ISSN 0137-4346; e-ISSN 2544-3135

DOI: https://doi.org/10.31338/2544-3135.si.2023-97.6

Katarzyna Malinowska
Kozminski University, Poland
e-mail: katarzynamalinowska@kozminski.edu.pl
ORCID: 0000-0003-0623-402X

PROTECTION OF THE SPACE ENVIRONMENT AND SUSTAINABLE DEVELOPMENT AS A PARADIGM FOR THE DEVELOPMENT OF SPACE LEGISLATION

Abstract

Managing human activity in outer space requires a mixture of tools, including technology, economics, and law. Though technology and economics are of prime importance, the space sector needs a clear, coherent, and adequately granular regulatory environment that ensures its sustainable development and also serves sustainability on Earth. No doubt the law can be a tool for introducing sustainability into the space sector's daily life. To serve as such, law should be almost as dynamic and agile as the space activity and space environment. The space law should not only be descriptive, but it should also address new concepts such as in-orbit servicing, asteroid mining, etc. By doing so, it should also embrace the technical aspects of space activities even if they are not mandatory by international law. The lawmakers, especially national legislators, must also not be afraid to tackle new areas. The primary duty of national governments is to enhance safety and minimize risk in all, traditional and emerging space ventures, both in material and financial contexts that do not only directly affect their citizens and their assets, but also the environment, which obviously serve the entire society in an inclusive way and on a long-term basis.

The purpose of this paper is to provide a voice in the discussion on the concept of sustainable development of space activities and suitability of the existing space regulatory framework. In order to draw some conclusions, it seems necessary to analyse the notion of sustainability against the existing legal framework, so as to state whether

it is still up to date in this respect and whether it may contribute to materializing the sustainable development of the space sector. In particular, it is interesting to consider whether the liability regime, including the notion of damage and prerequisites of claims for compensation as adopted in the Liability Convention may still serve its purpose and answer the needs of the shift in the priorities of space exploration. Finally, I intend to consider the possibility of drawing on principles from other branches of law, including in particular, environmental law and insurance law and practice, in order to build legal mechanisms to implement the demands of sustainable development of space. Thus, among other issues, the topic of space environmentalism as well as the coherence of space and earth sustainability instruments will be analysed.

KEYWORDS

sustainability, space insurance, Liability Convention, prevention, precautionary approach

SŁOWA KLUCZOWE

zrównoważony rozwój, ubezpieczenia kosmiczne, Konwencja o odpowiedzialności, prewencja, podejście ostrożnościowe

"For space to support sustainability on Earth, there needs to be sustainability in space"
(Inmarsat)[1]

1. INTRODUCTION

The purpose of this paper is to provide a voice in the discussion on the concept of sustainable development of space activities on the suitability of the existing space regulatory framework. The reason of taking this subject matter is, as has been recently stated in the Opinion of the Social-Economical Committee of the EU, the fact that

> "in many respects, space is now an additional economic territory. The acceleration of public and private investment is leading to an increase in space activities, and is transforming space into a major geo-strategic issue. Technological competition, the development of start-ups dedicated to the space sector, the opening of new markets

[1] Inmarsat, Space Sustainability Report 2022, https://www.inmarsat.com/en/insights/corporate/2022/space-sustainability.html (accessed 30.01.2023).

and services and the willingness of States and private operators to strengthen in-orbit activities mean that space is being used more and more".[2]

Also, due to human's excessive activity in outer space in the past, we have found ourselves in a situation where sustainability becomes the only and the most urgent axiom for the development of space exploration. Some experts name it "space environmentalism" – a type of a cultural mind-set and call for placing it "at the heart of all satellite operations with the aim of using the space domain responsibly and with consideration of future generations".[3]

If so, the space law dominating paradigm should be the same. In particular, we should focus on answering the question of how the space law may be supportive to achieve the sustainability goal. In that respect, serious questions appear with respect to the role and suitability of the Liability Convention at its 50th anniversary.[4]

In order to draw some conclusions, it seems necessary to analyse the notion of sustainability against the existing legal framework, so as to state whether it is still up to date in this respect and whether it may contribute to materializing the sustainable development of the space sector. In particular, it is interesting to consider whether the liability regime, including the notion of damage and prerequisites of claims for compensation as adopted in the Liability Convention, still may serve its purpose and answer the needs of the shift in the priorities of space exploration. Finally, the author intends to consider the possibility of drawing on principles from other branches of law, including, in particular, environmental law and insurance law and practice, in order to build legal mechanisms to implement the demands of sustainable development of space. Thus, among other issues, the topic of space environmentalism and the coherence of space and earth sustainability instruments will be analysed.

2. ROADMAP OF SPACE ACTIVITIES: FROM EXPLOITATION TO SUSTAINABILITY

All activities undertaken in relation to outer space exploration are ultra-hazardous, inherently very risky, and random. Outer space exploration is potentially

[2] Opinion of the European Economic and Social Committee on the Proposal for a Regulation of the European Parliament and of the Council establishing the Union Secure Connectivity Programme for the period 2023–2027 (COM(2022) 57 final – 2022/0039 (COD)) and Joint Communication to the European Parliament and the Council: An EU Approach for Space Traffic Management – An EU contribution addressing a global challenge; (JOIN(2022) 4 final), OJ C 486, 21.12.2022, pp. 172–184 (hereinafter: Opinion).

[3] Inmarsat, 2022, *op. cit.*

[4] UNGA, Convention on International Liability for Damage Caused by Space Objects, RES 2777 (XXVI), adopted on 29 March 1972, in force 1 September 1972.

so harmful that an ordinary person would not regularly take on such an activity.[5] Risk in space activities is a mixture of technological, human, and nature-related perils.[6] Risks naturally present in the space sector also accommodate manmade threats which result from excessive outer space exploitation, substantially increasing the risk of damage and, most of all, endangering the possibility of long-term safe exploitation of outer space, so vital for human life on Earth. Thus the sector also faces risks that we could call emerging from a legal perspective, for which traditional legal framework is still not prepared. These are known as environmental risks. The fact is that the space environment has always been not just a source of risk (radiation, extreme temperatures, vacuum, etc.), but also a victim of human activity. However, the latter perspective has only recently knocked on our consciousness when space pollution reached such a level that it began to threaten human space activity itself.

The space environment is so unique that it is difficult to attribute actions to specific operators.[7] The most pertinent example is space debris created by human predatory activity in space, which can affect space missions and the sustainability of the sector as such. It is estimated that there are more than 30,000 objects qualified as trackable debris.[8] Collisions only with the trackable category of debris can destroy a satellite and additionally may produce more consequential debris thus having a cascading effect.[9] The danger of actual damage to be

[5] The notion of the ultra-hazardous activity has been outlined in C.W. Jenks, *Liability for Ultra-Hazardous Activities in International Law,* 'Hague Recueil' 1966, Vol. 117 as cited in Z. Brodecki, *Liability in International Law*, (in:) *Studia Europejskie*. Vol 5., Instytut Stdiów Europejskich 2000, p. 179; C.A. Parquet, *Allocation of Potential Liabilities and Risks in Launch Services Agreements,* (in:) Project 2001 Plus Workshop, Berlin, 29-30 January 2004, https://slideplayer.com/slide/4798344/ (accessed 10.07.2023); also A. Soucek, *International Law,* (in:) A. Soucek, Ch. Brunner (eds), *Outer Space in Society, Politics and Law*, Vienna 2011, p. 342.

[6] Technological hazards are mostly related to the use of highly explosive propellants needed to lift the launch vehicle and place the satellite in orbit. Any accidents related to the release of the propellant during the launch stage are known to cause explosions, debris, fire, and toxic vapour clouds. See M. Hapgood, *Space Weather, The Sun as a Natural Hazard,* (in:) R.J. Wilman, Ch.J. Newman (eds), *Frontiers of Space Risk. Natural Cosmic Hazards and Societal Challenges*, Boca Raton 2018, chapter 3, pp. 37-76; R.J. Wilman, P. Dayal and M.J. Ward, *Hazards and Habitability: Galactic Perspectives,* (in:) R.J. Wilman, Ch.J. Newman, 2018, *op. cit*., chapter 4, pp. 77-105; C. Colombo, F. Letizia, M. Trisolini, H. Lewis, *Space Debris: Risk and Mitigation,* 2018, *op. cit*., chapter 5, pp. 105-142; M. Williamson, *Commercial Space Risks, Spacecraft Insurance, and the Fragile Frontier*, 2018, *op. cit*., chapter 6, pp. 143-164.

[7] OECD, Space Sustainability. The Economics of Space Debris in Perspective, 2020.

[8] ESA, ESA's Annual Space Environment Report 2022, 22 April 2022, https://www.esa.int/Space_Safety/Space_Debris/ESA_s_Space_Environment_Report_2022 (accessed 30.01.2023).

[9] This refers to the threat of the so-called Kessler syndrome (space-asset destructive chain reaction) following the name of a NASA's expert Donald Kessler who in 1978 as the first discussed the potential of orbital debris becoming self-perpetuating. It was predicted that debris coming from collisions would collide with other satellites and rocket bodies and create even more debris. As a result of this chain reaction, the risk to satellites in certain regions of space would increase

caused by debris is just one of several hazards in the space environment.[10] The other issue concerns the electromagnetic spectrum which as a recognized natural resource is significantly shrinking due to the old inactive satellites remaining in orbits, but also to the new business models of outer space exploration, such as mega-constellations. Also, the methods of disposing of satellites contribute to the increasing pollution in outer space and on earth as de-orbiting satellites deposit more aluminium particles than all the meteorites ever do.[11] What is more, there are no universal standards for classification or cataloguing objects and modelling assumptions. Government and commercial operators' practices are increasingly predatory, leading to a growing number of threats, such as mega-constellations or anti-satellite weapons (ASAT tests by China, India and Russia).[12] Mega-constellations of small satellites also pose threats for the future such as difficulties of astronomical observations, lack of new orbital slots for vitally important types of satellites, etc. All this means that the current prospects of orbit exploration are not optimistic. The conglomerate of the above problems, the source of which is technology, business and a state of legal regulations,[13] has given rise to the new concept of developing outer space exploration. This idea is sustainability and it is present in all sectors of industry, not just the space industry.[14]

Within this concept, attention should be paid not only to the necessity of optimising environmental and social management on Earth when using satellite data but, more importantly, to the need for sustainable development of the space sector itself. The potentially damaging effects were noted long ago, though it is only recently that focus has begun to turn to the long-lasting effects of human activity. Space exploration has turned to exploitation, a notion known so well from the

---

exponentially with time, even without further launches into those regions. In a 1991 paper, Kessler used the term "collisional cascading" to describe this process. This has created the widely used term "Kessler syndrome". See e.g. European Commission, Avoiding damage from space debris – space surveillance and tracking proposal, 28 February 2013, MEMO/13/149.

[10] OECD, 2020, *op. cit.*

[11] *Ibid.*

[12] O. Bittencourt Neto, *Preserving the Outer Space Environment: The "Precautionary Principle" Approach to Space Debris,* (in:) C.M. Jorgenson (ed.), *Proceedings of the International Institute of Space Law 2013 (56),* The Hague 2013, pp. 341-351; S. Cassotta, *The Development of Environmental Law within Changing Environmental Governance Context: Towards a New Paradigm Shift in the Anthropocene Era,* 'Yearbook of International Environmental Law 54-67' 2019, No. 30(1); M. Williams, *Safeguarding Outer Space: On the Road to Debris Mitigation,* (in:) *The Next Generation–Conference Report*, 31 March–1 April 2008, United Nations Institute for Disarmament Research/UNIDIR, 17 December 2008, pp. 81-101; T. Cuddihy, *Environmental Liability Risk Management for the 21st Century,* 'The Geneva Papers on Risk and Insurance. Issues and Practice' 2000, No. 25(1), pp. 128-135.

[13] The notion of "legal regulations" is understood here not just as space treaties or statutes, but also technical requirements as far as they have a general binding force.

[14] M. Stanley, *5 Key Themes in the New Space Economy*, 19 May 2022, https://www.morganstanley.com/ideas/space-economy-investment-themes (accessed 6.01.2023).

devastating effects caused also on Earth. It became obvious that new values and tools had to be adopted so that we can enter the era of sustainable space exploration. Still though, there is a general conviction that the efficiency of space environmental regulation is quite low, and there are no universal standards around the world.[15] Is this criticism also directed at the Outer Space Treaty and Liability Convention? Can these Treaties support the political shift of paradigm towards sustainable development? In order to draw reliable conclusions, an in-depth analysis is needed with respect to the notion and concept of sustainability against the assumptions and content of the existing space regulatory framework.

3. WHAT DOES SUSTAINABILITY MEAN FOR SPACE?

Sustainability is a mature notion, though not yet embedded in all sectors of industry. It was used for the first time with respect to environmental issues, but its axiom has been much broader since the very beginning. It was daylight with the 1987 Brundtland Report, "Our Common Future", and the 1992 UN Conference on Environment and Development (UNCED) ("the Earth Summit"). It was the Brundtland Report which introduced for the first time the need for the integration of economic development, environmental protection and social justice and inclusion.[16]

The Report defined sustainable development as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It included two key concepts, i.e. (1) the concept of "needs", in particular the essential needs of the world's poor, to which overriding priority should be given; and (2) the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs. A similar concept has been adopted by the EU, introduced in the Strategy for Sustainable Development:

> "Sustainable development means that the needs of the present generation should be met without compromising the ability of future generations to meet their own needs. […] It is about safeguarding the earth's capacity to support life in all its diversity and

[15] Immarsat Report, 2022.

[16] The Earth Summit was followed by such revolutionary documents as the Rio Declaration which contained 27 principles of sustainable development, including the precautionary and polluter pays principles, Forest Principles, the Convention on Biological Diversity and the Framework Convention on Climate Change, as well as Agenda 21, which was a voluntary SD plan of action for implementation by national, regional and local governments; J. Pisani, *Sustainable Development – Historical Roots of the Concept*, 'Environmental Sciences' June 2006, No. 3(2), pp. 83 – 96. U.M. Bohlmann, G. Petrovici, *Developing Planetary Sustainability: Legal Challenges of Space 4.0.,* 'Global Sustainability' 2019, https://doi.org/ 10.1017/sus.2019.10 (accessed 30.01.2023).

> is based on the principles of democracy, gender equality, solidarity, the rule of law and respect for fundamental rights, including freedom and equal opportunities for all. It aims at the continuous improvement of the quality of life and well-being on Earth for present and future generations."[17]

The common principles of sustainable development have been recognised as inherently correlated with environmental limits and include integrated decision making (policy and legislation that works in a complementary way), "good" governance that is democratic, transparent, inclusive, participatory and accountable, and a responsible use of robust and credible scientific evidence in decision making. What seems especially interesting is the concept of boundaries which represent global Earth systems and processes within which there is a safe living space for humans and wildlife. It is argued that exceeding one or more of these boundaries could create a tipping point where the global Earth system may shift into a permanently less hospitable state. There are nine recognized boundaries, but none of them directly relate to the [state of the] outer space.[18] Thus, it was necessary to design architecture of sustainability which would respond to the specifics of outer space exploration.

As for Earth, the sustainable development concept in the space sector is to be an answer to the problem of growth in the space industry. The main statement in the Stockholm Conference in 1972 (though concerning the earth environment) looks like it addresses the consequences of the human exploitation of the Earth's orbits. It was said then, that:

> "A point has been reached in history when we must shape our actions throughout the World with a more prudent care for their environmental consequences. Through ignorance or indifference, we can do massive and irreversible harm to the earthly environment on which our life and well-being depend. Conversely, through fuller knowledge and wiser action, we can achieve for ourselves and our posterity a better life in an environment more in keeping with human needs and hopes. To defend and improve the human environment for present and future generations has become an imperative goal for mankind".[19]

The first works on the sustainability concept with respect to the space sector were undertaken a few years ago, along with active debris removal (ADR) initia-

[17] The Renewed EU Sustainable Development Strategy as adopted by the European Council on 15/16 June 2006, Brussels, 26 June 2006, 10917/06.

[18] These are climate change, change in the biosphere integrity (biodiversity loss and species extinction), stratospheric ozone depletion, ocean acidification, biogeochemical flows, land-system change (such as deforestation), freshwater use, atmospheric aerosol loading (microscopic particles in the atmosphere that affect climate and living organisms), introduction of novel entities (e.g. organic pollutants, radioactive materials, nanomaterials, and micro-plastics). Sustainability Guide, *Planetary Boundaries*, https://sustainabilityguide.eu/sustainability/planetary-boundaries/ (accessed 10.07.2023).

[19] United Nations, as quoted in J. Pisani, *Sustainable Development – Historical Roots of the Concept*, 'Environmental Sciences' June 2006, No. 3(2), p. 91.

tives.[20] Though not yet in a structured way, space stakeholders started considering how to stop and reverse the trend of exploiting outer space without due regard to future generations. An analysis of the attempts to regulate this issue in the space sector shows numerous documents that focus on space debris. The latest ones try to deal with the problem of debris through the prism of the concept of sustainability. The first document to mention the need for sustainable development seems to be the European Code of Conduct, proposed in 2004. It tried to turn the public attention to how important it is to understand the nature of the threat and the steps that we must take to ensure the sustainable development of near-Earth space. Though not successful, it commenced the era of discussing the necessity to adopt coherent measures in that respect. The draft Code of Conduct did not define the notion of sustainability. The same was the case in the Space Debris Mitigation Policy for Agency Projects adopted by ESA on 28 March 2014,[21] the Space Debris Mitigation Guidelines issued by IADC,[22] the COPUOS 2010 Space Debris Mitigation Guidelines[23] and Recommendation ITU-R S.1003-2 on Environmental protection of the geostationary-satellite orbit S Series.[24] Nevertheless, the direction set in those documents led gradually to a more comprehensive (than just space debris) approach taken by the UN and by European and national legislators.

The first document at the international level that directly addressed the concept of sustainability seems to be the proposal of the Committee on the Peaceful Uses of Outer Space, adopted at the Fifty-ninth session on 8-17 June 2016 which concerned the first set of guidelines together with a renewed work plan for the Working Group on the Long-term Sustainability of Outer Space Activities of the Scientific and Technical Subcommittee.[25] It was followed by the Guidelines for the Long-term Sustainability of Outer Space Activities, which define such activities as

[20] C. Toussaint, H. Dumez, *On the Emergence of an Active Debris Removal Market*, (in:) *Earth's Orbits at Risk: The Economics of Space Sustainability*, OECD Publishing 2022, https://doi.org/10.1787/fc689ef6-en (accessed 6.01.2023).

[21] ESA/ADMIN/IPOL(2014)2, https://www.iadc-home.org/documents_public/file_down/id/4150 (accessed 30.01.2023).

[22] IADC, https://orbitaldebris.jsc.nasa.gov/library/iadc-space-debris-guidelines-revision-2.pdf (accessed 10.07.2023).

[23] UNOOSA, https://www.unoosa.org/pdf/publications/st_space_49E.pdf (accessed 30.01.2023).

[24] Recommendation ITU-R S.1003.2 (ITU), https://www.itu.int/dms_pubrec/itu-r/rec/s/R-REC-S.1003-2-201012-I!!PDF-E.pdf (accessed 30.01.2023).

[25] These guidelines were followed by the Resolution No. 75/36 of 7 December 2020, A/RES/75/36, where the UN COPUOS expressed "the desire that all Member States reach a common understanding of how best to act to reduce threats to space systems in order to maintain outer space as a peaceful, safe, stable and sustainable environment, free from an arms race and conflict, for the benefit of all, and consider establishing channels of direct communication for the management of perceptions of threat".

> "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."[26]

That idea was picked up to become the main axiom of the modern regulation of space activity. The most recent document worth citing is the Opinion of the European Economic and Social Committee.[27] It indicates the management of space traffic, including debris, as the highest priority and calls for the practical implementation of a space situational awareness system to ensure long-term sustainability of space for all Member States. As has been noted by the Social Economic Committee,

> "the challenges posed by orbit and frequency spectrum saturation, as well as the threat posed by the increase in space debris, have led the Member States, the ESA and the EU SST consortium to consider better coordination of surveillance tools and technologies. The EESC calls for strict regulations in the face of an increasing number of private constellations and possible no-go zones."[28]

The last sentence of this statement calls into question the suitability of the existing legal framework to the needs of sustainable development.

4. IS THE EXISTING REGULATORY FRAMEWORK UP TO DATE?

Having the above in mind, the first question that emerges is whether sustainable development is really such a new quality. If we look into the components of its definition, we have to realize that at least part of it is apparently not new. It has been based, at least partially, on the principles of space exploration included in the Space Treaties, especially in Outer Space Treaty.[29] By this, I mean the

[26] COPUOS, Guidelines for the Long-term Sustainability of Outer Space Activities, 27 June 2018, 5A/AC.105/2018/ CRP.20.

[27] Opinion, 2022, *op. cit.*

[28] *Ibid.*

[29] The principles set in the Space Treaties (Convention on International Liability for Damage Caused by Space Objects (done 29 March 1972, in force 1 September 1972); Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space (done 22 April 1968, in force 3 December 1968); Convention on Registration of Objects Launched into Outer Space (done 14 January 1975, in force 15 September 1976); Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (done 18 December 1979, in force 11 July 1984)) have been preceded by UNGA 18th Session, Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space, 13 December 1963, Resolution 1962 (XVIII).

principle of equal access to the benefits of exploration, peaceful purposes of this exploration, as well as responsibility rules. Special emphasis is put on "equitable access" to outer space's benefits for all the countries regardless of their technical and financial capacities, which corresponds to the "needs" as mentioned in the Brundland Report. What is new, however, is the concept of being able to maintain the conduct of space activities into the infinite future, which corresponds to the element of "limitation" in the said Report. This is definitely a new approach to risk management in the space sector which luckily reverses the trend mirrored well in the quote "*Apres nous le deluge"*. The space environment itself becomes the object of protection, not only the stage of the polluting drama.

However, the change in attitude and gaining a "space environmental mindset" is only the first step and including sustainability in official documents does not automatically mean that the space sector will start acting accordingly. This is due to several reasons. First of all, the binding force of the rules adopted by the UN as well as by other organizations is problematic. Secondly, the principles that were sufficient to support the interests of countries in the 1960s-70s no longer seem so suitable for the purpose of embarking on the path of sustainable development. This is also pointed out by the Social and Economic Committee in its opinion which reads that:

> "While main principles have been adopted following five international treaties and eight international resolutions, the issue of defining space law is still up in the air, since concerns at the start of space exploration had mostly been about preventing leading space powers from appropriating celestial bodies, rather than explicitly defining the subject matter of this law. Additionally, "despite the strategic magnitude of space, there is no overarching authority or any binding laws applicable to low and geostationary orbits, and there is no space traffic regulation or management system, despite an increase in the number of satellites in orbit."

As has been raised in the Opinion, organizations that govern the use of Earth orbits are facing frequency allocation requests and the proliferation of satellite systems from countries and businesses that sometimes disregard ITU rules, even though under international law[30] earth orbits are considered limited natural resources. Proper legislation on space activities and satellite traffic to ensure the long-term sustainability of space is [thus] urgent as well as strategic, as is the use of artificial intelligence to avoid collision risks.[31]

What makes the good intention also problematic is not only the lack of binding force of the documents adopted by international organizations, which eventually have a chance of becoming a custom, but also lack of coherence of technical

[30] Constitution of International Telecommunication Union, UNTS 1825, https://www.itu.int/en/council/Documents/basic-texts/Constitution-E.pdf (accessed 30.01.2023).

[31] Opinion, 2022, *op. cit*., para. 2.5.

standards, on which the behaviour of the space explorers ultimately depends.[32] These differences between modern environmental regulations and space law are quite apparent at every level. While the environmental law is being actively amended with the increasing pollution and climate change, the space law is stalled in its inability to reach a global consensus on the obvious needs of mankind.

A short overview can be helpful in order to realize what rules we operate with respect to reducing the threat to outer space through standards, principles and rules of responsible behaviour. Apart from the above-mentioned principles of the Space Treaties, the UN General Assembly Resolution 75/36 includes statements on encouraging member states, inter alia, to characterize activities that can be considered responsible, irresponsible or threatening, and their potential impact on international security, analyse existing and potential threats and risks to the security of the space system, including those arising from activities, or systems in space or on Earth, share ideas on the further development and implementation of standards, regulations and principles of responsible behaviour and the reduction of risks and misunderstandings and miscalculations with regard to space.[33] On the level of technical standards, we can mention technical norms belonging to the ISO family that deal with space debris risks, etc.[34] National laws too, in particular recently adopted ones, include certain rules worth noting. One of such example may be the Space Industry Act adopted in 2018 by the United Kingdom.[35] The first axiom of the new regulation is sustainable development of the space sector.[36] The provisions of the Act (though it does not define sustainability) mention "environmental objectives set" as one of the paradigms of the Act's regulation and prescribe an extensive obligation to perform environmental impact assessment as one of the conditions to obtain a space license. What is equally important is the executive regulation issued by the licensing authorities, i.e. the UK's Civil Aviation Authority (CAA)'s, where the space licensing guidance,[37] based on the sus-

[32] As a well-known example is the case of India, Angels, *Space Licencing in India,* https://spacelaws.com/articles/space-licensing-in-india/ (accessed 30.01.2023).

[33] UNGA Resolution 75/36, 13.07.2021, Reducing space threats through norms, rules and principles of responsible behaviours.

[34] ISO 24113:2019 on 'Space debris mitigation requirements', ISO 27852:2016 on 'Estimation of orbit lifetime', as well as ISO/TR 16158:2021 on 'Avoiding collisions among orbiting objects'; ISO 26900:2012 on 'Orbit data messages'; ISO 13526:2010 on 'Tracking Data message'; and finally ISO 14200:2021— Guide to process-based implementation of meteoroid and debris environmental models (orbital altitudes below GEO + 2 000 km).

[35] https://www.legislation.gov.uk/ukpga/2018/5/contents/enacted/data.htm (accessed 24.01.2023).

[36] "We are engaging with industry to stimulate sustainable interest in the UK launch market and in the operation and use of UK spaceport services": L. Hughes, *Liabilities & Insurance*, UN COPUOS LSC – 2018; https://www.unoosa.org/documents/pdf/copuos/lsc/2018/tech-01.pdf (accessed 10.07.2023).

[37] CAA, Applying for a licence under the Space Industry Act 2018. CAP 2209, https://publicapps.caa.co.uk/docs/33/Applying%20for%20a%20licence%20under%20the%20Space%20Industry%20Act%202018%20(CAP2209)%20(1).pdf (accessed 30.01.2023).

tainability principle, provides explanation to sustainability. It says that it must be ensured that activities licensed in orbit are sustainable and it makes this objective enforceable by imposing specific requirements on environmental and other risk assessment. The notion of the sustainability is repeated in the context of space activity as such that meets the requirements of the present without compromising the ability of subsequent generations to embark on activities (or missions) to meet their own requirements in the future. Sustainability is inherently linked to safety and security: whereas safety and security look to mitigate impacts of spacecraft activities on the operations of existing spacecraft, sustainability attempts to mitigate the impacts of spacecraft activities on the future environment. The other good example seems to be the Belgian space law.[38] In accordance with its provisions, environmental impact assessment (ground and space) includes now assessment of the impact of the use/operation of space resources. Additionally, a new warning procedure in case of failure of a space object registered in Belgium (internal and external) has been introduced.

Though only under discussion stage, it is also worth mentioning the Polish draft of space law which is to provide for a rule that space activities at every stage are carried out with consideration of the need for long-term sustainable use of space for peaceful purposes and eliminate or reduce to the greatest extent possible the negative impact on the Earth's environment and on space. However, the technical rules which make the new sustainable manifesto an enforceable obligation would be equally significant. Thus it is proposed that the technical requirements of the Polish space law provide an explicit rule that the space of low Earth orbit and the space of geostationary Earth orbit are protected spaces and that the space objects must be designed in a way that does not result in space debris being released into Earth orbit. The law should provide enforceable requirements that ensure that intentional generation of space debris during normal space operation is avoided. It is also important that the operator applying for the license provide an analysis of the risk of collision of a space object in the orbit where the space object will perform a space mission.

The conclusion that follows from the above brief presentation of standards that can contribute to the materialization of sustainable development of the space sector is that the general principles themselves, however necessary and legitimate, will not bring effective changes without coherence of regulations binding for and enforceable on entities performing space activities. Though, as can be seen from the regulatory framework to date at the international, regional (e.g. European Union) or national level, the homogeneity exists only at the level of principles, while implementing regulations, where they have even been introduced (it should

[38] Law of 17 September 2005 concerning activities relating to the launch, flight operations or guidance of space objects. It was amended in 2013, the Executive Order was adopted in 2008 and amended in 2022. Belspo, *The Belgian Space Law*, https://www.belspo.be/belspo/space/belaw_en.stm (accessed 10.07.2023).

be noted that only about 30 countries have adopted space laws), lack coherence. The Economic and Social Committee points this out, confirming that the main problem concerning the patchwork of space traffic management (STM) programs is the absence of international standardization. It is therefore clear that standards, guidelines and international best practices need to be developed.[39]

One of the important issues that needs further analysis in the context of its usefulness for the sustainable development objectives is the principle of liability and the manner of its implementation and enforceability. As mentioned earlier, it seems that the basic principles of space exploration contained in the Space Treaties are essentially in line with the concept of sustainable development. The regime of liability for damage is one of the main legal issues potentially supporting its enforcement and it has been also recognized as such by the Economic and Social Committee. It said that liability for damage is the second key principle of space law consisting of international responsibility for monitoring activities, and liability for damages caused by these activities in outer space. In this regard, it seems necessary to reflect on whether the principles of responsibility adopted in the Liability Convention are able to bear the burden of the new reality.

5. PARADIGM SHIFT IN LIABILITY PRINCIPLES – NECESSITY OF OUR TIMES

The question thus emerges whether the Liability Convention can be a starting point for the development of sustainability? Does it address the needs of space environmental protection or do we need to search for a new paradigm when facing the requirements of sustainable development? As stated in sections 2 and 3 of this paper, the principles included in the Convention which have already been established in our consciousness can still be of great use. They do not contradict or deviate in their content from what we want to achieve. These are among others the peaceful use of the outer space, observing the interests of all the nations or avoiding harmful interferences. The fact is, however, that behind each of them also lurk traps that result from the current state of facts, so the way we interpret these principles must evolve.

Though the issue requires an in-depth but also horizontal analysis, below I would like to focus on the notion and concept of damage as regulated in the Outer Space Treaty as well as in the Liability Convention against modern regulations of the "terrestrial" environmental law. In that respect, apparent differences

[39] See more in A. Soucek, J. Tapio, *Normative References to Non-Legally 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' 2018.

between modern environmental regulations and space regime seem to appear. The analysis could start from important elements related to the existing liability regime.

Firstly, there is no precise definition of the space environment in the space law. Instead, there are many different concepts deriving from various branches of science. From the legal point of view, jurisprudence focuses on where space begins and whether it needs to be defined. It is however doubtful whether equating space beyond the nondescript boundary of outer space and the space environment is the right approach. The wording of the Moon Treaty may provide some guidance, as its Article I tries to identify some elements of the space environment, by saying that the Agreement should apply to the Moon and also to other celestial bodies within the solar system other than the Earth and that the Moon shall include orbits around or other trajectories to or around it. Due to the low ratification ratio of the Moon Agreement it cannot be treated as a leading document to judge on this issue. From the point of view of the common knowledge, but also taking into account the engineering approach, we may find an explanation that "Space environment is a branch of astronautics, aerospace engineering and space physics that seeks to understand and address conditions existing in space that affect the design and operation of spacecraft" (wiki).[40] Also the educational materials produced by FAA explain what space environment is, "where space begins, (…) our place in the universe (…) and the major hazards of the space environment and their effects on spacecraft (…)."[41] On the other hand, the ITU Constitution equals the space environment to "radio frequencies and any associated orbits, including the geostationary satellite orbit", which also does not sound satisfactory.[42] Other documents, such as the OECD Report,[43] correlate space environment with the vaguely listed exemplary components such as Earth's orbit, and electromagnetic spectrum.[44] The definition of terrestrial environment can be quoted for comparison. It has been defined as a set of natural elements, including those transformed by man. In particular, these include (as an exemplary catalogue) inland waters, air, land surface, minerals, plant and animal world, as well as both natural and human-transformed landscape and climate, and other elements of biodiversity, as well as their interactions.[45]

[40] 'Space environment', *Wikipedia*, https://en.wikipedia.org/wiki/Space_environment (accessed 30.01.2023).

[41] FAA, *The Space Environment*, https://www.faa.gov/about/office_org/headquarters_offices/avs/offices/aam/cami/library/online_libraries/aerospace_medicine/tutorial/media/III.4.1.2_The_Space_Environment.pdf (accessed 30.01.2023).

[42] ITU Constitution, Chapter VII, Article 44.

[43] OECD, 2020, *op. cit.*

[44] *Ibid*.

[45] 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, OJ L 143, 30.4.2004, pp. 56–75.

Secondly, the concept of damage to the space environment does not exist or is vague. It seems that this aspect requires a substantial change in thinking. What we are able to derive from the Space Treaties, in particular the Outer Space Treaty and the Liability Convention, is an understanding of damage focused on human life and health as well as man's tangible assets. According to the Liability Convention, the damage as defined in Article I includes (1) loss of life, (2) personal injury or other impairment of health, or (3) loss of or damage to property of States or of persons, natural or juridical, or property of international intergovernmental organizations. Consequently, the liability regime of the Liability Convention focuses on the damage which has already occurred to persons or tangible assets owned by humans. No damage to the environment as such is subject to the liability regime.

In consequence, it seems necessary that the understanding of the damage in the space liability regime is expanded so as to include environmental damage as well. To do so, however, it is necessary, to first identify the elements of the space environment to be protected. This topic undoubtedly requires a broader analysis. For the purposes of this paper, an evident element of this environment are Earth's orbits. Undoubtedly, precision is needed in this regard and most probably the definition outer space frontiers. This issue may also be compared with earthly environmental regulations. As an example, the 2004 Environmental Liability Directive defines environmental damage as damage to protected species and natural habitats, water damage, and land damage.[46]

To summarize this part of the discussion, it seems that the basic principles of space exploration provided in the Space Treaties are not very different from the principles and expectations the society has with respect to sustainable development. The good starting point is the status of the space environment as an environment subject to equal freedom of exploration and exploitation by all nations. What makes them different is, however, their focus on (1) the exploitation and not preservation of the space environment, (2) the direct effects on human beings, their property, and eventually on the protection of the earth's environment, (3) the damage that has already happened and compensation for it, as well as (4) lack of binding force of technical standards. The above form apparent differences between modern environmental regulations and the actual status of the space liability regime.

[46] *Ibid.*: Environmental damage means any damage that has significant adverse effects on reaching or maintaining the favourable conservation status of such habitats or species. The significance of such effects is to be assessed with reference to the baseline condition, taking account of the criteria set out in Annex I to the Directive. It also means any damage that significantly adversely affects the ecological, chemical and/or quantitative status and/or ecological potential, as defined in Directive 2000/60/EC, of the waters concerned, with the exception of adverse effects where Article 4(7) of that Directive applies.

What are the solutions for such a state of affairs? Despite numerous opinions, standpoints or voices, we have to realize that adopting a new or revised liability regime on the international level is wishful thinking. However, when it is compared with the legal framework for protection of the terrestrial environment, the situation is not so different. The majority of legal documents, such as the 1992 Rio Declaration are also of non-binding nature. Numerous international acts remain soft law instruments that only include political declarations of the States Parties. Still, the postulates included therein gained the status of binding laws, in majority *via* regional (such EU) laws, and have been implemented into national legislation. Thus, when we look at the type of rules of space law and their effectiveness as compared with the environmental law, we must realize that what is ultimately needed is the national laws that are enforceable against space actors.

6. COMPENSATION VERSUS PREVENTION

An issue that requires a separate analysis is the effectiveness of the liability regime for space damage in the context of damage prevention. As raised on several occasions earlier in the paper, and which is particularly relevant to the efficiency of prevention efforts, the binding nature of provisions regulating liability for damage takes place only at the level of the principles expressed in the Space Treaties. All technical norms, proposed so far by various international and regional bodies in the context of the prevention of space debris, are soft law standards. In this regard, the shortcomings of the concept of damage as defined in the Liability Convention are apparent. They are related to (1) the necessary attribution of the damage to the activity of the space object and to (2) the damage which has already occurred. Both these issues are important when considering entering the path of sustainable development.

As regards the first issue, some doubts appear whether in the current state of technology and in the face of a huge variety of space activities, attributing the regime of liability only to damage caused by a space object ensures the proper protection of the space environment. There are calls for a change of that rule in such a way that liability for space damage is not limited solely to damage caused by a space object, but by any type and form of space activity. Such an approach seems to be necessary, or at least reasonable, due to the significant development of satellite technology and techniques compared to the period when the Liability Convention was drafted. These days we experience the emergence of new types of activities, often beyond launching objects into orbit. This includes activities such as on-orbit servicing, space mining and others, which, although only in the early stages of development, must be taken into account when building a liability

regime serving the future generations. It is especially true since interpretations of the Liability Convention proved to be quite narrow (e.g. including just kinetic impact of space objects). Doubts about the limitation of such liability solely to damage caused by a space object began to arise soon after the adoption of the Convention. An extensive body of relevant literature points to numerous controversies on at least the causal relationship between the damage and the impact of the space object.[47] Out of the ways in which the impact of a space object can result in international liability, one can mention both the kinetic impact of the object as well as the radioactive or chemical contamination. It is now obvious that damage, including damage of large magnitude and catastrophe character, can be caused without (at least directly physical) an impact of a space object, but may still result from space activities (e.g., due to the use of space fuel) where no space object was involved. Reconsidering this issue the same way as has been done in the environmental law should at least be an inspiration.[48]

Equally important is the matter of attributing the liability regime only to the damage that has already occurred. It is a part of larger subject matter of prevention and precaution as a principle of outer space exploration. Can we derive the preventive approach from the Space Treaties? An analysis of the Space Treaties brings a conclusion that the preventive approach is expressed there in a very soft manner and basically focuses on the protection of humans and earth environment. Prevention has been mentioned in the preamble of the Liability Convention which says 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", though no further provisions even mention the issue of prevention in the context of liability regime. In turn, the Outer Space Treaty, in its Article IX states 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".

As we can deduct from the above provision, an obligation to avoid causing harmful contamination can be interpreted as a precautionary approach, but it concerns solely the Earth environment. As regards the obligation related to the danger of harmful interference or contamination, it seems to be limited to the duty of information and consultation. In particular, no obligation to prevent damage or to take precautionary actions has been repeated in the Liability Convention so that

[47] B. Cheng, *International Responsibility and Liability for Launch Activities*, 'Air & Space Law' 1995, Vol. XX, No. 6.

[48] In Annex III, ELD provides for types of activities to which a strict regime of liability is attributed.

we could derive any liability from the omission to prevent the damage under this Convention.[49] The prevention approach is though present in the space regulatory framework. The Active Debris Removal solutions are all quite clearly based on the prevention and precautionary approach. On the international level, they are however "just" soft law measures.

On the other hand, the prevention and precaution approach very firmly resounds in environmental law. There are clear provisions for that purpose included in national and EU law as to the obligation to take preventive action before the damage occurs and the consequences of evading them. The principle of precaution emerged for the first time in the Rio Declaration of 1992. It was related to the clear purpose of protecting the environment: "in order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities". The now famous Article XV says: "where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation". Following that, a precautionary approach has been proposed in some treaties, such as UNFCC.[50] At the European level, the precautionary principle was enshrined in the Maastricht Treaty in 1992. It is now included in Article 191 of the Treaty on the Functioning of the European Union among the principles underpinning EU environmental policy.[51]

Having all the above in mind, some basic comparisons between environmental and space law can be made with respect to the policy of law and its efficiency. In both cases, the branch of law emerged and started to develop at the same time, that is in the 1970s. In both cases, there are only few generally binding acts of international law, numerous soft law instruments, and a few dozen binding national laws. Finally, it is a national law that ensures the effectiveness of the principles created at the international level, where there is often nothing more than

[49] The further part of Art. IX of OST says that:

> "If a State Party to the Treaty has reason to believe that an activity or experiment planned by it or its nationals in outer space, including the Moon and other celestial bodies, would cause potentially harmful interference with activities of other States Parties in the peaceful exploration and use of outer space, including the Moon and other celestial bodies, it shall undertake appropriate international consultations before proceeding with any such activity or experiment. A State Party to the Treaty which has reason to believe that an activity or experiment planned by another State Party in outer space, including the Moon and other celestial bodies, would cause potentially harmful interference with activities in the peaceful exploration and use of outer space, including the Moon and other celestial bodies, may request consultation concerning the activity or experiment."

[50] Article 3(3) of the 1992 United Nations Framework Convention on Climate Change (A/RES/48/189), as well as the preamble to the 1992 Convention on Biological Diversity (1760 UNTS 69).

[51] See more in: D. Bourguignon, *The Precautionary Principle. Definitions, Applications and Governance*, European Parliament, December 2015, PE 573.876, https://www.europarl.europa.eu/RegData/etudes/IDAN/2015/573876/EPRS_IDA(2015)573876_EN.pdf (accessed 10.07.2023).

a political manifesto of the states-parties. For this reason, it seems that we should not focus on the fact that the Liability Convention is out of date, and that it lacks effectiveness. The effectiveness of the law is ensured by national laws, and that primarily includes norms of a technical nature. When thinking about sustainable development, attention should be focused on the bottom-up activities of national authorities that impose licensing obligations. These requirements should have a common denominator and be globally coherent. Perhaps, then, there is no need to wait for Godot in the form of appropriate changes to the Space Treaties, as the Kessler syndrome may materialize before we embark on the path of sustainable development. The lack of coherence of technical standards has been pointed out for some time now not only by engineers but also by representatives of jurisprudence. And the problem, in particular, is becoming acute in the face of Space 4.0 and the intense growth of New Space, which by its very nature has yet to develop good practices and technical know-how.[52]

While there may be too many differences between space law and environmental law to simply incorporate or copy protective rules included in the "terrestrial" environment law into space law, it is worth considering using the methodology applied in environmental law to the liability regime and attributing it not only to the space object and not only to the damage that occurred. National legislators are faced this task now. Although they are obliged by the Outer Space Treaty to adopt a national law, they can and should adopt it in such a form that will adapt the regime contained in the Liability Convention to the requirements of sustainable development. What we can do, therefore, is to consider adopting three elements present in modern environmental laws. Firstly, it is worth involving different kind of actors with different takes on the issue as an interdisciplinary approach seems necessary due to the complexity of the problems. Secondly, a focus on public- private interactions, also in terms of law (between hard law and soft law measures), would be reasonable and practical. And thirdly, the issue of great importance is preventing "flags of convenience" which will be possible only when technical requirements ensuring the sustainable activity in outer space are globally coherent. Thus, strengthening synergies among different levels would seem to be a desired course of action. This could consist of (1) application of the Space Treaties on the level of principles, (2) introducing actions on the level of regions (such as the EU), (3) pursuing the path of Artemis Accords ("artemization" of international space law), (4) long term activity of inter-governmental or non-governmental bodies, setting universal standards, such as the ISO or ADR by IADC, and finally (5) introducing enforceable law on national level. All these might lead

[52] M. Szwajewski, K. Malinowska, *Coherence of Engineering Models for the Prediction of Debris in Terms of Space Licensing. Case of Small Satellites,* (in:) T. Flohrer, S. Lemmens, F. Schmitz (eds), *Proceedings of the 8th European Conference on Space Debris* (virtual, Darmstadt, Germany, 20–23 April 2021, published by the ESA Space Debris Office Ed. May 2021, https://conference.sdo.esoc.esa.int/proceedings/sdc8/paper/192/SDC8-paper192.pdf (accessed 6.01.2023).

to effective multi-level and interdisciplinary governance of outer space environmental protection.

With the above in mind, it is worth paying more attention to the "artemization" of international space law mentioned above. Despite criticism of the way the U.S. has acted within the promotion of the principles contained in the Artemis Accords, there has also been an increase in support for this type of method of promoting space exploration principles, also among legal scholars.[53] Perhaps, the most effective way in the recent geopolitical situation is elaborating a solution to which countries could join without having to negotiate a treaty workable for all at the same time on the forum of the United Nations. This method of regulating the space sector on the international level, different than the UN adopting treaties, proved to be quite efficient, as the Artemis Accords was signed in a short time by more countries than the Moon Agreement. As noted by Kamala Harris with respect to the ASAT ban (which is going to take a similar accession path for the states willing to join it), which also suits the situation of sustainability as nothing else:

> "Without clear norms we face unnecessary risk in space (…). The United States will work with commercial industry and allies to lead in the development of new measures that contribute to the safety, stability, security, and long-term sustainability of space activities. Through this new commitment and other actions, the United States will demonstrate how space activities can be conducted in a responsible, peaceful, and sustainable manner. It's an attempt to lead by example, and demonstrate we're willing to make this commitment ourselves and then encourage others to follow."[54]

Another issue gaining momentum is the possibility of implementing space sustainable development in European Union law by regulatory measures. The issue of harmonization of space law is problematic due to the content of Article 189 of the Treaty on the Functioning of the European Union.[55] However, could it not be considered to treat the principles of sustainable development of space exploration as part of environmental regulation? Undoubtedly, an in-depth anal-

[53] See for example R. Deplano, *The Artemis Accords: Evolution Or Revolution In International Space Law?*, 'International & Comparative Law Quarterly' 2021, No. 70(3), pp. 799-819, doi:10.1017/S0020589321000142.

[54] S. Erwin, *U.S. declares ban on anti-satellite missile tests, calls for other nations to join. VP Harris: A commitment to not destroy satellites in orbit should become a 'new international norm for responsible behavior in space'*, 'Space News', 18.04.2022, https://spacenews.com/u-s-declares-ban-on-anti-satellite-missile-tests-calls-for-other-nations-to-join/ (accessed 10.07.2023).

[55] OJ C 326, 26.10.2012, pp. 47–390. Article 189 provides the power of the EU: 1. To promote scientific and technical progress, industrial competitiveness and the implementation of its policies, the Union shall draw up a European space policy. To this end, it may promote joint initiatives, support research and technological development and coordinate the efforts needed for the exploration and exploitation of space. 2. To contribute to attaining the objectives referred to in paragraph 1, the European Parliament and the Council, acting in accordance with the ordinary legislative procedure, shall establish the necessary measures, which may take the form of a European space programme, excluding any harmonisation of the laws and regulations of the Member States.

ysis and discussion is needed in this regard. At this stage, the author fully agrees with the proposal included in the Opinion of the Economic and Social Committee that reads that

> "the ambitions set out require, in the short term, that the industry undertakes certain obligations, and, in the medium term, that the Member States draw up a legislative proposal to address the fragmentation of national approaches and avoid distortions of competition with operators established outside the EU, by imposing the principle of equal treatment for operators. Non-binding measures, such as guidelines, are also envisaged. The legislative proposal would be the first step; European organisations must then adopt technical requirements, such as universally applicable standards or guidelines".[56]

7. THE ROLE OF INSURANCE IN THE DEVELOPMENT OF SUSTAINABLE SPACE ACTIVITY

The sustainability of the space sector, as in other industries, requires a collective effort from various stakeholders in the space ecosystem. Insurers are an excellent type of such stakeholders. They are heavily involved in initiatives that will improve the space environment while reducing the risk of space exploration. They have an important role to play in the context of sustainable development of space ventures through the involvement in the risk management of space ventures such as (1) damage mitigation, (2) risk assessment for the insurer at the in-orbit stage, (3) cause of damage detection in terms of recourse actions being more possible, (4) reducing the number of catastrophic losses or TCL, both due to better loss detection and the possibility of remedying the damage.

The involvement of insurers in all the above actions means that they act as "regulators of the industry". A good example of this is the method of assessing the risks of space operations, primarily applied by the insurance industry and which has recently been increasingly taken over by national regulators. It can be seen in emerging legislations, such as in the Space Industry Act adopted in the United Kingdom, as well as risk assessment methods included in the US, Australian, and Finnish space laws, where the obligation of liability insurance is no longer set on a fixed level but adjusted to the actual level of risk related to the given space mission. The draft of Polish space law may be also mentioned, where the idea of the minimum coverage requirements for liability insurance based on an assessment of the risk of damage caused by space activities is under discussion. The safer the mission, the lower the risk, and, consequently, the lower

[56] Opinion, 2022, *op. cit.*, para. 2.11.

the insurance requirement and the easier the licensing process.[57] In the above sense, insurance of space risks is a critical enabler of innovation and investment in the space sector as it secures the interests of investors by insuring space assets. In that context, insurance "encourages" responsible behaviour in space.

When it comes the impact the space insurers may have on sustainability in the space industry, at least two contexts should be mentioned. The first one is the requirements of sustainability imposed on the insurance sector. Space applications respond to that requirement and become a desirable and promising industry helping to materialize the goals of sustainable development in general. The second refers to the liability paradigm considered in section 4 of this paper, i.e. the issue of prevention and precaution. Though traditionally space insurance covers risks that cannot be mitigated or otherwise eliminated in space projects, a clear change of paradigm can be observed which shortly can be called the shift "from risk transfer to risk prevention".[58] This new trend can also serve as support for space exploration activity. Insurers are increasingly involved (also through space applications) in prevention. Development of insurance techniques along with new technologies, such as AI, IoT, and similar, mean that the prevention and not just compensation increasingly become one of the main services of the insurers. It is well visible in cyber risk insurance and environmental insurance, where the insurers are able, in cooperation with the insured, to actively counteract the materialization of the risk and pay not just for the damage that has already occurred, but also for the preventive actions. Insurers themselves are investing in technologies that enhance loss prevention and are able to model risks and make predictions on their materialization that will enable prevention. They can therefore be partners in the discussion on sustainability in the space sector. Insurers are some of the world's most effective regulators.[59]

8. CONCLUSIONS

Managing space missions and space industry requires a mixture of tools, including technology, economics, and law. Though technology and economics

[57] A good example can be Finnish law where space missions with risk assessed results under a certain level are released from the obligation of having insurance (Section 8 of the Finnish Act on Space Activities, 63/2018).

[58] I. Flückiger, M. Carbone, *From Risk Transfer to Risk Prevention: How IoT is Reshaping Business Models in Insurance*, Geneva Association 2021, https://www.genevaassociation.org/sites/default/files/iot_insurance_research_report.pdf (accessed 10.07.2023).

[59] C. McKeon, A. Satovich, M. Simmons, C. O'Connor, B. Barger, *Boldly Insure where No one Has Gone. Commercialization of Space is a Once-in-a-Generation Opening*, ITL, 19.10.2021, https://www.insurancethoughtleadership.com/commercial-lines/boldly-insure-where-no-one-has-gone (accessed 10.07.2023).

are of prime importance, the space sector needs a clear, coherent, and adequately granular regulatory environment that ensures sustainable development. There is no doubt that regulating the matter of economic exploration of space is an extremely difficult task, even with many examples of European national laws and model concepts for such laws developed by international organizations and almost 30 states.

No doubt, law can be a tool of introducing sustainability into the space sector's daily life. To serve as such, law should be almost as dynamic and agile as the space activity and space environment. Space law should not only be descriptive to the industry's mainstream but also address new concepts such as in-orbit servicing, asteroid mining, etc. By doing so, it should also embrace the technical aspects even if they are not mandatory by international law. However, the lawmakers must also not be afraid to tackle new areas. The second area for the States is to be engaged through their laws (hard or soft) in sustainable development in a way that supports and encourages new ventures. The primary duty of the government in that respect is to enhance safety and minimize risk, both material and financial. This affects directly not only their citizens and their assets, but also the environment, which obviously serves the entire society in an inclusive way and on a long-term basis.

When thinking of sustainable space exploration, space law should not be developed in isolation from other sectors just because it is so special. For example, some elements present in modern environmental laws could serve as a pattern for the development of space sustainability regulations, at least as regards the methods of adopting new regulations. These include involving different kinds of actors with different approaches and public-private interactions also between hard and soft laws. The multi-level governance of outer space environmental protection could serve to strengthen synergies among different levels: by Outer Space Treaty and Liability Convention on the level of principles, but also, if necessary, by accepting other ways of adopting new standards of behaviour in outer space, i.e. not by a UN treaty, but also by multinational (plurinational) agreements or technical standards like ISO on a national level. And, last but not least, the change of the paradigm of managing space risks by law should visibly move away from focusing on consequences (such as compensation), to prevention and precaution.

It may be then repeated after the Committee, what we all have known for a long time, "that proper legislation on space activities and satellite traffic to ensure the long-term sustainability of space is urgent as well as strategic, as is the use of artificial intelligence to avoid collision risks". The famous quote attributed to Madame de Pompadour: "Apres nous le deluge" began to come true far too soon.

REFERENCES

Bittencourt Neto O., *Preserving the Outer Space Environment: The "Precautionary Principle" Approach to Space Debris,* (in:) C.M. Jorgenson (ed.), *Proceedings of the International Institute of Space Law 2013 (56)*, The Hague 2013

Bohlmann UM., Petrovici G., *Developing Planetary Sustainability: Legal Challenges of Space 4.0.* 'Global Sustainability' 2019, No. 2, E10, doi:10.1017/sus.2019.10 (accessed 30.01.2023)

Brodecki Z., *Liability in International Law,* (in:) *Studia Europejskie*. Vol 5. Instytut Studiów Europejskich 2000

Cassotta S., *The Development of Environmental Law within Changing Environmental Governance Context: Towards a New Paradigm Shift in the Anthropocene Era,* 'Yearbook of International Environmental Law 54-67' 2019, No. 30(1)

Cheng B., *International Responsibility and Liability for Launch Activities*, 'Air & Space Law' 1995, Vol. XX, No. 6

Colombo C., Letizia F., Trisolini M., Lewis H., *Space Debris: Risk and Mitigation*, (in:) R.J. Wilman, Ch.J. Newman (eds), *Frontiers of Space Risk. Natural Cosmic Hazards and Societal Challenges*, Boca Raton 2018

Cuddihy T., *Environmental Liability Risk Management for the 21st Century,* 'The Geneva Papers on Risk and Insurance. Issues and Practice' 2000, No. 25(1)

Deplano R., *The Artemis Accords: Evolution Or Revolution In International Space Law?*, 'International & Comparative Law Quarterly' 2021, No. 70(3), doi:10.1017/S0020589321000142

Erwin S., *U.S. declares ban on anti-satellite missile tests, calls for other nations to join. VP Harris: A commitment to not destroy satellites in orbit should become a 'new international norm for responsible behavior in space'*, 'Space News', 18.04.2022, https://spacenews.com/u-s-declares-ban-on-anti-satellite-missile-tests-calls-for-other-nations-to-join/ (accessed 10.07.2023)

ESA, ESA's Annual Space Environment Report 2022*,* 22 April 2022, https://www.esa.int/Space_Safety/Space_Debris/ESA_s_Space_Environment_Report_2022 (accessed 10.07.2023)

European Commission, Avoiding Damage from Space Debris – Space Surveillance and Tracking Proposal, 28 February 2013, MEMO/13/149

Flückiger I., Carbone M., *From Risk Transfer to Risk Prevention: How IoT is Reshaping Business Models in Insurance*, Geneva Association 2021, https://www.genevaassociation.org/sites/default/files/iot_insurance_research_report.pdf (accessed 10.07.2023)

Hapgood M., *Space Weather, The Sun as a Natural Hazard,* (in:) R.J. Wilman, Ch.J. Newman (eds), *Frontiers of Space Risk. Natural Cosmic Hazards and Societal Challenges*, Boca Raton 2018

Inmarsat, Space Sustainability Report 2022, https://www.inmarsat.com/en/insights/corporate/2022/space-sustainability.html (accessed 30.01.2023)

Jenks C.W., *Liability for Ultra-Hazardous Activities in International Law,* 'Hague Recueil' 1966, Vol. 117

McKeon C., Satovich A., Simmons M., O'Connor C., Barger B., *Boldly Insure where No one Has Gone. Commercialization of Space is a Once-in-a-Generation Opening*,

ITL, 19.10.2021, https://www.insurancethoughtleadership.com/commercial-lines/boldly-insure-where-no-one-has-gone (accessed 10.07.2023)

OECD, Space Sustainability. The Economics of Space Debris in Perspective, 2020

Parquet C.A., *Allocation of Potential Liabilities and Risks in Launch Services Agreements,* (in:) *Project 2001 Plus Workshop*, Berlin 29-30 January 2004, https://slideplayer.com/slide/4798344/ (accessed 10.07.2023)

Pisani J., *Sustainable Development – Historical Roots of the Concept*, 'Environmental Sciences' June 2006, No. 3(2)

Soucek A., *International Law,* (in:) A. Soucek, Ch. Brunner (eds), *Outer Space in Society, Politics and Law*, Vienna 2011

Soucek A., Tapio J., *Normative References to Non-Legally 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' 2018

Szwajewski M., Malinowska K., *Coherence of Engineering Models for the Prediction of Debris in Terms of Space Licensing. Case of Small Satellites,* (in:) T. Flohrer, S. Lemmens, F. Schmitz (eds), *Proceedings of the 8th European Conference on Space Debris* (virtual, Darmstadt, Germany, 20–23 April 2021, published by the ESA Space Debris Office Ed. May 2021), https://conference.sdo.esoc.esa.int/proceedings/sdc8/paper/192/SDC8-paper192.pdf (accessed 6.01.2023)

Toussaint C., Dumez H., *On the Emergence of an Active Debris Removal Market*, (in:) *Earth's Orbits at Risk: The Economics of Space Sustainability*, OECD Publishing 2022, https://doi.org/10.1787/fc689ef6-en (accessed 6.01.2023)

Wilman R.J., Dayal P., Ward M.J., *Hazards and Habitability: Galactic Perspectives,* (in:) R.J. Wilman, Ch.J. Newman (eds), *Frontiers of Space Risk. Natural Cosmic Hazards and Societal Challenges*, Boca Raton 2018

Williamson M., *Commercial Space Risks, Spacecraft Insurance, and the Fragile Frontier,* (in:) R.J. Wilman, Ch.J. Newman (eds), *Frontiers of Space Risk. Natural Cosmic Hazards and Societal Challenges*, Boca Raton 2018

Williams M., *Safeguarding Outer Space: On the Road to Debris Mitigation,* (in:) *The Next Generation—Conference Report*, 31 March–1 April 2008, United Nations Institute for Disarmament Research/UNIDIR, 17 December 2008.