to exploitation and disposal of the space object) [21]. According to IADC recommendations the Space Debris Mitigation Plan should include, among other things, plans for managing, assessing and mitigating the effects of space debris, measures to minimise the risks associated with disturbances that could lead to space debris and a plan for the removal of the space object once its mission is accomplished [22]. The International Organization for Standardization proposals are more complex and technical in nature. The recommendations consist of a number of standards and technical reports concerning, among others, space systems, space environment (artificial and natural) or space data and information transfer systems [23]. Based on COPUOS Space Debris Mitigation Guidelines the implementation of measures should be done through the state's own mechanisms, ensuring their effectiveness to the greatest extent possible [24]. A further question arises how to convince operators to apply preventive measures recommended by international community as an expression of responsible space behavior? [25].Taking inspiration from international environmental law, two principles can be cited in the context of space, namely the *"Polluters Pay Principle"* and the *"Precautionary Principle*". The polluter pays principle indicates that, without any exception those responsible for causing pollution should bear the expenses of environmental remediation as well as pollution prevention programmes [26]. This principle was justified in accordance with Environmental Liability Directive (ELD) from 2004, in which the Preamble indicates that such an approach would aim to encourage entities to develop practices and adopt measures to minimize the risk of harm to the environment and minimize the exposure of operators to financial liabilities [27]. However, given the complexity of space projects, it often seems problematic to establish liability and thus the analogous application of environmental law may be more complicated [28]. The Precautionary Principle in simple terms, it is more advantageous to take precautions (which may ultimately prove to be unnecessary) than to take none and risk serious consequences. This is particularly common in domestic environmental law and also permeates international law [29]. It is worth noting that the precautionary principle is mentioned in the preamble of the Liability Convention as follows:*"Taking into consideration that, notwithstanding the precautionary measures to be taken by States and international intergovernmental organizations involved in the launching of space objects, damage may on occasion be caused by such objects […]"* but no further provisions regulate application of this rule.

Concluding this part of analysis, there seems to be a serious mismatch between the ownership rights and the practical need for efficient remediation and mitigation of damage that ban be caused by space debris. The legal tools, at least on international level do not impose sufficiently enforceable obligations with respect to prohibiting the generation of debris and cleaning them up by the debris owner. From the other side, the law seems to prevent actions to be undertaken collectively in the interest of the humankind for the sake of protecting "private" property causing damage. The similar dilemma concerns the regime of the liability for damage, which includes only liability for the damage which has actually occurred and does not provide for a mechanism of imposing liability for lack of undertaking necessary precautionary actions.

4. *"Internationally recognized standards"* under National Space Legislations

At the national level, the implementation of recommendations and guidelines is practiced through various form of legal acts such us executive orders, decrees or regulations. When analyzing the national space legislations of selected countries it seems that the approach to the protection of the space environment in national regulations is comparable. The model phrase of *"internationally recognized standards and guidelines"* is increasingly addressed at the level of national space legislations. This is justified by international obligations in the context of state authorisation and supervision of non-governmental space activities, notably under the Outer Space Treaty. Using relevant examples, such regulations can be found in Australian, Austrian, Finnish or Danish as well as in French law. Australia's national mechanism regarding the space debris mitigation is based on two acts; The Space (Launches and Returns) Act from 2018 and the Space (Launches and Returns) (General) Rules from 2019. In accordance with the Space Act from 2018 implementation of an appropriate strategy for mitigation of space debris is required in the case of application for the grant of an Australian launch permit and for the grant of an overseas payload permit. This strategy must be based on internationally recognized guidelines or on debris mitigation standard and should indicate relevant standards and guidelines [30]. In addition, according to Article 54 of the General Rules "*the strategy must describe any mitigation measures planned for orbital debris arising from the proposed launch or launches including payloads"* Based on an internationally recognized model, the strategy must also include an orbital debris assessment [31]. Austrian law, as in the case of Australia, indicates mitigation mechanisms in two legal acts. Austrian Outer Space Act from 2011 in paragraph 5 refers to the operator's obligation "*to make provision for the mitigation of space debris in accordance with the state of the art and in due consideration of the internationally recognised guidelines for the mitigation of space debris."* In particular it applies to normal operations during which the debris are released [32]. The Regulation includes details relating to the implementation of the Space Act [33]. Another example is the legislation of Denmark; The Danish Outer Space Act of 2016 and The Danish Executive Order on requirements in connection with approval of activities in outer space, etc. The operator's application for authorisation must include appropriate documentation on maintaining relevant measures to manage space debris [34]. In the Executive Order references to specific guidelines are indicated, namely to International Organization for Standardization (ISO) or European Cooperation for Space Standardization (ECSS) [35]. The instruments applied by Finland are also based on two regulatory levels. Act on Space Activities, adopted in January 2018 indicates that the operator shall seek to ensure that the space activities do not generate space debris, in accordance with generally accepted international guidelines [36]. Section 3 of the Decree of the Ministry of Economic Affairs and Employment on Space Activities introduces a time limit of 25 years (from the end of the period of functional operation) for the transfer of a space object into the atmosphere or into an orbit where it is deemed not to cause danger or harm to the other space activities or other space objects [37]. Finally, particular attention should be given to the French Space Operation Act (FSOA) and Technical Regulations. The Technical Regulations impose two types of obligation on operators in relation to the mitigation of space debris both in orbit and with regard to launch operations. These standards are based on the European Code of Conduct for Space Debris Mitigation, on the Inter-Agency Space Debris Coordination Committee guidelines as well as ISO Standard: ISO 24113:2010 (recently reviewed by third edition: ISO 24113:2019) relating to space systems - Space debris mitigation requirements [38]. As can be seen from the examples indicated above, the model of reference to *"internationally recognised guidelines"* is repeated. This appears at two regulatory levels, the basic laws on space activities and the detailed provisions included in executive orders, decrees or regulations. The idea seems the right one, as the standards mentioned above may be now and then adjusted without the necessity of amending numerous space laws, which allows to achieve real coherence around the world. Though, the examples of numerous international guidelines and standards identified in the study often demonstrate a certain arbitrariness in the choice of internationally recognised guidelines. Noticeably few legislators, as in the case of Denmark or France, choose to point to a specific recommended document. Therefore, there is legal uncertainty as to which standards should be applied. As a consequence, this leads to different requirements for licenses for space activities, fragmentation of the manner of compliance and recognition of the requirements that the operator should meet. Efforts should thus be made to encourage the national lawmakers to apply the same technical standards.

5. Differences between non-binding recommendations – examples

The most commonly referenced standards are the COPUOS Space Debris Mitigation Guidelines endorsed by the United Nations General Assembly, Inter-Agency Space Debris Coordination Committee (IADC): Space Debris Mitigation Guidelines and International Organization for Standardization (ISO) Standards. In the content of the first two, slight differences can already be noticed for example in the case of limiting debris released during normal operations. In addition to the recommendation in both guidelines to design space systems in such a way that they do not release debris during normal operations, the COPUOS Guideline additionally provide that *"if this is not feasible, the effect of any release of debris on the outer space environment should be minimized"* (Guideline 1). Based on

IADC Guideline:*"where this is not feasible any release of debris should be minimised in number, area and orbital lifetime."*(Guideline 5.1) [39]. The issue of the impact on the space environment in this case can be broadly interpreted and thus quite discretionary in the context of an appropriate risk assessment. Is it possible to determine any amount of space debris and its type so that it does not significantly endanger the space environment? Example of a supporting standard in this regard, recommended by the International Organisation for Standardisation, concern the issue of prevention of breakup of unmanned spacecraft (ISO 16127:2014). This standard addresses both operational and design requirements to minimise the risk of spacecraft breaking up during and after operational life. Elements such as propulsion systems, pressurized systems or electrical systems (for examples batteries) are indicated as a particular elements that may cause the disruption [40]. In the case of the prevention of On-Orbit Collisions recommendations are quite similar. According to COPUOS Space Debris Mitigation Plan *"in developing the design and mission profile of spacecraft and launch vehicle stages, the probability of accidental collision with known objects during the system's launch phase and orbital lifetime should be estimated and limited. If available orbital data indicate a potential collision, adjustment of the launch time or an on-orbit avoidance manoeuvre should be considered"* [41]. As compared with IADC guidelines *"in developing the design and mission profile of a spacecraft or orbital stage, a program or project should estimate and limit the probability of accidental collision with known objects during the spacecraft or orbital stage's orbital lifetime. If reliable orbital data is available, avoidance manoeuvres for spacecraft and co-ordination of launch windows may be considered if the collision risk is not considered negligible*" [42]. The difference between these recommendations lies in the broader content of the IADC standard where in addition *"Spacecraft design should limit the consequences of collision with small debris which could cause a loss of control, thus preventing post-mission disposal"* [43]. The key in this case is to indicate the notion of "known objects". Depending on which standard is used, space debris is often not identifiable, hence the scope of the IADC's recommendation appears to be much broader.

6. Voluntary Arrangements

Crowding and competition in outer space has been identified as one of the global risk during the 22nd World Economic Forum. According to the Global Risk Report, mitigation of space debris, situational awareness in space and space traffic management are areas that could be based on the standards of formal international agreements so as to bring the expected benefits to all entities. According to the Report, the inclusion of private space stakeholders in the agreement process should help ensure that both commercial and technical realities are adequately reflected in such agreements [44]. Following this recommendation, it is worth considering the types of agreements that, despite their non-binding nature, can have an appropriate impact on both states and private actors. An example of voluntary, multilateral arrangement that has created a set of non-binding guidelines is the Wassenaar Arrangement and Artemis Accords. The Wassenaar Arrangement is a type of voluntary export control system in which 42 members participate exchanging transfer information of dual-use goods and technologies as well as of conventional weapons [45]. This Arrangement is a voluntary alliance which is not bound by a treaty that is why it has no formal instrument to enforce compliance [46]. Regarding the Dual-Use Goods and Technologies List, Member States exchange information, at a frequency of twice a year, on all export licences denied on proposed transfers to non-Wassenaar members [47]. Nonetheless, the most interesting example concerning activities in the space sector from the perspective of non-binding instruments is known as the Artemis Accords [48]. According to the purpose and scope of these Accords *"adherence to a practical set of principles, guidelines, and best practices in carrying out activities in outer space is intended to increase the safety of operations, reduce uncertainty, and promote the sustainable and beneficial use of space for all humankind. The Accords represent a political commitment to the principles described herein, many of which provide for operational implementation of important obligations contained in the Outer Space Treaty and other instruments"* [49]. Like the Wassenaar Arrangement, the Artemis Accords are non-binding regulations, however in the case of Artemis its provisions partially refer to Outer Space Treaty. Multilateral soft law instruments at international level concerning the formulation and development of standards or guidelines can be replaced by a type of agreement, i.e. Artemis Accords, forming more specific and targeted bilateral agreements or agreements between a group of states willing to shape space law and governance in the same direction [50]. In a sense, the Artemis Accords seem to be a turning point in the creation of space law, being at the crossroads of unilateral national legislation and multilateralism [51]. The strong interest in both multilateral Wassenaar Arrangements (42 Members) and Artemis Accords (23 signatories so far) demonstrates an noticeable tendency for this type of cooperation.

7. Conclusion

The following conclusions can be drawn from the analysis included in the paper:

There are no binding international laws addressing directly the needs of sustainable development in the space sector

Sustainability may be referred to two basic methods: (1) remediation, and (2) mitigation. While remediation is regulated to certain degree by Outer Space Treaty and Liability Convention, though causing some concern, mitigation must base solely on soft law measures and those national legislations which see the pertinent necessity of addressing the environmental challenges of outer space exploration and gained sufficient level of "space environmentalism".

Therefore, enforceability is in the hands of national lawmakers. The correlation, though, can be achieved between national laws and international technical standards. This perspective looks promising in the era of geopolitical tension which eliminates chances for global consensus at the level of the United Nations. The coherence of technical standards do not require such a consensus and may be dynamically adjusted to the technology and sustainability needs. The efforts should be made on applying the same standards by the states.

Besides, good prospects seem to be when we look at the efficiency of instruments as Artemis Accord and quite recently also ASAT Bank moratorium and if so, it should be applied in even wider context – if it is to contribute to materializing the sustainable development of the space sector.

As the last but not least, a note should be made, that so far the space debris is the main problem considered within the context of sustainable development. It is surely a good starting point due to its pertinent nature, but also other elements of the Sustainable Development concept should get the attention of the international community, such as *"the ability to maintain the conduct of space activities indefinitely into the future in a manner that realizes the objectives of equitable access to the benefits of the exploration and use of outer space for peaceful purposes […]"*[52].

References:

[1] Since 1968, 15 anti-satellite tests have been carried out. Countries that have conducted such tests include: Russia, U.S., China and India; G. Bhutada, Anti-Satellite Weapons: Threatening the Future of Space Activities 14 June 2022, https://www.visualcapitalist.com/sp/anti-satellite-weapons/, (accessed 20.01.2023).

[2] The definition of *"Long-Term Sustainability of outer space activities"* contained in Guidelines for the Long-term Sustainability of Outer Space Activities , COPUOS 27 June 2018 (Doc. A/AC.105/2018/ CRP.20.

[3] Euroconsult, Satellites to be Built & Launched, 25th edition. A complete analysis and forecast of satellite manufacturing and launch services 2022, https://digitalplatform.euroconsultec.com/product/satellites-to-be-built-launched-new/, (accessed 15.01.2023).

[4] Inmarsat, Space Sustainability Report 2022, https://www.inmarsat.com/en/insights/corporate/2022/space-sustainability.html, (accessed 16.01.2022).

[5] L. F. Martinez Legal regime sustainability in outer space: theory and practice,Global Sustainability 2, (2019) e26, 1–6.

[6] T. Gruchalla – Wesierski, A Framework of Understanding "Soft Law", McGill Law Journal (1984), pp. 52.

[7] J.N. Pelton, Overview of the Existing Mechanisms, in: R.S. Jakhu, J.N. Pelton (Eds.) Global Space Governance: An International Study, Springer International Publishing AG, 2017, p.45.

[8] B. Cheng, International Responsibility and Liability for Launch Activities, Air&Space Law, Vol. XX, no 6, 1995.

[9] J.-C. Liou, M. Matney, A. Vavrin, A. Manis, and D. Gates, "NASA ODPO's Large Constellation Study," Orbital Debris Quarterly Newsletter 22,2018, p.3.

[10] S. Hobe Space Law, Nomos Verlagsgesellschaft, 2019.

[11] NASA, Nasa's Efforts To Mitigate The Risks Posed By Orbital Debris 27 January 2021, https://oig.nasa.gov/docs/IG-21-011.pdf, (accessed 03.01.2023).

[12] J. Koller , T. Way Active Debris Removal: Policy and Legal Feasibility, 22 April 2021, https://csps.aerospace.org/papers/active-debris-removal-policy-and-legal-feasibility, (accessed 04.01.2023).

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

[14] S.M. Steele, Space Debris: A Basis for Actively Removing Objects Under an International Legal Order American Journal of Aerospace Engineering, 22 April 2022, Vol.8, No. 2 p. 52.

[15] ESA, Space Debris by the Numbers, 22 December 2022, https://www.esa.int/Space_Safety/Space_Debris/Space_debris_by_the_numbers, (accessed 07.01.2023).

[16] S.M. Steele, Space Debris: A Basis for Actively Removing Objects Under an International Legal Order American Journal of Aerospace Engineering 22 April 2022,
vol. 8 no. 2, p.52.

[17] The Committee on the Peaceful Uses of Outer Space approved a new draft resolution, entitled *"Destructive direct-ascent anti-satellite missile testing"* (Document A/C.1/77/L.62).

[18] For example IADC Guideline: *"Space debris are all man made objects including fragments and elements thereof, in Earth orbit or re-entering the atmosphere, that are non functional."*

[19] For example: Federal Law No. (12) of 2019 Issued on 19/12/2019 Corresponding to 22 Rabi' Al-Akhar 1441H. On The Regulation Of The Space Sector, Article 1: *"A Space Object that has no role or purpose, or the remains thereof, and the materials, waste, or fragments resulting therefrom, whether in Outer Space, including the Earth's orbit, or inside the Earth's atmosphere."*

[20] NetZeroSpace, Sustainable outer space by 2030 Fostering Better and More Interoperable Norms: Recommendations For Enhanced Regulations and Public Policy with Regard to Space Debris Mitigation and Remediation Comparing Existing Binding National Requirements Relating to Space Debris. Paris Pease Forum,

November 2022, https://parispeaceforum.org/wp-content/uploads/2022/11/20221108-Net-Zero-Space-WG1-White Paper-FINAL-MISE-EN-PAGE_v4.pdf, (accessed 20.01.2023) .
[21] Guideline 4 of the Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space.
[22] Guideline 4 of the Inter-Agency Space Debris Coordination Committee: Space Debris Mitigation Guidelines.
[23] International Organization for Standardization: Standards and technical reports.
[24] *"Member States and international organizations should voluntarily take measures, through national mechanisms or through their own applicable mechanisms, to ensure that these guidelines are implemented, to the greatest extent feasible, through space debris mitigation practices and procedures."*
[25] H. Brettle J. Forshaw J. Auburn, Towards a Future Debris Removal Service: Evolution of an ADR Business Model, IAC-19,A6,10-B4.10,8,x49992, 70th International Astronautical Congress, Washington D.C., United States, 21-25 October 2019.
[26] The 'Polluter Pays Principle' (PPP) was first introduced in 1972 by The Organisation for Economic Co-operation and Development (OECD); ECA, The Polluter Pays Principle: Inconsistent application across EU environmental policies and actions, 2021, https://www.eca.europa.eu/Lists/ECADocuments/SR21_12/SR_polluter_pays_principle_EN.pdf, (accessed 20.01.2023).
[27] Preamble of Directive 2004/35/CE of the European Parliament and of the Council of 21 April 2004 on environmental liability with regard to the prevention and remedying of environmental damage - Environmental Liability Directive (ELD).
[28] S.M. Steele, Space Debris: A Basis for Actively Removing Objects Under an International Legal Order American Journal of Aerospace Engineering 22 April 2022, Vol. 8 No. 2, p.52.
[29] Lyall F. PROTECTION OF THE SPACE ENVIRONMENT AND LAW Proceedings on the Law of Outer Space,p. 42,', IAA-99-IAA.7.1.05, IAA/IISL Scientific-Legal Round Table on Protection of the Space Environment, 50th IAF Congress, Amsterdam, the Netherlands, October 4-8, 1999.
[30] Article 34, 46G of the Space (Launches and Returns) Act 2018.
[31] Article 54 of the Space (Launches and Returns) (General) Rules from 2019.
[32] Article 5 of the Authorization of Space Activities and the Establishment of a National Space Registry (Austrian Outer Space Act).
[33] Regulation of the Federal Minister for Transport, Innovation and Technology in Implementation of the Federal Law on the Authorisation of Space Activities and the Establishment of a National Space Registry (Outer Space Regulation).
[34] Article 6(4) of the Danish Outer Space Act (act no.409 of 11 May 2016).
[35] Article 6(1) of the Danish Executive Order on requirements in connection with approval of activities in outer space, etc.
[36] Section 10 of the Act on Space Activities (63/2018).
[37] Section 3 of the Decree of the Ministry of Economic Affairs and Employment on Space Activities (74/2018).
[38] W. Mikalef The Space Law Review: France 5 January 2023, https://thelawreviews.co.uk/title/the-spacelaw review/france?fbclid=IwAR1iEZqGR-o4ldDBicW8CF1rA0h7VS-pSHffE6e8FPcWpxw2bN5Up4OL9Uk, (accessed 17.01.2023).
[39] A. Soucek, J. Tapio, Normative References to NonLegally Binding Instruments in National Space Laws: A Risk Benefit Analysis in the Context of Public International and Domestic Law, Proceedings of the International Institute of Space Law, vol. 2018, no. 4, p. 560.
[40] H. Stokes, A. Bondarenko, R. Destefanis, N. Fuentes, A. Kato, A. LaCroix, D. Oltrogge, and M. Tang STATUS OF THE ISO SPACE DEBRIS MITIGATION STANDARDS 2017, https://conference.sdo.esoc.esa.int/proceedings/sdc7/paper/979/SDC7-paper979.pdf (accessed 17.01.2023).
[41] Guideline 3 of the Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space.
[42] Guideline 5.4 of the Inter-Agency Space Debris Coordination Committee : Space Debris Mitigation Guidelines,.
[43] Ibid.

[44] World Economic Forum 2022, The Global Risk Report 2022 17th Edition, *https://www3.weforum.org/docs/WEF_The_Global_Risks_Report_2022.pdf*, (accessed 17.01.2023).
[45] D. Kimball, The Wassenaar Arrangement at a Glance, February 2022, https://www.armscontrol.org/factsheets/Wassenaar, (accessed: 17.01.2023).
[46] Nuclear Threat Initiative Wassenaar Arrangement, https://www.nti.org/education-center/treaties-and-regimes/wassenaar-arrangement/ , (accessed: 17.01.2023).
[47] D. Kimball The Wassenaar Arrangement at a Glance February 2022,https://www.armscontrol.org/factsheets/Wassenaar, (accessed: 17.01.2023).
[48] The Artemis Accords Principles For Cooperation In The Civil Exploration And Use Of The Moon, Mars, Comets, And Asteroids For Peaceful Purposes.
[49] Ibid. Section 1 – Purpose and Scope.
[50] R. Neef, ARTEMIS ACCORDS: A NEW PATH FORWARD FOR SPACE LAWMAKING? https://law.adelaide.edu.au/system/files/media/documents/2022-01/alr_422_06_neef.pdf, (accessed:17.01.2023)
[51] R.Deplano THE ARTEMIS ACCORDS: EVOLUTION OR REVOLUTION IN INTERNATIONAL SPACE LAW? Cambridge University Press, ICLQ Vol. 70, July 2021, pp. 799–819.
[52] The definition of *"Long-Term Sustainability of outer space activities"* contained in Guidelines for the Long-term Sustainability of Outer Space Activities , COPUOS 27 June 2018 .