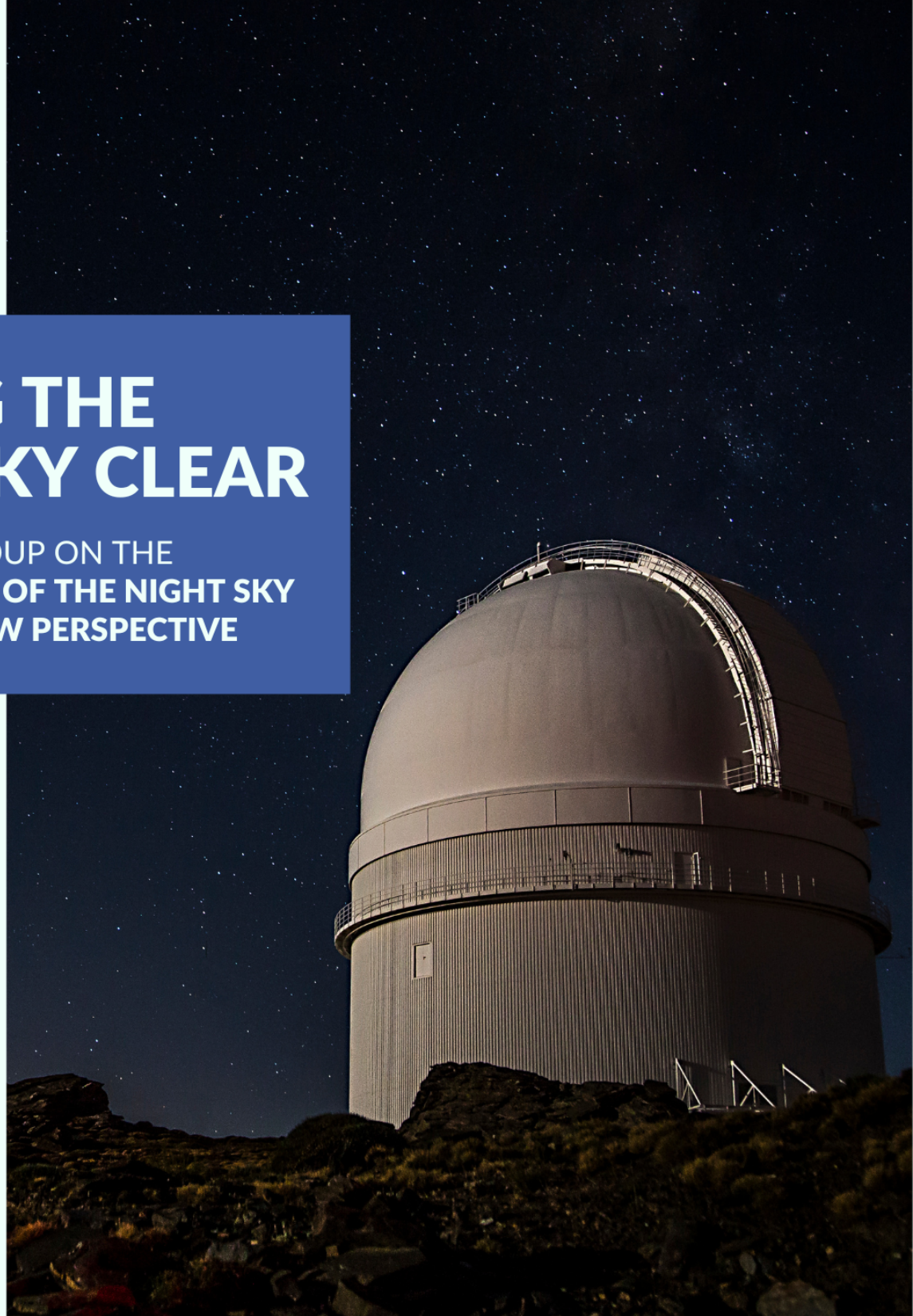




KEEPING THE NIGHT SKY CLEAR

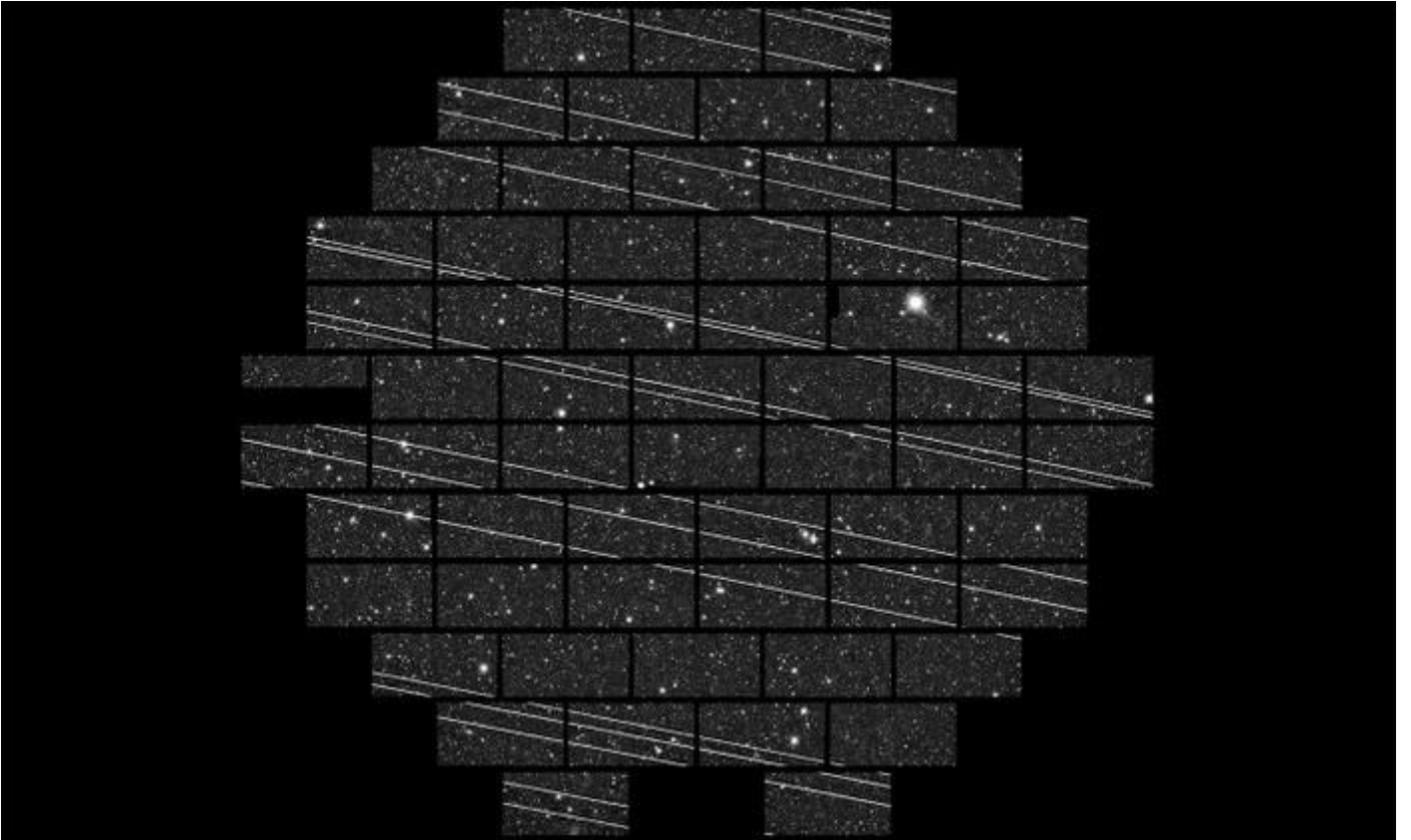
IISL WORKING GROUP ON THE
LIGHT POLLUTION OF THE NIGHT SKY
FROM A SPACE LAW PERSPECTIVE



FINAL REPORT | JUNE 2023

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KEEPING THE NIGHT SKY CLEAR



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IISL Working Group on the Light Pollution of the Night Sky from a
Space Law Perspective - Final Report



Cover Image: Calar Alto Observatory, Spain

Previous page: A 333-second exposure captured using the Blanco 4m telescope at the Cerro Tololo Inter-American Observatory (CTIO) shows 19 streaks that astronomers attributed to Starlink satellites. Credit: NSF's National Optical-Infrared Astronomy Research Laboratory/CTIO/AURA/DELVE.

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FINAL REPORT

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LIST OF ABBREVIATIONS

ALAN – Artificial Light At Night

COPUOS (UNCOPUOS) – United Nations Committee on the Peaceful Uses of Outer Space

COSPAR – Committee on Space Research

ESO – European Southern Observatory

IAU – International Astronomical Union

IDA – International Dark-Sky Association

IHRL – International Human Rights Law

IISL – International Institute of Space Law

ISO – International Organization for Standardization

ITU – International Telecommunication Union

LEO – Low Earth Orbit(s)

LSC – Legal Sub-Committee of COPUOS

NEO – Near Earth Object

OST – Outer Space Treaty, 1967

STSC – Scientific and Technical Sub-Committee of COPUOS

UK – United Kingdom

UN – United Nations

UNESCO – United Nations Educational, Scientific and Cultural Organization

UNOOSA – United Nations Office for Outer Space Affairs

USSR – Union of Soviet Socialist Republics

US – United States of America

WG – Working Group

FOREWORD BY THE PRESIDENT OF IISL

Dear Readers of this Report,

Founded in 1960, the International Institute of Space Law (IISL) is the global association of space lawyers. The membership of IISL is composed of individuals and institutions from more than 50 countries on all continents. Our membership comprises academic, governmental, industrial, and legal practice sectors. The IISL's key mission is the promotion of further development of space law and the expansion of the rule of law in the exploration and use of outer space.

Furthering the mandate of IISL, the topic addressed by this Report rather than being theoretical, is practical and directly relevant to space activities. The huge number of satellites placed in low Earth orbit has important positive economic and societal effects. At the same time, the impact on astronomy has already begun to reveal particularly negative dimensions. In terms of disruption of astronomical science, certain observations such as wide-sky surveys, observations conducted during twilight hours, and radioastronomy are severely affected. Even orbital telescopes are starting to be impacted by passing-by satellites. The situation is alarming, and addressing it is increasingly becoming urgent. As a result, the topic of dark and quiet skies is gaining global relevance. IISL decided to face this situation: in the spring of 2021, a Working Group was created by the IISL Board of Directors, which has been led and coordinated by Professor Rafael Moro Aguilar from Florida International University. He is thoroughly involved in IISL and in other fora on legal cooperation on outer space. He has experience in both the academic and the private sectors, having served as a legal advisor on aerospace issues in the past, and has an extensive research background in international space law. I thank him for his leadership and all contributors to the Report as well as the participants in the public webinar which took place in early June 2023, discussing the study results, for their contributions and their dedication to the topic.

The IISL Working Group built on an ongoing conversation between the astronomical community and satellite constellations operators. A series of mitigation measures have

already been adopted by the operators of the largest constellations. However, there is an almost complete lack of regulation of this issue. The IISL Working Group identified and examined existing legal regulation already in place that may be relevant for this problem, and also explored the possible emergence of new rules of international space law, and international law in general, which may offer some protection to astronomy and dark skies. The topic is already under discussion in several international fora and the creation of an expert group on dark and quiet skies has been proposed at the Scientific and Technical Subcommittee of UNCOPUOS. Astronomy itself has been recognized by UNCOPUOS as instrumental to all space activities and therefore worthy of protection by internationally agreed legal regulation.

The IISL Working Group's results show that the matter is broad. It is not only about the science of astronomy, which for millennia has provided benefits to humankind and which encounters huge public and private investments by governments and also enthusiastic people, young and old. It further encompasses our very understanding of nature. But there are additional societal implications as well: every citizen might claim a fundamental right to view and enjoy a pristine night sky. Therefore, we need solutions. This Report is set out to provide avenues to handle the protection of the night sky and to deal with light pollution as a matter of space law development. I am confident that it will contribute substantially to the debate on the national and international levels.

Prof. Dr. Kai-Uwe Schrogl

President, IISL

IISL Working Group on the Light Pollution of the Night Sky
from a Space Law Perspective
FINAL REPORT

BACKGROUND

At the Spring Meeting of 2021, the Board of Directors of the International Institute of Space Law (IISL) approved the creation of a study group under the name “IISL Working Group on Light Pollution of the Night Sky from a Space Law Perspective”. The Working Group (WG) was officially formed and started operating in September 2021.

At its peak, the WG was composed of a dozen people, including the present Coordinator. There were a few people who participated in one or more meetings of the WG but in the end they did not contribute to the present report.

All participants of the WG were IISL members, except for two. One person participated from Europe’s major astronomical organization, the European Southern Observatory (ESO), and provided much information from a technical point of view. The WG also reached out to the Canaries Astrophysical Institute, the most important astronomical institution in Spain, which provided some additional technical support. Finally, significant support in terms of research of existing national laws and rules on light pollution was provided by a member of The Space Court Foundation.

The purposes for the creation of this WG were to collect information about the issue of the light pollution of the night sky caused by satellite constellations, analyze the problem from a Space Law perspective, raise awareness on the topic among all IISL members, and provide the IISL Board of Directors with an up-to-date report describing the current state of the situation.

From the outset, several members supported the WG’s consideration of the work already done by other bodies on the topic of light pollution of the night sky, in particular the reports of the IAU/UNOOSA/Spain “Dark & Quiet Skies for Science and Society” Workshop¹ and Conference² that were held on-line, in October 2020 and October 2021 respectively. In fact,

¹ https://www.unoosa.org/oosa/en/ourwork/psa/schedule/2020/2020_dark_skies.html.

² <http://research.iac.es/congreso/quietdarksky2021/pages/rationale.php>.

several members of the present IISL WG contributed actively to the reports³ that were compiled and published as a result of the 2021 Dark & Quiet Skies Conference.

The WG agreed that the aforementioned reports were a very significant source of information, and that they would be consulted as a basis for our discussions. The recommendations addressed to all stakeholders concerning satellite constellations that are contained in pages 151 to 157 of the report of the 2020 Dark & Quiet Skies Workshop⁴ are particularly noteworthy, and they should be taken into account by everyone who approaches this issue. The WG underlined nevertheless that it should proceed independently in its examination of the topic, and that it would produce its own report on behalf of IISL.

The subject matter of the present IISL WG has been the light pollution caused by space objects in the night sky, and in particular the optical impact caused by the large satellite constellations, or satcons, which are currently being placed in low earth orbits (LEO); these large satcons are also informally known as ‘mega-constellations.’ (The WG agreed to use all three names in their deliberations, although the term ‘mega-constellation,’ which has been rightly pointed out as being inaccurate from a technical point of view, has been used only occasionally in this report.)

At present, there are several companies building and already launching large constellations composed of hundreds or even thousands of satellites each. The main goal of these networks is to provide broadband internet access from space to virtually any place on the planet. Other companies and nations also have plans for setting up large satellite constellations in orbits that are close to the Earth, with the intention to provide global internet access as well, or to provide other communications or remote sensing services. As a result, a number of new projects in LEO are emerging, taking advantage of the decreasing launch and satellite costs.

Providing worldwide internet connectivity and helping bridge the digital divide is undoubtedly a worthy goal. However, the surge in the number of satellites that have been placed in LEO since the first satcons started launching in 2019 is creating significant technical and regulatory

³ The full reports can be found at <https://noirlab.edu/public/products/techdocs/techdoc051/>. A summary of the reports was presented to COPUOS in 2022 as UN document A/AC.105/1255, available at <https://undocs.org/Home/Mobile?FinalSymbol=A%2FAC.105%2F1255&Language=E&DeviceType=Desktop&LangRequested=False>

⁴ The report including the recommendations can be found at: <https://www.iau.org/static/publications/dqskies-book-29-12-20.pdf>.

issues,⁵ and it is also having an unintended environmental effect: a steady increase in the light pollution of the night sky. Astronomers in particular are concerned with the negative impact that a night sky filled up with shiny artificial objects will have on their scientific research. Also affected by this luminic contamination are Indigenous communities, which may suffer an alteration of their cultural traditions as a result of the changes produced in the dark night sky, and many wildlife species, which may see their daily life cycles altered as well.

In terms of numbers of people affected, potential economic damage, and scientific repercussions, the disruption of astronomical observations is particularly worrisome. There is no need to recall here the many long-term scientific and cultural contributions that astronomy makes to humanity.⁶ However, should all the proposed satellite constellations become a reality in the next few years, the situation may well become unsustainable for ground-based astronomy.⁷ It may even become unsustainable for much space-based astronomy as well, as telescopes orbiting in LEO such as the Hubble Space Telescope are starting to be affected now by the visual impact of other satellites.⁸

This emerging problem has already been the object of several international conferences. It has prompted statements from the International Astronomical Union (IAU) and from other astronomical institutions, and it has attracted the attention of many people, inside and outside the space community.

These concerns have also reached the United Nations and its Committee on the Peaceful Uses of Outer Space (COPUOS), where a number of delegations have brought the issue to the attention of the Committee. At the 58th session of COPUOS' Scientific and Technical Subcommittee (STSC), held in February 2021, a group of countries submitted, together with the IAU, a conference room paper entitled "Recommendations to keep dark and quiet skies for science and society".⁹ At the same session, the STSC decided to add to its agenda a single item

⁵ Such as congestion of orbits and proliferation of space debris. See e.g. Stuart Eves, "Congested, contested... under-regulated and unplanned", *Room Space Journal*, 2021: <https://room.eu.com/article/congested-contested-under-regulated-and-unplanned#:~:text=%2C%20contested...-under%2Dregulated%20and%20unplanned,the%20order%20in%20the%20plot>.

⁶ See e.g. the UN General Assembly Resolution 62/200, of December 19, 2007, which declared 2009 as the International Year of Astronomy, particularly preamble paragraphs 2 and 3. Available at: <http://www.worldlii.org/int/other/UNGA/2007/248.pdf>.

⁷ American Astronomical Society. 2020. Impact of Satellite Constellations on Optical Astronomy and Recommendations Toward Mitigation. (SATCON 1). Available at: <https://aas.org/sites/default/files/2020-08/SATCON1-Report.pdf>

⁸ On the impact on Hubble, see e.g. <https://www.nature.com/articles/s41550-023-01903-3>.

⁹ https://www.unoosa.org/oosa/en/oosadoc/data/documents/2021/aac.105c.12021crp/aac.105c.12021crp.17_0.html.

entitled “General exchange of views regarding satellite system effects upon terrestrial-based astronomy”, in order to allow delegations in future sessions to provide their views on both the issue of the impact of satcons on astronomy and its potential relevance on the work of COPUOS.¹⁰ Among other developments since then, in June 2022, COPUOS recognized that “astronomical observations for both optical and radio astronomy [a]re an essential aspect of space activities and should be protected from interference”.¹¹

The visual interference posed by these large groups of satellites is still moderate, since there are not too many satellites in LEO yet, and most of the orbiting satellites fall below the threshold of naked-eye visibility. At the same time, this is a real problem that is already affecting the work of professional and amateur astronomers all over the world, and which poses a serious potential risk of disrupting their research.

In this context, an interesting reflection shared at the outset of the IISL WG, was that this issue should be addressed promptly, and not be ignored until it becomes much worse. One member of the group noted the similarity with the space debris problem, which was moderate initially, but it has grown enormously over the years, due to an almost total lack of regulation and preventive action. One participant in the webinar organized by IISL in June 2023 commented along this line, noting that space debris also resulted largely from activities that are considered beneficial.

Obviously, satellite constellations providing global telecommunication services are a lawful activity. So is ground-based astronomical observation of the sky. It is desirable to achieve coordination in order that both activities can co-exist peacefully. A consensus could be reached on a series of measures that should promote the development of space activities in a fully sustainable manner, allowing the coexistence of technology advances in terms of satellites and other orbiting space objects with the traditional activity of ground-based observation of the sky.

International Space Law can play a role in achieving that purpose. First of all, the WG aimed to examine the possible application to this problem of international rules in force, particularly the 1967 Outer Space Treaty, the cornerstone of all currently existing International Space Law.

¹⁰ https://www.unoosa.org/oosa/oaadoc/data/documents/2022/aac.105/aac.1051257_0.html.

¹¹ <https://documents-dds-ny.un.org/doc/UNDOC/GEN/221/025/6E/PDF/2210256E.pdf?OpenElement> at p. 21, para. 182.

Some rules contained in the Outer Space Treaty that could apply have been identified by the WG and by other legal authors, most notably Article I (which establishes freedom of access to and utilization of outer space), Article III (which opens the way to the application of general International Law in outer space, in particular International Environmental Law), Article VI (which brings the duty to authorize and supervise private operators of satellite constellations), and Article IX and its ‘due regard’ and ‘harmful interference’ provisions. The latter article seems particularly suitable to apply to our problem, provided that ground-based astronomy may be considered as an activity contained within its scope of application. Historical interpretation of Article IX OST seems to favor that view, as argued in this report.

Apart from these provisions, and the potential application of International Environmental Law to outer space via Art. III OST, at present there are no international rules that apply to the problem of light pollution of the night sky caused by space objects.

For many years now there have been provisions protecting radio astronomy observations, which are contained in the Radio Regulations of the International Telecommunication Union (ITU). Protection is achieved by excluding from commercial purposes a number of radiofrequencies to be used exclusively by ground-based radiotelescopes. National and local laws also enable the establishment of so-called radio-quiet zones around radio observatories, such as e.g. South Africa’s Geographic Advantage Act of 2007. However, no similar protection is to be found anywhere with regard to purely optical interferences. This lack of specific standards limiting the visual impact caused by space objects has been pointed out as an important legal void.

Given that current regulation is clearly insufficient, the potential elaboration of new legal rules addressing specifically this problem was also considered by the WG.

As a first step, the WG considered the path of adopting a series of non-binding guidelines in COPUOS, as this has been proposed as a method for elaborating the first international rules aimed to limit light pollution due to activities in LEO. Such rules could take as a model the space debris mitigation guidelines and the long-term sustainability guidelines that were adopted in COPUOS in 2007 and in 2019, respectively. Accordingly, a potential next step would be to engage the STSC to issue some guidelines that will reflect a reasonable compromise between the satellite operators and the needs of astronomers.¹² Those guidelines

¹² Alexandra Witze, “Astronomers push for global debate on giant satellite swarms”, Nature News, 16 July 2021: <https://www.nature.com/articles/d41586-021-01954-4>.

could then be picked up by national governments as licensing regulations. The actual elaboration of such guidelines could take place either within the currently existing long-term sustainability working group or in the framework of a new, separate expert group, depending on how the Member States of COPUOS should decide to proceed.

Another interesting reflection that was shared in the WG is that this is not necessarily a legal but a space governance problem, in the sense that there are actually some norms already that could apply to the problem—most notably OST Article IX and its obligations of due regard, prevention of harmful interference, and international consultation, as noted—but for some reason they are not being implemented in practice by States.

In this context of global space governance, mention should be made of the Statement issued by the Board of Directors of IISL in July 2021, “Consideration of the Interests of the Public and other Stakeholders in the Authorization and Continuing Supervision of Commercial Space Activities.” This Statement highlights the importance for national licensing authorities to consider the interests of the global public while granting licenses to private sector applicants. It also states that “space activities should be developed in accordance with the rule of law, for peaceful purposes, and in a manner that is sustainable for the present and future generations.” In order to achieve that goal, national regulators should give careful consideration to the interests of all stakeholders, including the scientific community and the general public, regarding the consequences of authorizing activities such as large constellations of satellites.¹³

Indeed, solutions to the current situation could also come from national Space Law, by introducing new licensing rules and legal standards that would be imposed on operators at the domestic level, taking into account the obligation of the relevant states to authorize and constantly supervise private space activities, such as satellite constellations.

The WG searched for countries that would actually be doing something about the visual impact of space objects on the night sky. However, except for a 2001 US federal law prohibiting obtrusive space advertising, no national legislation was found on that matter. On the other hand, there are already multiple national laws and regulations around the world preserving dark skies at the local level. In our report, we are providing a brief overview of those laws and regulations that are already in force and protecting the quality of the night sky, albeit from ground-emitted light pollution only.

¹³ https://iislweb.space/wp-content/uploads/2021/07/IISL_Statement_Authorization_and_continuing_supervision_2021.pdf.

The eventual adoption of one or more international agreements protecting the dark sky as a world heritage, perhaps in the framework of UNESCO's role in protecting natural and cultural heritage, was also explored by the WG. In addition, the possible creation of a new fundamental human right of a cultural nature that would protect stargazing or the enjoyment of a pristine night sky has also been discussed by the WG.

Finally, the WG analyzed what is actually being done at the moment in order to address the problem of the light pollution of the night sky caused by large satcons, in terms of mitigating measures adopted by satcons. So far, collaboration between the satellite industry and the astronomical community has led to a set of best practices to reduce the amount of optical interference, which include implementing some voluntary changes to satellite designs, providing positional data of the satellites, and modifying the orientation of satellites in orbit-raising and orbit-lowering procedures in order to minimize the reflected light produced by satellites. The WG examined to what extent these voluntary measures are working. The WG also considered the future of self-regulation in this area, as well as recent initiatives related to space sustainability rating.

SECTION 1: INTRODUCTION

This Report contributes to the current discussion on the impact of satellite constellations on the darkness of the skies and the consequences that emerge for astronomical observations. The underpinning approach is to seek answers to the legal questions regarding the existing international legal framework applicable to the problems that might proliferate when satellite constellations become commonplace. In that effort, this Report has addressed the research topic with an encompassing approach considering space global governance.

Global governance is a notion developed upon the findings of the Global Commission on Governance, a Swedish initiative that in 1995 concluded with a report defining this concept as “the sum of the various ways in which individuals and institutions, public and private, manage

their common affairs”.¹⁴ More recently, the High Level Advisory Board on Effective Multilateralism proposed to understand it as “the various ways in which order occurs, sometimes via top-down rules, but often as a result of networks, the influence of markets, and the behavior of individuals and organizations”.¹⁵

It is generally accepted that outer space is a *res communis omnium*, i.e. an area open to all States and not subject to appropriation by anyone. This is the result of the legal combination of two core provisions of the Outer Space Treaty: Articles I and II. The former establishes that the use and exploration of outer space shall be the province of all (hu)mankind. The latter enshrines the fundamental principle of non-appropriation of outer space, including the Moon and the celestial bodies. The characterization of outer space with such a legal nature calls for a global regime to govern space matters. In other terms, the international community has an interest and a role to play in space governance.

The Second Manfred Lachs International Conference on Global Space Governance, organized by McGill University, adopted the Montreal Declaration applying this neologism to address the emerging global challenges of the use and exploration of outer space. It defined global governance as a comprehensive concept “that includes a wide range of codes of conduct, confidence building measures, safety concepts, international institutions, international treaties and other agreements, regulations, procedures and standards.”¹⁶

At the space multilateral level, this term started to be used in 2016 during the preparations of COPUOS for UNISPACE+50 as a need for the implementation of the 2030 Agenda for Sustainable Development. The Secretariat of the United Nations Office for Space Affairs (UNOOSA) acknowledged at that time that there was no universally accepted definition but that “it could be interpreted as referring to international action to, or the manner (process) of, governing and regulating space-related activities” (A/AC.105/1137 at para. 6).¹⁷ It is understood to include various legally binding or non-legally binding instruments (such as

¹⁴ Commission on Global Governance, “Our Global Neighbourhood”. Available at: <https://www.gdrc.org/u-gov/global-neighbourhood/chap1.htm/>.

¹⁵ HLAB, Framing Paper Definitions, Principles and Objectives. Available at <https://highleveladvisoryboard.org/wp-content/uploads/2022/04/Governance-Innovation-Framing-Paper.pdf>.

¹⁶ The Montreal Declaration on Global Space Governance (2014). Available at: <https://www.mcgill.ca/iasl/gsg/montrealdeclaration/>.

¹⁷ General Assembly Resolution, A/RES/73/6, 26 October 2018, operative paragraphs 7 and 4. Available at: <https://documents-dds-ny.un.org/doc/UNDOC/GEN/N18/343/85/PDF/N1834385.pdf?OpenElement>

guidelines, codes of conduct, confidence-building measures) and national, bilateral, regional or international institutions.

In effect, the global governance of space encompasses *inter alia* the five United Nations treaties, an important set of principles enshrined in resolutions adopted by the General Assembly of the United Nations, guidelines on the long-term sustainability of outer space activities and on space debris mitigation, reports on international mechanisms for cooperation and on domestic space legislation, and the safety framework for nuclear power source applications.

However, it is important to underscore that not only instruments but also institutions and mechanisms are components of space global governance. This means that COPUOS and its Subcommittees, working groups and their outcome documents enrich and make this concept a living and progressive one. In this vein, General Assembly Resolution 73/6, adopted during the UNISPACE+50 high level segment in 2018, reaffirmed the unique role of COPUOS as a platform for the global governance of outer space activities and encouraged States to continue to promote and contribute to it.¹⁸ In furthering that objective, new issues emerging as a natural consequence of technological developments and the increased access to space by private actors are addressed with a regulatory perspective.

This is an important aspect that needs to be underlined: the global governance of space is dynamic and tends to constantly cover new issues as technological developments pose new challenges (*reactive* approach of space global governance) or as the international community becomes aware of the potential negative effects of existing *lacunae* (*preventive* approach of space global governance).

A topic that has caught the attention of COPUOS recently is the preservation of dark and quiet skies for science and society, which was included in the agenda of the Scientific and Technical Subcommittee (STSC) of COPUOS in 2022 for discussion at its 59th session. The plenary of COPUOS at its 65th session endorsed the inclusion of a single issue item on dark and quiet skies on the agenda of the 60th session of STSC in 2023. The discussion during the 60th STSC centered on whether an expert group should be set up to specifically deal with this topic, or

¹⁸ COPUOS, UN Doc. A/AC.105/1137, “Fiftieth anniversary of the United Nations Conference on the Exploration and Peaceful Uses of Outer Space: the Committee on the Peaceful Uses of Outer Space and global governance of outer space activities,” 20 September 2016. Available at: <https://documents-dds-ny.un.org/doc/UNDOC/GEN/V16/059/82/PDF/V1605982.pdf?OpenElement>.

whether these issues fall under the mandate of the existing working group on the long-term sustainability of space activities. At least for the moment, the vast majority of the international community seems to favor the first approach.

The impact of satellite constellations on radio astronomy, optical and infrared astronomy was flagged in 2022 also at the Legal Subcommittee (LSC) of COPUOS by some Member States, but no decision has been made yet on the proposal to include a related agenda item. However, it is to be expected that a renewed interest to include this topic on the agenda of the LSC might emerge following the discussions of the STSC and the increasing number of satellite constellations in orbit.

Meanwhile, the IISL Working Group on the Light Pollution of the Night Sky from a Space Law Perspective has been studying core provisions of the space regime to further this discussion. In this context, bearing in mind that the 1967 Outer Space Treaty¹⁹ is the cornerstone of Space Law and taking into consideration its almost universal character, this Report will examine Articles I, III, VI and IX of that instrument as important existing provisions that might provide some guidance on how to regulate undesirable impacts caused by space objects.

In effect, Sections 2, 3 and 4 of the present Report dwell on how these provisions might be applicable to strike a balance between the contradictory issues emerging from the conflict of the right to use and explore outer space and the prohibition of harmful contamination and harmful interference. In that task, possible systemic interpretations will be explored to determine if the combination of existing International Environmental and Space Law already provide enough protection or whether further regulation should be specifically pursued in the space context.

Another component of the global governance of space is national legislation. The role of domestic law is twofold: sometimes it implements existing International Law and other times it lays the foundation for future international initiatives, either binding or non-binding. This is the reason why, assuming the absence of a specific regulation beyond the general guidance of the Outer Space Treaty applying to the preservation of dark skies from the negative impact of

¹⁹Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, in force since 10 October 1967, 610 UNTS 205. Available at: <https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/introouterspacetreaty.html>.

satellite constellations, Section 5 of this Report will look into existing domestic law addressing light pollution in general which might provide some elements to be taken into account when light pollution caused by space objects finally becomes regulated.

The balance between economic development and environmental protection is at the core of sustainable development, and space technology is a cross-cutting tool for the achievement of the 2030 sustainable development goals. The necessary merger of space matters with the global agenda of sustainable development has given rise to a decade of work on the long-term sustainability of outer space activities that has enriched global space governance with a dedicated set of guidelines. Since that document has been envisaged as an evolving instrument that should be updated as new challenges are identified, the guidelines will be examined in the present Report in Section 6, as a possible source or as a possible model for establishing non-binding regulation of satellite constellations with an aim to preserve dark skies.

As already mentioned, it should be recalled that one of the proposals made within the STSC was to address the matter under the Working Group on the Long-Term Sustainability of space activities. Thus, Section 6 might provide additional elements to be considered for the future regulatory framework, emphasizing the fact that both the STSC and the LSC of COPUOS need to work in coordination with a holistic approach.

Since ancient times, all cultures have developed some level of astronomy for daily purposes and to support living conditions. Even nowadays, a pristine sky is a necessary requisite to preserve the survival of several indigenous populations. The link between culture, science and policy is an interesting aspect that requires further exploration while avoiding overlapping competences. Aware of that need, Section 7 of this Report examines the possibility and the desirability of adopting some kind of natural and cultural heritage protection of the night sky at the international level.

The role that many astronomical and scientific institutions, including the International Astronomical Union (IAU), the European Southern Observatory (ESO) and the Committee on Space Research (COSPAR) is of the utmost importance when it comes to cooperation with other multilateral fora, such as the United Nations Educational, Scientific and Cultural Organization (UNESCO). The interconnection of different study fields is at the cornerstone of any multifaceted investigation.

Finally, Section 8 is devoted to self-regulation as an additional source to the global governance of space. In effect, the concept of a “more inclusive multilateralism” as proposed by the United Nations Secretary-General Antonio Guterres in his report entitled “Our Common Agenda”²⁰ calls for the participation of the private sector and non-State actors in meeting global challenges. In that line, commitments by the space industry to innovate and produce satellites in an attentive manner to the needs of society and the scientific community may be a viable path to be explored in the face of the “New Space” phenomenon. However, it is appropriate to underscore that self-regulation should not replace the international institutions and instruments governing problematic matters. In contrast, it should be conceived as a complementary tool in the joint efforts to preserve the darkness of the skies.

This Report does not aim at solving all the legal issues surrounding light pollution caused by satellite constellations. It rather provides some food for thought for any future initiative at the intergovernmental level. In this endeavor, this Report compiles valuable information and approaches to contribute to the furtherance of space global governance in the near future.

²⁰Our Common Agenda, Report of the Secretary-General, United Nations, New York, September 2021. Available at <https://www.un.org/en/common-agenda>.

SECTION 2 - APPLICATION OF THE OUTER SPACE TREATY: ARTICLES I AND III

2.1 Application of Article I

The 1967 Outer Space Treaty (OST) established a number of fundamental rules and principles to govern space activities that, upon adoption, became positive International Law and that, over fifty-five years on, continue to be valid.

In accordance with Article I of the Treaty, States are free to access, explore and use outer space, including celestial bodies, “without discrimination of any kind, on a basis of equality and in accordance with international law”.

Therefore, Article I OST establishes the principle of free exploration and use of outer space, which shall be “the province of mankind” according to the Treaty. This principle was foreshadowed in prior United Nations General Assembly Resolutions, such as Resolution 1721 (XVI) of 1961²¹ and para. 2 of the 1963 Declaration of Legal Principles²². It was then incorporated into the OST and thus participates in the legally binding character of the Treaty.

There is general agreement that the term “use” means the utilization of outer space for both non-economic and economic ends, including the exploitation of outer space with the goal of making economic profit.²³

The OST expressly grants this freedom to states or governments. As for non-governmental or private entities, provided that they are duly authorized to conduct space activities by a State party (see below, Section on Article VI), they are also free to launch objects and to conduct space activities, which have to be done always in accordance with International Law.

Undoubtedly, the freedom to use outer space includes the freedom to launch and operate satellites in outer space, including satellite constellations placed in LEO, by either public or private entities, subject only to the limitations imposed by the Treaty.

²¹ UNGA Resolution 1721 (XVI), 20 December 1961, “International Cooperation in the Peaceful Uses of Outer Space,” at Part A 1.b.

²² United Nations General Assembly, Resolution 1962 (XVIII), 13 December 1963, “Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space,” at para. 2.

²³ Stephan Hobe, “Article I” in Hobe, Schmidt-Tedd, and Schrogl, (eds), *Cologne Commentary on Space Law* (Vol. I), Cologne, 2009, p. 35 (para. 36).

Another relevant provision can be found in the last part of Article I: “There shall be freedom of scientific investigation in outer space, including the Moon and other celestial bodies, and States shall facilitate and encourage international cooperation in such investigation.”

It has been noted that “the fact that the OST reiterates scientific investigation, although it is the most specific activity covered by ‘exploration’, shows the importance of this activity.”²⁴

This freedom of scientific investigation that is separately granted under Article I OST could be argued to include astronomical observation, even when such observation is conducted from the surface of the earth, as this is a peaceful activity that is aimed at exploring outer space. As stated in the Report of the 2021 Dark and Quiet Skies Conference, given the deep connections that exist between astronomy and other forms of space exploration, it seems reasonable to assert that astronomy is a kind of space activity.²⁵

In brief, the two activities that are being considered in this report (satellite constellations and astronomical observation) are perfectly lawful according to the Outer Space Treaty. A problem arises due to the fact that the Treaty does not establish any priority between competing space or space-related interests.²⁶

Which one should prevail: basic science or space applications? Since no hierarchy of any kind is established by the OST itself, both activities can be considered as on equal footing and will have to coexist. A coordination should be established between astronomy and commercial uses of outer space such as satcons in LEO.

Article I establishes freedom of use of outer space subject to the limitations imposed by the Outer Space Treaty itself. That means every activity is subject to, *inter alia*, the obligations of non-appropriation of outer space, responsibility for non-governmental entities, and liability in case of damage, as well as cooperation, due regard, non-interference, and preventing harmful contamination of outer space.

As also noted in the Report of the Dark and Quiet Skies Conference, “general freedom exists to access space, and its exploration and use constitute provinces of all humankind. However,

²⁴ Stephan Hobe, *ibidem*, at p. 36.

²⁵ Report of the 2021 Dark and Quiet Skies Conference, at p. 99.

²⁶ Giuliana Rotola & Andrew Williams, “Regulatory Context of Conflicting Uses of Outer Space: Astronomy and Satellite Constellations”, *Air & Space Law* 46, No. 4&5 (2021), at p. 550.

these freedoms are not absolute, and must find a limit in the freedoms exercised by other actors.”²⁷

Nowadays we are witnessing how commercialization and intensive use of LEO is impinging on that freedom of exploration that is available to every country. Some limitations in addition to those explicitly established under the OST may have to be established with regard to the use of LEO for large scale projects such as ‘mega-constellations,’ in order to ensure that the free access principle is still available to everyone, as well as to ensure that the rights of others who are exploring and using outer space are taken into account.²⁸

2.2 Application of Article III

Another key provision included in the 1967 Outer Space Treaty establishes that general International Law applies to human activities in outer space. Article III declares that "States Parties to the Treaty shall carry on activities in the exploration and use of outer space, including the Moon and other celestial bodies, in accordance with international law, including the Charter of the United Nations, in the interest of maintaining international peace and security and promoting international co-operation and understanding”.

Article III OST was certainly not the first reference to International Law in Space Law legal texts.²⁹ In a series of resolutions, the United Nations General Assembly had already made it clear that International Law should be applicable to human activities conducted in outer space. UNGA Resolution 1721 (XVI) first introduced the application of International Law to outer space and the celestial bodies as a guiding principle in 1961.³⁰ One year later, a

²⁷ Report of the 2021 Dark and Quiet Skies Conference, at p. 83. Available at: https://www.iau.org/static/science/scientific_bodies/working_groups/286/dark-quiet-skies-2-working-groups-reports.pdf.

²⁸ Aaron C. Boley and Michael Byers, “Satellite Mega-constellations Create Risks in Low Earth Orbit, the Atmosphere and on Earth”, Nature Scientific Reports, May 20, 2021, <https://www.nature.com/articles/s41598-021-89909-7>; Miles Lifson and Richard Linares, “Is There Enough Room in Space for Tens of Billions of Satellites, as Elon Musk Suggests? We Don’t Think So”, Space News, January 4, 2022, saying that “Space is a communal and finite resource – for better or for worse, when one nation uses it, it limits the orbits that can be used by others.” <https://spacenews.com/op-ed-is-there-enough-room-in-space-for-tens-of-billions-of-satellites-as-elon-musk-suggests-we-dont-think-so/>.

²⁹ Olivier Ribbelink, “Article III” in Hobe, Schmidt-Tedd, and Schrogl, (eds), Cologne Commentary on Space Law (Vol. I), Cologne, 2009, at p. 65 (paragraphs 3 & 5).

³⁰ United Nations General Assembly, Resolution 1721A (XVI), 20 December 1961, at para. 1 (a).

recommendation to states to carry out space activities in conformity with International Law was included in UNGA Resolution 1802 (XVII).³¹

Another milestone was achieved by UNGA Resolution 1962 (XVIII), which first established in a clear manner the provision that “the activities of States in the exploration and use of outer space shall be carried on in accordance with international law”.³² Article III OST was simply the final step that took this legal principle and transformed it into a binding obligation between the parties.³³

Article III OST, like many other principles contained in the Outer Space Treaty, can now be considered to have become customary international law, and hence binding on all states.³⁴

As noted in the Report of the Dark and Quiet Skies Conference, “this provision confirms that space law is part of the broader system of international law.” However, Article III is not a wholesale extension of the entirety of International Law to outer space. In this sense, “it is an interpretative task that member states might wish to undertake to elucidate which areas of international law may be imported into space law to give content and clarity to some of its provisions, such as the obligation to avoid harmful contamination.”³⁵

Article III specifically refers to the UN Charter, but this is obviously not the only international text that can apply in outer space. The Cologne Commentary on Space Law has considered that newer and later but also generally accepted International Law principles can be imported into Space Law, from areas such as International Environmental Law or International Human Rights Law.³⁶

This means that there are important principles of Environmental Law that may be applicable, and may serve as an inspiration for a solution to the problem at hand, such as the precautionary principle or the good neighborliness principle.

In particular, the good neighborliness -or good neighborhood- principle was first recognized in the findings of the Trail Smelter arbitral tribunal (1941), which declared that “under the

³¹ United Nations General Assembly, Resolution 1802 (XVII), 14 December 1962, Preamble.

³² United Nations General Assembly, Resolution 1962 (XVIII), 13 December 1963, “Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space,” at para. 4.

³³ Francis Lyall and Paul B. Larsen, *Space Law - A Treatise*, Ashgate Publishing, 2009, pp. 54, 56, 59.

³⁴ Francis Lyall and Paul B. Larsen, *ibidem*, pp. 78 *et seq.*, 510.

³⁵ Report of the 2021 Dark and Quiet Skies Conference, pp. 104, 105.

³⁶ Olivier Ribbelink, *ibidem*, at p. 67 (para. 14).

principles of international law... no State has the right to use or permit the use of its territory in such a manner as to cause injury... to the territory of another”.³⁷

The Trail Smelter case referred to an action performed within a State’s territory causing direct influence on the territory of another State. Harmful actions in outer space take place outside the territory of any State; however, they may produce a harmful influence having its effects on other State’s territory. Therefore, influences produced in outer space which cause harmful effects in the territory of another State are also prohibited by International Law. For this reason, the principle of good neighborhood implies that any actions influencing the terrestrial environment in outer space appropriate to produce harmful effects on the territory of another State must be avoided.³⁸ Light pollution of the night sky caused by space objects would be a good example of an action taken in outer space that influences the terrestrial environment and produces harmful effects.

A number of other principles concerning the protection of the natural environment have crystallized into customary rules in the last few decades. For instance, Principle 2 of the 1992 Rio Declaration on Environment and Development establishes that States have the duty to avoid the contamination of areas beyond their national jurisdiction, the latter areas including outer space and the celestial bodies.³⁹ According to some authors, this principle is already recognized as a customary rule of International Law.⁴⁰ The International Court of Justice (ICJ) seemed to support this proposition when it declared that “the general obligation of States to ensure that activities within their jurisdiction and control respect the environment of other States or of areas beyond national control is now part of the corpus of international law relating to the environment.”⁴¹ (On the application of international environmental principles to outer space, see below, in Section 2.3).

Of course, International Law applicable to outer space may well include other aspects beyond the natural environment. As noted in the Report of the 2021 Dark and Quiet Skies Conference, “the harmonization of conflicting freedoms and interests in the use and exploration of outer

³⁷ Available at https://legal.un.org/riaa/cases/vol_III/1905-1982.pdf.

³⁸ Günter B. Krauss-Ablass, “Protection of the Terrestrial Environment in Outer Space, A Principle of International Law”, (1971) 14 Proceedings IISL, pp. 72-73.

³⁹ UN Doc. A/CONF.151/26, Report of the United Nations Conference on Environment and Development, 3–14 June 1992 Rio de Janeiro (Brazil), Annex I, ‘Rio Declaration on Environment and Development’, 12 August 1992: https://www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A_CONF.151_26_Vol.I_Declaration.pdf.

⁴⁰ Sergio Marchisio, “Article IX”, in Hobe, Stephan/Schmidt-Tedd, Bernhard/Schrogl, Kai-Uwe (eds.), Cologne Commentary on Space Law (CoCoSL), Volume I, Carl Heymanns, Cologne 2009, p. 177.

⁴¹ Legality of the Threat or Use of Nuclear Weapons (Advisory Opinion) 1996 ICJ Rep 226, para 29.

space may call for a broader understanding of the treaty text where ‘accordance with international law’ might also include other areas of international law that guarantee, *inter alia*, the right to starlight, indigenous rights, and the right to development; the latter including the right to internet access, which has been labeled as a ‘global public good’ by the UN Secretary General in his ‘Our Common Agenda’.⁴²

2.3 Applicability of International Environmental Law principles.

Considering that International Law compatible with *corpus juris spatialis* is applicable to space activities as per Article III OST, it is necessary to address other international legal domains that may be applicable in the context of this issue, in particular International Environmental Law.

The principle of preventing transboundary harm articulated in the ILC's Draft Articles on the Prevention of Transboundary Harm from Hazardous Activities (ILC PTH) may apply to satcons-related activities, as they are not prohibited by International Law (Article 1) and are carried out under the jurisdiction or control of a State (Article 2).⁴³ The latter requirement is also consistent with OST norms, since the State of registration of satellites in the constellation will have jurisdiction and control over them, according to Art. VIII OST. As a result, the government should take all necessary steps to prevent or mitigate damage.⁴⁴ This clause of the ILC PTH Articles is compatible with the principle of due regard in Space Law, enhancing the potential of its applicability.⁴⁵

Furthermore, when it comes to satcons, experts focus on **the precautionary principle**, which is inscribed in Principle 15 of the 1992 UN Rio Declaration on Environment and Development:

“In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or

⁴² Report of the Dark and Quiet Skies Conference II (2021), at p. 105.

⁴³ International Law Commission, Draft Articles on Prevention of Transboundary Harm from Hazardous Activities, 2008, Arts. 1 and 2.

⁴⁴ Art. 3 ILC PTH.

⁴⁵ Munters, Ward. “Small Satellites, Large Constellations and Space Debris: In Dubio Pro LEO?” Commercial Uses of Space and Space Tourism — Legal and Policy Aspects 1, (January 2017): 64-111, p.99.

irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.”⁴⁶

This concept implies that even if the severity of a threat is unknown, it is still vital to take action to eradicate it.⁴⁷ Recognising the vulnerability of the space environment⁴⁸ as well as the uncertainties associated with the transition to a new type of satellite operation in the form of satcons, the precautionary principle should be applied to inspire appropriate action for safeguarding the space environment.⁴⁹

The next environmental law principle that applies in the present case is **the “polluter pays” principle**, which stipulates that the ‘polluter’ must pay compensation for the produced damage. Unlike the 1972 Convention on International Liability for Damage Caused by Space Objects (the “Liability Convention”), this approach specifically addresses environmental harm caused by activities, making its use to satellites more viable.⁵⁰

The principles of equitable use and sustainable development (Principles 3 and 4 of the 1992 Rio Declaration on Environment and Development) support the use of any resource in such a way as to prevent rapid depletion leading to extinction. The logic behind those principles is that nature's bounty should be used in a controlled way, since it should serve everyone. Those principles also support the idea of intergenerational equity, making resources available to all and meeting developmental and environmental needs of present and future generations. The application of the principle of sustainable use to outer space is of great importance in various ways, including with respect to the use of low Earth orbit.⁵¹ In order to minimize the generation of debris, operators may be asked to limit the launch of components of each space mission to only those that are absolutely necessary.⁵² This is also reflected in the Inter-Agency Space Debris Coordination Committee (IADC) approach.

⁴⁶ Rio Declaration on Environment and Development, 12 August 1992 (see n. 34 above).

⁴⁷ Sandin, Per. “Dimensions of the Precautionary Principle.” *Human and Ecological Risk Assessment: An International Journal*, V.5 (1999), p. 898.

⁴⁸ UNGA Resolution A/RES/70/82, 15 December 2015, preamble paragraph 9: “Deeply concerned about the fragility of the space environment and the challenges to the long-term sustainability of outer space activities, in particular the impact of space debris which is an issue of concern to all nations,” <https://documents-dds-ny.un.org/doc/UNDOC/GEN/N15/416/47/PDF/N1541647.pdf?OpenElement>.

⁴⁹ Munters, *ibidem*, p. 109.

⁵⁰ Stubbe, Peter. *State Accountability for Space Debris: A Legal Study of Responsibility for Polluting the Space Environment and Liability for Damage Caused by Space Debris*. Brill, Nijhoff, 2018, p.124.

⁵¹ Elena Cirkovic, "The Next Generation of International Law: Space, Ice, and the Cosmolegal Proposal" 21 *German Law Journal*, Volume 2 (March 2021).

⁵² B. Sandeepa Bhat. (2014). “Application of Environmental Law Principles for the Protection of the Outer Space Environment: Feasibility Study”. *Annals of Air and Space Law*, 39, 323-354.

Despite the applicability of these principles to space activities, and the call for a space environmentalism, there exists an absence of regulations explicitly doing so within State Parties to the Outer Space Treaty. In fact, State Parties do not appear to explicitly view Earth's orbital space as part of its environment and regulate it as such. That being said, State Parties do in fact regulate Earth's orbital space as an environment, though perhaps more in substance than name. For example, the regulation of space debris imposes obligations on public and private actors to mitigate the creation of space debris within Earth's orbital space or, preferably, Earth's orbital environment. Efforts to manage space situational awareness and space traffic management also address Earth's orbital environment in environmental terms.

Consequently, if a shift in perspective could be achieved so as to perceive Earth's orbital space as part of the natural environment, the principles of International Environmental Law discussed here could be extended and applied to the preservation of the space environment and its protection from both space debris and from light pollution caused by space objects.

In any case, according to the preceding principles, it is increasingly clear that International Environmental Law is applicable to the natural environment as a whole, and not just to those parts that lie within the jurisdiction of particular States. Contamination must be avoided in those areas that are out of the jurisdiction of all States, including outer space, and certainly in the orbits around the Earth where 'mega-constellations' are located.⁵³

⁵³ Andy Lawrence et al., "The case for space environmentalism", *Nature Astronomy* volume 6, pp. 428–435 (2022): <https://www.nature.com/articles/s41550-022-01655-6>: "In this Perspective, we summarize the case for considering the orbital space around the Earth as an additional ecosystem, subject to the same care and concerns, and the same broad regulations as the oceans and the atmosphere, for example. (...) Damage to the orbital space environment has problematic features in common with other types of environmental issue."

SECTION 3 - APPLICATION OF THE OUTER SPACE TREATY: ARTICLE VI

As commented by Peter Malanczuk, when Manfred Lachs gave his course at The Hague Academy of International Law on “The International Law of Outer Space” in 1964, the issue of different actors taking part in space activities was not really a concern for him.⁵⁴ Naturally, at that time the focus was on the role of States alone. Nowadays we find new actors involved in space activities, an area where the participation by private enterprises has become of great importance.

As Manfred Lachs observed, to extend the international legal regime governing States on Earth into outer space has a major consequence, viz. the extension of State responsibility. For this reason, it is essential to analyze international State responsibility and its application to commercial space activities and in particular, to the problem of ‘mega-constellations’ of satellites and light pollution.

As Ian Brownlie stated: “the law of responsibility is concerned with the incidence and consequences of unlawful acts, and particularly the forms of reparation for loss caused.”⁵⁵

Roberto Ago, from the initial steps of his work in this area, believed it essential to distinguish between “primary rules” and “secondary rules”. Primary rules establish primary obligations, and secondary rules, secondary obligations. Secondary obligations are those that originated from the breach of a primary obligation, and primary obligations are those imposed on States directly by International Law. Secondary obligations come into play when the “primary” ones are violated.⁵⁶

Article 1 of the International Law Commission’s Draft Articles on Responsibility of States for Internationally Wrongful Acts of 2001, as appended to GA Resolution 56/83, 12 December 2001, states that:

⁵⁴ Malanczuk, Peter: “Actors, States, International Organizations, Private Entities” in Lafferranderie, Gabriel (Editor in Chief): *Outlook on Space Law over the Next 30 Years*. Kluwer Law International: The Netherlands. 1997. P. 23.

⁵⁵ Crawford, James: *Brownlie’s Principles of Public International Law*. 9th Edition. Oxford University Press. 2019. P. 629.

⁵⁶ Ago, Roberto: *Second Report on State Responsibility (A/CN.4/233)*, 1970, para 11. See also Ago, Roberto: *Third Report on State Responsibility (A. CN. 4/246)*, 1971, para 15.

“Every internationally wrongful act of a State entails the international responsibility of that State”.⁵⁷

This article is consistent with the reasoning of the Permanent Court of International Justice in the *Chorzów Factory* case, which held that:

“It is a principle of international law that the breach of an engagement involves an obligation to make reparation in an adequate form. Reparation therefore is the indispensable complement of a failure to apply a convention, and there is no need for this to be stated in the convention itself.”⁵⁸

State responsibility is an essential element in the field of commercial space activities and in the light pollution problem. Therefore, it is necessary to analyze the effects of the general theory of law on Article VI of the Outer Space Treaty.

Bin Cheng recalls that in the negotiations leading to the conclusion of the Outer Space Treaty, the Soviet Union intended to restrict space activities to States only, excluding private entities, whilst the United States advocated the inclusion of private entities as well.⁵⁹ Article VI reflects a compromise between these two positions. The result is, to Bin Cheng, that non-governmental national space activities are assimilated to governmental space activities. As a result, the Soviet Union accepted the view that non-governmental entities may participate if they are authorized and supervised by the State with the consequent international responsibility of that State.⁶⁰

Article VI of the Outer Space Treaty, according to Krystyna Wiewiorowska, has been interpreted in several ways. In this sense this author quotes J. Rajski, who considers that “the Treaty of 1967 set a principle, according to which the exploration and exploitation of outer space and celestial bodies can be carried out only by subjects of International Law.” The same author, as Wiewiorowska explains, believes that the need for such a solution is justified on the one hand by the international implications of this kind of activity, and on the other, by the need for assuring that it will be carried out exclusively for purposes advantageous to mankind as a whole. A country may conduct this activity either directly or indirectly by authorizing

⁵⁷ https://legal.un.org/ilc/texts/instruments/english/commentaries/9_6_2001.pdf.

⁵⁸ See *Factory at Chorzów* (Merits), 1928 PCIJ (ser. A No. 17). Available at: https://www.icj-cij.org/sites/default/files/permanent-court-of-international-justice/serie_A/A_17/54_Usine_de_Chorzow_Fond_Arret.pdf.

⁵⁹ Cheng, Bin: “Article VI of the 1967 Space Treaty Revisited: International Responsibility, National Activities, and The Appropriate State” in *Journal of Space Law*. Vol. 26 No. 1. 1998. Pp. 14 ff.

⁶⁰ McMahon, J. F.: “Legal Aspects of Outer Space: Recent Developments”, in *The British YearBook of International Law - 1965-1966*. Oxford University Press. 1968. Pp. 423 ff.

subordinated natural or juridical persons. On the other hand, Marco Marcoff, also quoted by Wiewiorowska, states that “Le terme activités nationales, peut désigner, à part les activités étatiques, celles de toute personne soumise à sa compétence territoriale ou personnelle”. This author believes that “the authorization procedure should cover continuing State supervision as an indispensable condition for non-governmental entities to carry out outer space activities.”⁶¹

The rule under analysis establishes state responsibility for space activities carried out within national jurisdiction imposing an absolute duty of authorization and supervision over space activities not only for governmental entities activities, but also for non-governmental and international entities activities. Thus, this provision embodies a primary rule: “The activities of non-governmental entities in outer space...shall require authorization and continuing supervision by the appropriate State Party to the Treaty”.⁶² This duty is, therefore, imposed on States parties.

Having established the primary rule we may then focus on the various duties originated therefrom. Article VI lays down two kinds of duties. In first place it establishes the duty of “authorization,” which means “give formal permission to or for,” and in second place the duty of “supervision,” meaning “to keep watch over a job or activity as a person in charge”.⁶³ Moreover, the non-governmental entities must be authorized by the appropriate State Party to carry out commercial space activities following which they must be supervised by that same State. To comply with this primary rule, States should enact domestic legislation stating all the requirements to be fulfilled, agencies in charge of the duties, etc.

Stephan Hobe suggested the drafting of a separate instrument to govern the activities of private entities in outer space. This new instrument should call upon States to enact national legislation on commercial space activities.⁶⁴ Nandasiri Jasentuliyana does not coincide with Professor Hobe’s idea. This is so, in Jasentuliyana’s views, because States are internationally responsible whereas private entities require authorization and permanent supervision to engage in space activities.⁶⁵

⁶¹ Wiewiorowska, Krystyna: “Some Problems of State Responsibility in Outer Space Law” in *Journal of Space Law*. Volume 7. Number 1. Mississippi. 1979. Pp. 26, 27, 28.

⁶² Article VI of Outer Space Treaty.

⁶³ Longman: *Dictionary of Contemporary English*. New Edition. UK. 1992.

⁶⁴ See Williams, Maureen (Rapporteur): “Review of Space Law Treaties in View of Commercial Space Activities”. Space Law Committee. International Law Association. London Conference (2000). P.3.

⁶⁵ See Williams, Maureen (Rapporteur): “Review of Space Law Treaties in View of Commercial Space Activities”. Space Law Committee. International Law Association. London Conference (2000). Pp. 8

There is a problem of interpretation in connection with the term “national activities” contained in Article VI OST. Maureen Williams suggests, as a possible solution, to consider all the activities under the effective jurisdiction of the State as national activities for which it is internationally responsible.⁶⁶

Upon adoption of its Resolution on recommendations to States on national space legislation, the UN General Assembly pointed out that:

“The conditions for authorization should be consistent with the international obligations of States, in particular under the United Nations treaties on outer space, and with other relevant instruments, and may reflect the national security and foreign policy interests of States; the conditions for authorization should help to ascertain that space activities are carried out in a safe manner and to minimize risks to persons, the environment or property and that those activities do not lead to harmful interference with other space activities; such conditions could also relate to the experience, expertise and technical qualifications of the applicant and could include safety and technical standards that are in line, in particular, with the Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space.”⁶⁷

In this sense, in relation to light pollution problem, “The US position has always been that private agencies would not be free to engage in space programs without governmental permission and continuing governmental supervision”⁶⁸ and “It is also important to note here that the manner in which national laws implement a State’s international obligation relating to authorization and continuing supervision does not in any way affect the nature of that obligation under International Law.”⁶⁹

It is also important to consider the Guidelines for Long-Term Sustainability of Outer Space Activities. Guideline A.3 (supervise National Space Activities) provides that:

“2. States bear international responsibility for national activities in outer space and for the authorization and continuing supervision of such activities, which are to be carried

⁶⁶ Williams, Silvia Maureen. *Derecho Internacional Contemporáneo*. Abeledo Perrot. 1990. P. 22.

⁶⁷ UNGA Resolution 68/74 of 16th December, 2013, ‘Recommendations on national legislation relevant to the peaceful exploration and use of outer space’, at para. 4. Available at https://www.unoosa.org/oosa/oosadoc/data/resolutions/2013/general_assembly_68th_session/ares6874.html.

⁶⁸ NOIRLab, AURA, AAS: SATCON2 Policy Working Group Report. Published October 28th, 2021, Page 22. Available at <https://baas.aas.org/pub/q099he5g/release/1>.

⁶⁹ NOIRLab, AURA, AAS: SATCON2 Policy Working Group Report. Published October 28th, 2021, Page 23. Available at <https://baas.aas.org/pub/q099he5g/release/1>.

out in conformity with applicable international law. In fulfilling this responsibility, States should encourage each entity conducting space activities to:

- (a) Establish and maintain all the necessary technical competencies required to conduct the outer space activities in a safe and responsible manner and to enable the entity to comply with the relevant governmental and intergovernmental regulatory frameworks, requirements, policies and processes;
- (b) Develop specific requirements and procedures to address the safety and reliability of outer space activities under the entity's control, during all phases of a mission life cycle.”⁷⁰

The Outer Space Treaty does not establish the criteria to be followed by States in compliance with the primary rule of authorization and supervision regarding activities in outer space. Therefore, each State is free to choose the means of compliance within domestic legislation but, Article VI OST requires that “at least one State authorize and supervise its nongovernmental entities, and assure their continuing compliance with international law.”⁷¹

To sum up, in relation to the light pollution problem, States are internationally responsible for guiding private actors to ensure responsible and sustainable use of space. Also and foremost, they are responsible for their compliance with International Law and principles through the imposition of relevant requirements for the authorization and supervision of space activities.

⁷⁰ COPUOS, Guidelines for the Long-term Sustainability of Outer Space Activities, UN Doc. A/AC.105/2018/CRP.20 (27 June, 2018), available at https://www.unoosa.org/res/oosadoc/data/documents/2018/aac_1052018crp/aac_1052018crp_20_0.html/AC105_2018_CRP20E.pdf.

⁷¹ United Nations Office for Outer Space Affairs/International Astronomical Union/Instituto Astrofísico de Canarias, edited by Connie Walker (NSF's NOIRLab) and Piero Benvenuti (University of Padova/IAU): Dark and Quiet Skies for Science and Society II. Working Papers. Print production NSF's NOIRLab. 2022, p. 109. Available at <https://www.iau.org/news/announcements/detail/ann22002/>.

SECTION 4 - APPLICATION OF THE OUTER SPACE TREATY: ARTICLE IX

4.1. Introduction.

Dark skies have amazed humankind since the beginning of history and are often also associated with cultural practices in many regions of the Earth. Dark skies are not only essential for astronomy, but also vital for the proper functioning of natural eco-systems. However, the steady increase in the number of space activities and the rise of satellite ‘mega-constellations’ have posed a new threat of light pollution of the night sky, amongst other concerns.

Light pollution due to artificial objects in space makes access to dark skies difficult. For instance, current estimations of general light pollution by space objects suggest that it is already 10% higher than the natural light of the night sky. This implies crossing a “red line” of increased diffuse skyglow that had been predicted by the IAU back in 1979 and that seriously interferes with the astronomical work.⁷²

Light pollution due to artificial satellites impairs the functionality of telescopes tasked with planetary defense, and thus affects global security. As noted in the Report of the Dark and Quiet Skies for Science and Society Conference, satellite constellations risk causing delays in the identification of Near-Earth Objects, an event which may have widespread ramifications if that object is on an Earth-impact trajectory.⁷³

Light pollution of the night sky also has negative impacts on life on Earth. For instance, the navigational and migration cycles of many animal species depend upon the observation of stars in outer space.⁷⁴ Dark skies play a vital role in wildlife survival and the functioning of eco-

⁷² See e.g. M Kocifaj, F Kundracik, J C Barentine, S Bará, “The proliferation of space objects is a rapidly increasing source of artificial night sky brightness”, *Monthly Notices of the Royal Astronomical Society: Letters*, Volume 504, Issue 1, June 2021, Pages L40–L44, <https://doi.org/10.1093/mnrasl/slab030>.

⁷³ Report of the 2021 Dark and Quiet Skies Conference, pp. 119 ff. Available at: https://www.iau.org/static/science/scientific_bodies/working_groups/286/dark-quiet-skies-2-working-groups-reports.pdf.

⁷⁴ <https://www.nationalgeographic.com/animals/article/stars-milky-way-navigation-dung-beetles>.

systems and nature at large.⁷⁵ The US National Park Service recognizes the importance of dark night skies as “part of a complex ecosystem that supports both natural and cultural resources.”⁷⁶

The foregoing events are just some examples of harmful interference by increased light pollution in the peaceful exploration and use of the night sky. Increase in light pollution will certainly disrupt the natural functionality of Earth-based life and have harmful effects on Earth. With such growing present and potential concerns, it is most essential to protect the dark skies from light pollution.

States have freedom to explore, use and conduct activities in outer space, but such freedom is in fact limited by certain provisions of the Outer Space Treaty, 1967, namely Article IX, which essentially states that exploration and use of Outer Space shall be carried on a basis of cooperation and mutual assistance; due regard must be given to corresponding interests of all other State Parties; harmful contamination and adverse changes in the environment of the Earth must be avoided; appropriate measures shall be adopted when necessary; and consultations are to be carried out if outer space activities can cause harmful interference with other activities in outer space.

Although the protection of dark skies is not mentioned directly in the Outer Space Treaty, the *factum* of creating limitations on outer space activities can be interpreted to include the protection of dark skies. A closer analysis of the events which led to formation of Article IX OST, together with the text of Article IX itself, suggest that the intention of the Treaty-makers was to protect the interests and activities of States carried out on Earth, as well as in outer space.

⁷⁵ Frank Turina, “Protecting Night Skies and Naturally Dark Conditions in National Parks”, Visual Resource Stewardship Conference Proceedings, pp. 186, 189: <https://www.fs.fed.us/nrs/pubs/gtr/gtr-nrs-p-183papers/19-turina-VRS-gtr-p-183.pdf>; National Park Service, “Acadia’s Wildlife Need Dark Skies”: <https://www.nps.gov/articles/000/wildlife-night-sky-acadia.htm#:~:text=Night%20skies%20play%20an%20important,skies%20they%20need%20to%20survive,> stating that “Night skies play an important role in animal survival. Thirty percent of vertebrates and sixty percent of invertebrates are nocturnal, and require dark skies to hunt, mate, or migrate. As cities grow around the globe, light pollution limits wildlife’s access to the dark skies they need to survive. By protecting our night skies, Acadia National Park not only maintains an astounding view of the stars, but also preserves the cyclical rhythm of night and day that animals have depended on since the beginning of life on Earth.”

⁷⁶ Night Skies: Protecting the Night, National Park Service, <https://www.nps.gov/subjects/night skies/index.htm> (explaining the importance of dark night skies to the National Parks and the efforts they take to protect the night skies).

4.2. Article IX of the Outer Space Treaty – Description and Scope of Application.

Article IX is the provision of International Space Law that most readily applies to the problem that we are discussing here. In its relevant parts, Article IX states the following:

“In the exploration and use of outer space... States Parties to the Treaty shall be guided by the principle of cooperation and mutual assistance and shall conduct all their activities in outer space... with due regard to the corresponding interests of all other States Parties to the Treaty. (...) 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... would cause potentially harmful interference with activities of other States Parties in the peaceful exploration and use of outer space... 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... would cause potentially harmful interference with activities in the peaceful exploration and use of outer space... may request consultation concerning the activity or experiment.”⁷⁷

Article IX has been described by legal scholars as ‘vague,’ as it seems to open more questions than it gives clear answers, due to its programmatic formulation.⁷⁸ However, it has also been remarked that the entire Outer Space Treaty contains general principles rather than detailed rules.⁷⁹

⁷⁷ Outer Space Treaty, Art. IX.

⁷⁸ See e.g. Ivan A. Vlasic, “The Space Treaty: A Preliminary Evaluation”, *California Law Review*, vol. 55, No. 2 (May 1967), declaring that “the provisions of the OST relating to control over potentially harmful space activities are too general and rudimentary to offer adequate protection to the world community against the hazards brought about by recent advances in technology” (at p. 518); Stephen Gorove, “Contamination and the Outer Space Treaty”, 14 *Proceedings IISL* (1971), pointing out that none of the terms used in Article IX OST is defined, and attributing this lack of clarity to the fact that, at least in part, this Article resulted from a compromise between the Soviet Union and the United States proposals (at p. 64); Nicholas M. Poulantzas, “Legal Problems Arising Out of Environmental Protection of the Earth”, 14 *Proceedings IISL* (1971), declaring that “Article 9 is drafted in general terms” (at p. 76).

⁷⁹ Sergio Marchisio, “Article IX”, in Hobe, Stephan/Schmidt-Tedd, Bernhard/Schrogl, Kai-Uwe (eds.), *Cologne Commentary on Space Law (CoCoSL)*, Volume I, Carl Heymanns, Cologne 2009, at p. 170.

This article was an attempt to resolve the problem of reconciling the freedom of exploration and use of outer space with the need to ensure that no adverse effects and no harmful interference with other activities will take place as a result of such exploration and use.⁸⁰

From this provision, very largely patterned after the 1963 Declaration of Legal Principles, it seems that States Parties to the Outer Space Treaty must conduct all of their activities in outer space 1) with due regard to the corresponding interests of all other States Parties to the Treaty; 2) avoiding harmful interference with the activities of others; 3) avoiding the harmful contamination of outer space and celestial bodies, as well as adverse changes in the Earth's environment; and 4) engaging in international consultations whenever necessary.

In this sense, as previously noted, Article IX constitutes a limitation on the freedom of exploration and use of outer space provided for in Article I paragraph 2 of the Outer Space Treaty. Furthermore, the list of duties enumerated above, together with the reference that 'States Parties to the Treaty shall be guided by the principle of co-operation and mutual assistance' when exploring and using outer space, point towards the need to achieve a multilateral, negotiated solution to any problem that involves space activities, in conformity with the general spirit of the OST.

It is worth to recall here that for all purposes of the Outer Space Treaty, "activities in outer space" means all space activities, whether carried out by governmental agencies or by non-governmental entities (i.e. private companies and private organizations).⁸¹

Similarly, it is worth recalling that for all purposes of the Outer Space Treaty, "activities in outer space" include also any activities that may be carried out in space by international organizations. Both the international organization involved and the Member States are responsible for the activities carried out by the organization.⁸²

4.3. Article IX of the Outer Space Treaty – Key Terms.

The key terms used in Article IX that are relevant for our discussion are "space activity", "due regard", "harmful interference", "harmful contamination", and "appropriate consultations."

⁸⁰ Stephen Gorove, *ibidem*, p. 63.

⁸¹ Outer Space Treaty, Art. VI. See above, Section 3 on Article VI OST.

⁸² Outer Space Treaty, Art. VI and Art. XIII.

The notion of “due regard” has been identified as coming from International Air Law, while the term “harmful interference” derives from International Telecommunications Law.

4.3.1 Space Activity. The term ‘space activity’ is undefined and open to interpretation. The OST expressly mentions several generic activities such as ‘exploration and use of outer space’ and ‘launching of space objects’, which can be understood to be space activities. However, space activities are certainly not limited to those few that are expressly mentioned in the Treaty. A review of the literature and the national legislation suggest that space activities encompass the launching, operation and return of space objects (including the related command, control and guidance actions from Earth), as well as all activities that happen in outer space generally.⁸³

At the international level, the lack of a definition in the Outer Space Treaty means the term “space activity” or its functional equivalents must be derived from the treaty’s plain language, according to the Vienna Convention on the Law of Treaties (VCLT). Based on the plain language of the Outer Space Treaty, there cannot be any reasonable doubt that an act or conduct that an actor performs while physically present in outer space is a space activity. The treaty’s plain language does not, however, necessarily exclude a terrestrial act making use of outer space as a space activity. The lack of clarity on whether “space activity” can encompass terrestrial acts has resulted in some legal scholars and commentators suggesting that “space activity” is not a term of art, but is a “generic term and not necessarily restricted geographically or rather cosmographically to only what occurs in outer space including the moon and other celestial bodies.”⁸⁴

4.3.2 Due Regard. The notion of “due regard” refers to the performance of an act with a certain standard of care, attention or observance. It is taken from the 1944 Chicago Convention,⁸⁵ which empowered the International Civil Aviation Organization (ICAO) to develop principles and procedures for the safety of air navigation. Article 3 of the Convention exempts all State aircraft from ICAO procedures, but it requires such aircraft to fly with “due regard for the safety of civil aviation”. This sentence is understood as giving rise to a duty of due diligence upon operators of State and military aircraft to ensure the safety of the navigation

⁸³ Stephan Hobe, “Article I” in CoCoSL Vol. I, pp. 34ff; Stefan A. Kaiser, “When Cyber Activities are Space Activities”, 63 IISL Proceedings (2020), p. 306.

⁸⁴ Bin Cheng, ‘Article VI of the 1967 Space Treaty Revisited: “International Responsibility”, “National Activities”, and “The Appropriate State”’, 26 Journal of Space Law 7 (1998), p. 19. Cited at: Stefan A. Kaiser, *ibidem*, p. 298.

⁸⁵ Convention on International Civil Aviation (done 07 December 1944, entered into force 04 April 1947) 15 UNTS 295 (Chicago Convention).

of civil aircraft. In fact, the “due regard” rule remains the principal treaty obligation imposed upon States for the regulation of the flight of military aircraft, and it is applicable during times of peace and armed conflict.⁸⁶

Due regard has been described to mean “with the proper care or concern for”, or “to give a fair consideration to and give sufficient attention to all the facts. (...) Due regard promises respect, tempered by the reality that respect for all inevitably involves tradeoffs and judgments.”⁸⁷

From the perspective of the Outer Space Treaty, due regard should be understood as an obligation to take into account, both prior to and during space activities and experiments, the legal rights of other States Parties in the peaceful use and exploration of outer space. Outer space is a shared common in which all States have the right to access and use. The failure of a State to give due regard to the rights and interests of other States has the potential to result in harmful interference with other States space activities.⁸⁸

The requirement of “due regard” is indeed a qualification of the rights of States in exercising the freedoms in outer space, the Moon and celestial bodies. Outer space is to be explored and used with due diligence, taking into account the interests and rights of other States. The State must prove beyond a reasonable doubt that everything possible was undertaken to prevent a harmful act from occurring. States are bound to ensure that the exercise of their rights and freedoms in outer space does not interfere with, or compromise the safety of, space operations. To this end, States should avoid any measures aimed at hampering the space activities of other States. In this perspective, the freedom to use outer space means that a State is entitled to undertake activities that would not interfere with the activities of other States.⁸⁹

It has been claimed, on the other hand, that due regard does not necessarily mean “total or maximum regard”. Some interference, even harmful, can occur in the context of due regard. The existence of good faith consultations would serve as evidence of an effort to act with due regard.⁹⁰

⁸⁶ Sergio Marchisio, *ibidem*, p. 175.

⁸⁷ Andrea Harrington, “The relationship between ‘exploration’ and ‘use’: The due regard principle as a tool to protect space science”, paper presented at the 65th Colloquium on the Law of Outer Space, Paris, September 2022.

⁸⁸ Michael Mineiro, “Principles of Peaceful Purposes and the Obligation to Undertake Appropriate International Consultations in Accordance with Article IX of the Outer Space Treaty”, paper presented at the 5th Galloway Symposium, Washington, D.C., December 2, 2010.

⁸⁹ Sergio Marchisio, *ibidem*, pp. 175-176.

⁹⁰ Andrea Harrington, *ibidem*.

4.3.3 Harmful interference. The ITU Constitution bans harmful interference in the context of telecommunication services: “All stations, whatever their purpose, must be established and operated in such a manner as not to cause harmful interference to the radio services or communications of other Member States...”⁹¹

“Harmful interference” as used in Article IX appears to be a broader concept, covering all possible kinds, forms or instances of interference (not only radioelectric) causing or capable of causing significant harm with the peaceful space activities conducted by other States in outer space, deliberate or unintentional alike.

Another useful definition of harmful interference would be: “Harmful interference occurs when the interference is deep and/or long enough to deteriorate the services of the affected systems.”⁹² In principle, this definition refers only to harmful interferences caused on radio systems. However, the analogy to the problem examined here, i.e., the causation of optical interferences with ground-based astronomical instruments to the point of deteriorating their utility is very clear.

A limiting aspect of the first part of this clause is the reference to “other States Parties,” which apparently could imply that there is no obligation whatsoever to take into account the interests of States that are not parties to the OST. However, the fourth sentence of Article IX incorporates a broader scope by extending the protection to the activities of any State, not just activities of States Parties to the Treaty.⁹³

Another potentially limiting aspect of this provision is whether only space activities are protected, thereby excluding from any protection all activities that are conducted on the Earth’s surface. However, as noted hereinunder, the majority of authors trace back the origin of Article IX to certain experiments conducted in the early 1960s in outer space, such as West Ford, and therefore agree that the phrase “potentially harmful interference” includes large-scale space

⁹¹ Article 45 of the ITU Constitution. Also in the ITU Radio Regulations, ITU RR 1.169: “Harmful interference — interference which endangers the functioning of radionavigation service or of other safety services or seriously degrades, obstructs, or repeatedly interrupts a radiocommunication service operating in accordance with Radio Regulations”. <https://search.itu.int/history/HistoryDigitalCollectionDocLibrary/1.43.48.en.101.pdf>.

⁹² Rajat Acharya, «Satellite Signal Propagation, Impairments and Mitigation» (2017), available at: <https://www.sciencedirect.com/science/article/pii/B9780128097328000089>.

⁹³ S. Gorove, *ibidem*, pp. 64, 65.

activities and their consequences, whether intended or not, and whether suffered in outer space or on the Earth.⁹⁴

4.3.4 Harmful contamination. According to Article IX OST, all contracting parties are under the obligation to avoid “harmful contamination of outer space and celestial bodies and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter.” Again, the key phrase “harmful contamination” is open to interpretation and argument. It is not clear what kind of contamination is to be considered harmful.

In addition, the *travaux préparatoires* of Article IX show that the main intention of the drafters of this provision was to prevent the biological, chemical, or radiological contamination of celestial bodies (forward contamination) as well as the biological contamination of the Earth’s biosphere (backward contamination).⁹⁵ Therefore, strictly speaking, the obligation contained in Article IX to avoid harmful contamination of space and the Earth, such as the light pollution of the Earth’s night sky, would not apply to a problem that was unforeseen by the Treaty makers. But if interpreted in a broader sense, light pollution of the night sky could be understood to be a harmful contamination of outer space, or even an adverse change in the environment of the Earth (see below, 4.5.4).

By Article IX, States Parties are required to adopt appropriate measures where necessary to avoid those harmful effects, although the provision falls short of specifying what measures are appropriate and when must they be adopted.

4.3.5 Consultations. Finally, space activities that can cause harmful interference with activities of other States Parties are intended to be subject to international consultations. First of all, if a State has reason to believe that an activity or experiment planned by it or its nationals in outer space would cause potentially harmful interference with activities of other States Parties in the peaceful exploration and use of outer space, it shall undertake appropriate international consultations before proceeding with any such activity or experiment.

⁹⁴ See below, ‘Origin of Article IX’.

⁹⁵ J. I. Gabrynowicz & S. Langston, *ibidem*. This particular clause did not appear in the Declaration of Legal Principles. Its origin can be found in article 10 of the US draft proposal for an OST. See UN Doc. A/AC.105/32 (1966).

Consultations may also be undertaken at the request of the State that fears interference, or that is suffering such interference in its own activities.

Considering the structure of the last part of Article IX, the timing of the request for consultation by the States concerned seems to be quite different. In fact, the State conducting the activity or performing the experiment in outer space is required to enter into consultation prior to the authorization or commencement of an activity, while the State potentially affected can supposedly ask for consultation not only before, but also during the performance of such activity or experiment. In the end, consultation is recognised as a prerequisite for the effective environmental protection of outer space.

However, the phrase “reason to believe” that is included in the first case seems to give ample opportunity for any party to get around the obligation by being lax in censoring itself. There is no procedure outlined for the consultations; no indication of how many States a party has to consult; no provisions in case a request for consultation is turned down or, once initiated, consultations end in a deadlock; and no duty to follow another party’s (or international body’s) recommendations or requests as to stop an activity. Neither the Treaty designates an agency to which States should turn for the authoritative evaluation of proposed experiments.⁹⁶ In the second case (when the State that requires consultations is the one affected by the interference), it could be argued that, so long as there is a consultation going on, this particular requirement would be satisfied.⁹⁷ On the other hand, it could also be argued that simply conducting empty talks or an appearance of a consultation would not be enough; pursuing negotiations in good faith, genuinely taking into account the interests of other States Parties, and aiming to achieve a useful solution should be required elements of all international negotiations.⁹⁸ However, for the moment it is impossible to discern how exactly an international consultation under Article IX would be conducted, since so far no States have undertaken this type of measure.

⁹⁶ Ivan A. Vlastic, *ibidem*, pp. 517-8; Stephen Gorove, “Contamination and the Outer Space Treaty”, 14 Proceedings IISL (1971), p. 65. Gorove states that perhaps COSPAR or the UN Secretary General could have been included as a possible forum for carrying out the consultations. He also claims that “an international code of conduct regarding pollution from outer space” and “an international environmental control authority regarding space” are vital needs to be able to halt undesirable interference with the space environment. Vlastic also regrets the absence of a competent international control authority, something that could in practice render ineffectual the principle of consultation, and likewise proposes “the establishment of an international organ... to which all experiments and programs potentially harmful to the earth-space environment would have to be reported in advance, and whose determination in each case would be final.” (Vlastic, at p. 518).

⁹⁷ S. Gorove, *ibidem*, p. 65.

⁹⁸ International Court of Justice, Legality of the Threat or Use of Nuclear Weapons, Advisory Opinion, ICJ Reports 1996, at paragraph 99. <https://www.icj-cij.org/public/files/case-related/95/095-19960708-ADV-01-00-EN.pdf>

4.4. Origin of Article IX OST.

According to the Vienna Convention on the Law of Treaties, interpreting treaties invariably begins with the text of the agreement. As an additional or secondary source of information, it is also possible to examine the background of the treaty, including the *travaux préparatoires*, in order to find out what the original parties had in mind at the time of negotiating and drafting the instrument. This is particularly necessary where the text of the treaty does not yield a clear answer as to the scope of application of a specific provision. The circumstances under which the treaty was negotiated and the problem it was designed to solve can also shed light on terms many years after the treaty's initial adoption.⁹⁹

The genesis of Article IX is very much indebted to a specific crisis between the Soviet Union and the United States of America from 1961 to 1963. On 28 May 1963, this dispute led to a statement presented to the UN by the USSR entitled “Dangerous United States Activities in Outer Space,” in which the USSR complained that certain risky activities in space, in particular the West Ford Project, had been conducted by the US without consultation prior to its conduct.¹⁰⁰

The West Ford Project, also known informally as “Project Needles,” was an experiment in communications developed at the MIT's Lincoln Lab and carried out by the United States Air Force. It involved the launch and release on 12 May 1963 of several hundred million small dipoles (2-cm long copper needles) into medium Earth orbit (at an altitude of between 3,500 and 3,800 kilometres) for the purpose of creating an artificial belt or band of needles around the Earth which could reflect long-range radio waves from ground stations. This plan generated grave concern and a great deal of criticism. The USSR and other countries complained that this project had been conducted without prior consultation with the global scientific community. In their letter to the UN Secretary-General, the Soviet representatives sharply criticized the launching of West Ford copper needles which, in the opinion of a number of scientists, would make it more difficult to maintain contact with spaceships bound for the Moon and the planets.¹⁰¹

⁹⁹ David J. Bederman and Chimène Keitner, *International Law Frameworks*, 4th ed. (2016), pp. 38-39.

¹⁰⁰ UN Doc. A/AC.105/13, 28 May 1963, “Letter dated May 24, 1963 from the Permanent Representative of the Union of Soviet Socialist Republics addressed to the Secretary General”. See also UN Doc. A/AC.105/15, 7 June 1963, containing a “Letter dated June 6, 1963 from the Permanent Representative of the United States addressed to the Secretary General”.

¹⁰¹ Francis Lyall and Paul B. Larsen, *Space Law - A Treatise*, Ashgate Publishing, 2009, at pp. 297-8. The vast majority of those needles reentered the Earth's atmosphere harmlessly in the following years, although some

Other groups, such as the IAU and the Committee on Space Research (COSPAR) of the International Council of Scientific Unions (ICSU) demanded access and consultations in this project and other such projects to be carried out in future. As a reaction to West Ford Project, COSPAR had set up a Consultative Group on Potentially Harmful Effects of Space Experiments in May 1962.

Astronomers from the UK and from other countries, together with the Royal Astronomical Society, also protested this action and explained that the West Ford experiment had the potential to cause severe interferences that would ruin radio and optical observations of the sky.¹⁰²

Additionally, in the early years of the space race, both the US and the USSR detonated nuclear devices in orbit. Three US “Operation Argus” explosions were conducted over the South Atlantic between August and September 1958, while the “Starfish Prime” explosion occurred in July 1962 over the Central Pacific. Radiation from Starfish destroyed or crippled at least three satellites, both American and belonging to other nations, and effects from the detonation were also felt in certain areas of the Earth’s surface such as Hawaii. Similarly, three USSR tests were performed in October-November 1962 over Siberia.¹⁰³

Indeed, the attachment to the 1963 Soviet note also alluded to the Argus nuclear tests conducted by the USA in the summer of 1962. In its reply, the United States objected that the Soviet note contained many distortions, because scientific information relating to these experiments had been made available to the international community prior to the conduct of the experiment (the plan had first been announced in August 1960). The US added that high altitude nuclear tests had also been conducted the previous year by the USSR (no mention had been made by the Soviets of their own nuclear explosions in space).¹⁰⁴

clusters of West Ford needles still remain in orbit. For more information on West Ford, see The Harvard Crimson, “Project West Ford”, May 24, 1963: <https://www.thecrimson.com/article/1963/5/24/project-west-ford-pfour-hundred-million/>.

¹⁰² Bernard Lovell and Martin Ryle, “Interference to Radio Astronomy from Belts of Orbiting Dipoles (Needles)”, *Quarterly Journal of the Royal Astronomical Society* 3 (1962): 100-108; D.E. Blackwell and R. Wilson, “Interference to Optical Astronomy from Belts of Orbiting Dipoles (Needles),” *ibid.*, pp. 109-117; Hermann Bondi, “The West Ford Project,” *ibid.*, p. 99.

¹⁰³ Francis Lyall and Paul B. Larsen, *ibidem*, at p. 291, n. 73. For more information on the Argus Project, see the report “Operation ARGUS, 1958” prepared by the Defense Nuclear Agency as executive agency for the Department of Defense: <https://babel.hathitrust.org/cgi/pt?id=uiug.30112075683737&view=1up&seq=10&skin=2021>.

¹⁰⁴ Sergio Marchisio, *ibidem*, p. 172.

Due to mounting criticism on all these actions, an agreement was reached on 29 May 1963 on a recommendation that directed the attention of COPUOS “to the urgency and the importance of the problem of preventing potentially harmful interference with peaceful uses of outer space,” which the USSR interpreted as confirming the need for prior agreement on future space experiments.¹⁰⁵

Moreover, the United States Ambassador to the UN, Adlai E. Stevenson, announced that:

“The U.S. would conduct no more such experiments until the results of this one were fully analyzed, and in any case none without the proper scientific safeguards; the results of the experiment would be disclosed to interested scientists of all nations; prior consultations with scientists would precede any further activity of this nature; advance notice of the launching of such experiments would be given in accordance with the procedure recommended by the General Assembly.”¹⁰⁶

While this crisis was unfolding, on 11th September 1963, the *Institut de Droit International* (IDI) unanimously adopted a Resolution on the legal regime of outer space. With regard to experiments conducted in outer space, principle no. 12 of that Resolution stated:

“Scientific or technological experiments or tests in space which may involve a risk of modifying the natural environment of the earth, of any of the celestial bodies or in space in a manner liable to be prejudicial to the future of scientific investigation and experiment, the well-being of human life, or the interests of another State, necessarily affect directly the interests of the whole international community.”¹⁰⁷

Building on all these precedents, and on the basis of COPUOS’ work, the first step in the codification of general principles applicable to outer space activities was taken with the Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space, contained in UNGA Resolution 1962 (XVIII) of 13 December 1963, which was adopted without a vote, unanimously. Principle 6 of the Declaration establishes that:

¹⁰⁵ Sergio Marchisio, *ibidem*, p. 172. See also Joanne Irene Gabrynowicz & Sara Langston, “Chronological Survey of Art. IX Development”, A Supplement to the Journal of Space Law, Univ. of Mississippi, 2010.

¹⁰⁶ Quoted by Delbert R. Terrill Jr., “The Air Force Role in Developing International Outer Space Law”, Air University Press, May 1999, at p. 66: <https://media.defense.gov/2010/Sep/22/2001330058/-1/-1/0/AFD-100922-019.pdf>.

¹⁰⁷ *Institut de Droit International*, ‘Resolution concerning the Legal Regime of Outer Space.’ See the English text of this Resolution in *The American Journal of International Law*, vol. 58 (1964), pp. 118-120.

“In the exploration and use of outer space, States shall be guided by the principle of cooperation and mutual assistance and shall conduct all their activities in outer space with due regard for the corresponding interests of other States. If a State has reason to believe that an outer space activity or experiment planned by it or its nationals would cause potentially harmful interference with activities of other States in the peaceful exploration and use of outer space, it shall undertake appropriate international consultations before proceeding with any such activity or experiment. A State which has reason to believe that an outer space activity or experiment planned by another State would cause potentially harmful interference with activities in the peaceful exploration and use of outer space may request consultation concerning the activity or experiment.”¹⁰⁸

It is widely acknowledged that the fundamental principles of the 1963 Declaration are now part of customary International Law.¹⁰⁹

After 1963, both Project West Ford and the high-altitude nuclear tests were halted, due to the concerns of the scientific community, the criticism arising from States such as the USSR and the United Kingdom (which had lost its first satellite, *Ariel-I*, due to Starfish Prime¹¹⁰), and the ratification by the major atomic powers of the Nuclear Test Ban Treaty in August 1963 in Moscow, which forbid any further nuclear explosions in outer space.¹¹¹

On 20 May 1964, the Executive Council of the COSPAR adopted a Resolution, which was largely a response to international concern over the West Ford project, calling on its members in future to give advance information on experiments of this sort, and stating “that any future experiments with this general character be given the benefit of a thorough evaluation by the international scientific community and notably the International Astronomical Union in order to check in advance their harmlessness to other scientific research.”¹¹²

On the basis of the latter document, the STSC of COPUOS adopted a new recommendation urging all Member States proposing to carry out experiments in space to give full consideration

¹⁰⁸ Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space, UNGA Res 1962 (XVIII), 13 December 1963, Principle 6.

¹⁰⁹ Francis Lyall and Paul B. Larsen, *ibidem*, at p. 276.

¹¹⁰ <https://nssdc.gsfc.nasa.gov/nmc/spacecraft/display.action?id=1962-015A>.

¹¹¹ Treaty Banning Nuclear Weapons Tests in the Atmosphere, in Outer Space and Under Water (done 05 August 1963, entered into force 10 October 1963) 480 UNTS 44.

¹¹² COSPAR Executive Committee, Resolution on the Report of the Consultative Group of 16 May 1964, Appendix 2: “Statement on Belt of Orbiting Dipoles” (20 May 1964).

to the problem of possible interference with other peaceful uses of outer space. Member States were also to consider possible harmful changes in the natural environment caused by space activities, and seek a scientific analysis of the qualitative and quantitative aspects of those experiments from the COSPAR. These recommendations were to be read without prejudice to the recourse to international consultations as provided for in UNGA Resolution 1962 (XVIII).¹¹³

Thus, when the draft text of the Outer Space Treaty was submitted to the First Committee of the UN General Assembly in December 1966, the provision which was to become Article IX was present with all its final elements, as summarized by the report of the fifth session of the Legal Sub-Committee of COPUOS:

“(9) Observance of corresponding interests of other States in outer space; the conduct of exploration of outer space, including the moon and other celestial bodies, so as to avoid their harmful contamination and adverse changes in the environment of the earth; conduct of international consultations if an activity or experiment planned by a State or its nationals in outer space would cause potentially harmful interference with activities of other States.”¹¹⁴

At the time of the adoption of the Outer Space Treaty, Ambassador Arthur Goldberg, the United States representative to the United Nations General Assembly, stated that:

“The treaty also laid down some basic ground rules for peaceful co-operation among nations in the exploration and use of outer space, which it declared to be the province of all mankind. Article I stated that the exploration and use of outer space was the right of all States without discrimination of any kind and on a basis of equality. That provision, like the provision prohibiting national appropriation by claim of sovereignty, was a strong safeguard for those States which at present had no space programme of their own. The interests of such States were also protected by articles

¹¹³ COPUOS, Report of the Scientific and Technical Sub-Committee on the Work of its 3rd Session (22 May–05 June 1964), UN Doc A/AC.105/20, pp. 16 ff. (23 June 1964). See S. Marchisio, *ibidem*, p. 173; Bin Cheng, *ibidem*, p. 628. States have generally followed the recommendations of COSPAR and COPUOS, and later proposals to utilize space technology to change the Earth’s environment for supposedly “beneficial” purposes, such as for instance orbiting large reflecting satellites (dubbed “space mirrors”) to illuminate dark areas of the world at night or during Arctic winter (the Russian *Znamya* Project), or to deviate sunlight from the Earth in order to slow the progression of global warming (so-called “geoengineering”) were made public beforehand, and have never actually gone beyond the design stage.

¹¹⁴ Yearbook of the United Nations 1966, pp. 35-36, 38.

VII, IX and XI, which guaranteed them not only protection against damage, contamination and disturbances but also full participation in the progress of scientific research.”¹¹⁵

The latter’s reference to States that have no space programme and the general tone of his speech argues in favor of inclusion of all nations (whether spacefaring or not) and all of their activities, wherever they are located, within the general protection from “disturbances” provided by Article IX.

4.5 Article IX of the Outer Space Treaty – Applicability to the light pollution problem

4.5.1 Astronomy as a “space activity” or generally as an activity to be protected under Art. IX. Very large satellite constellations are certainly raising critical questions about space debris, space traffic management, and international and national legal frameworks that are relevant to the provisions of Article IX of the Outer Space Treaty. More specifically, the unexpected challenge posed by satellite constellations has raised an important yet rarely asked question, namely to what extent astronomy is contemplated, and protected, under International Space Law.¹¹⁶

A pertinent question in this context is whether astronomy, including ground-based astronomical observation, could be considered a “space activity” and thus be directly subject to the obligations of due regard, prevention of harmful interference, and engagement in international consultations contained in Article IX OST.

The lack of judicial decisions and the inconsistencies in the practice of States make it difficult to provide a definitive assessment. Only the views of some authors can be found and considered in this regard.

As already noted hereinbefore, there is no internationally agreed definition of space activities. However, the literature and the national legislation both suggest that space activities refer to human activities that happen in outer space generally.

Ground-based astronomy is not conducted in outer space, instead it is conducted on the surface of the Earth, so in principle it would not qualify as a space activity proper. Under such

¹¹⁵ UNGA Doc. 21st Session, 1st Committee, 1492nd Meeting (17 December 1966), at para. 8.

¹¹⁶ Giuliana Rotola & Andrew Williams, “Regulatory Context of Conflicting Uses of Outer Space: Astronomy and Satellite Constellations”, *Air & Space Law* 46, No. 4&5 (2021), pp. 545-568, at p. 546.

restrictive view, the due regard and the rest of Article IX obligations would not apply to the problem discussed in this Report. However, a number of reasons argue in favor of a more extensive interpretation that would admit ground-based astronomy as a space activity. Perhaps the most relevant reason is that astronomy is an activity of exploration that is clearly oriented towards outer space, so it would be covered under the expression “peaceful exploration of outer space” that is prevalent throughout the Outer Space Treaty.

As additional arguments, it has also been noted that astronomy conducted on the ground provides an important support to many space activities that are engaged in both exploration and utilization of outer space, including the crucial task of planetary defense of the Earth against the threat posed by near-earth objects. In addition, astronomy is conducted generally following a policy of open sharing of data and open access to all astronomical facilities, without discrimination of any kind, and for the benefit of all humanity, all in keeping with the spirit of international cooperation promoted by the Outer Space Treaty.¹¹⁷

But even if we concluded that ground-based astronomy is not a space activity proper, it is still an activity worthy of protection under the legal regime established by the OST. Under the current International Space Law regime, lives and property located on the surface of the Earth are thoroughly protected by OST Article VII and by the 1972 Liability Convention, which impose absolute liability on the launching state in case any injuries or damages are caused by a space object to third parties on the ground. Similarly, ground-based astronomy should also be protected from any space activities that are conducted without due regard and which may be causing a harmful visual interference in the night sky.

Referring to the origin of Art. IX, the nations aimed at protecting the peaceful activities in space and on Earth from the harmful and negative impacts of the experiment. The terms “exploration” and “use of outer space” are not restrictive in its application and could be understood to extend to the activities undertaken on Earth as well. Taking the above into consideration, ground-based astronomy, protection of pristine sites of dark sky observation and safeguarding an individual’s right to explore and use dark skies from Earth can be included under “exploration and use of outer space.”

¹¹⁷ These and other interesting arguments in favor of considering astronomy, whether ground or space-based, as a space activity falling under the scope of the Outer Space Treaty are provided by Rotola and Williams, *ibidem*, pp. 556-561.

In fact, at least one portion of this basic science, radio astronomy, is already protected by existing rules. Radio astronomy is considered a service for which provision is made in the Table of Allocations in the ITU Radio Regulations. Even so, radio astronomy continues to be subjected to interference from both terrestrial and orbital stations. The institution of nationally and internationally protected radio “quiet zones” serves to ameliorate this problem.¹¹⁸

In contrast to this –albeit limited– protection of the radio spectrum for purposes of fundamental scientific exploration conducted from the ground, there is no international or national regulation about the visual appearance of the night sky, or in more technical terms, we are lacking a specific regulation of the optical spectrum and the impact of the brightness of space objects. The general protection of other states’ activities from harmful interference and the obligation of due regard as established in Article IX OST is all that we have for the moment. A more detailed regulation –such as e.g. the rules on planetary protection that have been implemented for the purpose of avoiding the harmful contamination of celestial bodies– is missing.

However, the drafting history of Article IX OST and its direct predecessor (Principle 6 of the Declaration of Legal Principles adopted by the United Nations General Assembly in 1963) supports the idea of including ground-based astronomical observations in the activities to be taken into account when carrying out activities in outer space, as illustrated by the West Ford precedent.

Indeed, according to the analysis expressed above, a significant part of Article IX derives from West Ford. The main negative consequences of the copper needles experiment were to be felt on the ground, and not on other activities conducted in outer space proper. The impact caused by West Ford on radio astronomical observations was one of the reasons to discontinue the experiment and add new provisions to the 1963 Declaration, which were subsequently incorporated into the 1967 Outer Space Treaty.¹¹⁹

4.5.2 Application of the “due regard” rule. Article IX of the OST lays down the duty on States to carry out activities with “due regard” respecting the “corresponding interests” of all

¹¹⁸ Lyall & Larsen, *ibidem*, at pp. 282-283.

¹¹⁹ F. Lyall & P. Larsen, *ibidem*, pp. 297-8; S. Marchisio, *ibidem*, p. 172; Bin Cheng, “The 1967 Space Treaty”, *Journal du Droit International*, 95 (1968) No. 3, at p. 626. See also Howard J. Taubenfeld, “International Environmental Law: Air and Outer Space”, *Natural Resources Journal* Vol. 13, No. 2 (April 1973), pp. 315-326, making a reference to West Ford as well at p. 315, available at <https://www.jstor.org/stable/24880673>.

other States. This provision suggests that States parties to the OST have an obligation to implement activities in space with due regard to the corresponding interests of other States in respect of potential light pollution created by satellite constellations.

The term “due regard” has not been defined under the Outer Space Treaty, although a parallel can be drawn to the United Nations Convention on the Law of the Sea which states that freedom to explore high seas “shall be exercised by all States with due regard for the interests of the other States in their exercise of the freedom of high seas.”

When applied to the case at hand, the “due regard” principle mandates that States parties to the OST implement activities in space with due regard to (i.e. duly taking into account) the corresponding interests of other States that will be affected by the light pollution created by large satellite constellations. States are bound to ensure that the exercise of their rights and freedoms in outer space does not interfere with the space activities of other States.

The Permanent Court of Arbitration stated in 2015 that “the ordinary meaning of “due regard” calls for [the first State] to have such regard for the rights of [the second State] as is called for by the circumstances and by the nature of those rights. The Tribunal declines to find in this formulation any universal rule of conduct. The Convention does not impose a uniform obligation to avoid any impairment of [the second State’s] rights; nor does it uniformly permit [the first State] to proceed as it wishes, merely noting such rights. Rather, the extent of the regard required by the Convention will depend upon the nature of the rights held by [the second State], their importance, the extent of the anticipated impairment, the nature and importance of the activities contemplated by [the first State], and the availability of alternative approaches.¹²⁰ Considering the definition by the Arbitral Tribunal, there would be no universal rule of conduct for due regard, which could also be interpreted as to carrying out activities respecting national and international legal and other obligations.¹²¹

The term “corresponding interests” has a broad scope that would encompass all lawful rights and interests pertaining to other States. It could also be understood as being inclusive and applicable to not just human beings but also animals and other organisms. Further, it is not restrictive in terms of location and is applicable to activities and interests of other states on

¹²⁰ The Chagos Marine Protected Area Arbitration (Mauritius v. U.K.), Case No. 2011-03, Award, at 519 (Perm. Ct. Arb. 2015). Available at: https://legal.un.org/riaa/cases/vol_XXXI/359-606.pdf.

¹²¹ Michael Mineiro, “FY-1C and USA-193 ASAT intercepts: An Assessment of Legal Obligations Under Article IX of the Outer Space Treaty” (2008) 34 J. Space L. 321, 333.

Earth or in outer space, thus extending protection to ground based exploration and use of outer space, including astronomy.

Due regard, then, is (at least theoretically) a valid international legal obligation that must be respected in all space activities. In practice, however, States have not been invoking Article IX's due regard principle as an enforceable international obligation that imposes legal constraints on space activities. Indeed, little to no State practice exists of States asserting a breach of the due regard obligation in space. It has been noted how, "in the past, destructive ASAT tests and operations in particular have not prompted legal objections based on the due regard principle... If this [ASAT tests] is not enough for States to start asserting the relevance of Article IX's due regard obligation, then it is fair to ask if States are, in effect, asserting its irrelevance."¹²²

With this caveat in mind, as a valid provision that is embodied in a legally binding international agreement, States Parties to the OST have an obligation to act with due regard and consider the corresponding interests of other States in respect of all the potential problems created by large satellite constellations; and this includes the issue of light pollution of the night sky. The way to put in practice this duty would be for the different States involved to adopt standards that take into account the impact of satellite constellations on ground-based astronomy, in order to reduce that impact as much as possible.

Any international and national guidelines and rules that may be developed to address that impact could make a reference to the obligation to act with due regard, to create a clear nexus with Article IX OST.¹²³

4.5.3 Application of the harmful contamination provisions. As already noted above, a first reading of the "harmful contamination provisions" does not seem to favor their application to the problem of light pollution of the night sky caused by space objects.

However, by making an extensive and dynamic interpretation of this provision, it could be argued that light pollution caused by space objects is a kind of harmful contamination of outer space itself. Pollution may be defined as "a human alteration of the environment by the

¹²² John Goehring, "The Russian ASAT Test Caps a Bad Year for the Due Regard Principle in Space", Just Security, January 12, 2022, at: <https://www.justsecurity.org/79820/the-russian-asat-test-caps-a-bad-year-for-the-due-regard-principle-in-space/>.

¹²³ Andrea Harrington, *ibidem*.

introduction of undesirable elements or by the undesirable use of elements.”¹²⁴ From this point of view, there is no doubt that light pollution is an “undesirable use of elements” that amounts to a harmful contamination of outer space, in a similar category as the proliferation of space debris, the biological, chemical or radioactive contamination of celestial bodies, and other kinds of harmful influence that might be exercised upon the space environment.

Light pollution caused by space objects could even be argued to be an adverse effect on the Earth’s environment through “the introduction of extraterrestrial matter” (the undesirable extraterrestrial matter in this case being sunlight collected in space and reflected downwards by the satellite constellations), and thus something that should also be avoided as per Article IX OST. Such extensive but in our opinion still admissible interpretation of Article IX would create an obligation *erga omnes* not to pollute the Earth’s surface in any manner with light pollution from outer space.

When it comes to non-governmental activities in outer space, once again, the way to comply with this international obligation would be for the different States involved in the authorization of satellite constellations to adopt licensing conditions that take into account the environmental impact of those constellations.

In this context it is worth remembering that the US Federal Communications Commission has been tasked with the reduction of the creation of new space debris and the pollution of earth’s orbit by these satellite constellations, and it is accordingly updating its orbital debris mitigation rules.

Also, the United Kingdom’s Outer Space Act of 1986 includes, among the conditions imposed on private operators in order to obtain a license for space activities, the requirement that their operations be conducted in such a way as to prevent contamination of outer space or adverse changes to the environment of the Earth.

The section of Article IX regarding non-contamination could also open the way –in conjunction with Article III OST– to the application of International Environmental Law principles in outer space.¹²⁵

¹²⁴ S. Gorove, “Legal Aspects of Pollution and Outer Space”, 14 Proceedings IISL (1971), p. 65.

¹²⁵ The applicability of IEL to the problem of light pollution is treated more in depth in Section 2 of this Report.

4.5.4 Application of the international consultation provision. The last part of Article IX deals with a mechanism of consultation with regard to the avoidance of potentially harmful interference in outer space, including the Moon and other celestial bodies. Firstly, a State that plans an activity or experiment has the obligation, before proceeding, to undertake appropriate international consultation with other States parties if it has reason to believe that such activity or experiment would cause potentially harmful interference to the activities of such other States parties in the peaceful exploration and use of outer space. This obligation shall be fulfilled also when the activity or experiment is planned by its nationals. Secondly, a State potentially affected by an activity or experiment planned by another State has the capacity to request that the latter enter into consultations concerning the activity or the experiment that would cause potentially harmful interference.

Following the previous reasoning that traces the origin of many of the provisions of Article IX to the West Ford Experiment and other large-scale experiments carried out in LEO, then we should conclude that activities conducted in outer space that cause a harmful interference to other space activities, including the exploration of outer space conducted from the ground, or alternatively cause a harmful interference with activities on the Earth's surface such as astronomy, are subject to this obligation to engage in international consultations, either by the State causing the interferences or by the State that is suffering them. When applied to our case, States Parties to the OST have an obligation to enter into consultations with other States as a result of the potential light pollution created by satellite constellations.

Nevertheless, as noted by the authors of the Dark and Quiet Skies I Report, the foregoing arguments remain theoretical because of the vagueness of the provisions of Article IX, and because of the absence of any judicial cases where such arguments have been applied to astronomy.¹²⁶

Also, when the OST was adopted, some authors already pointed out that the duty of prior consultation would be hard to apply in practice, since it rests on the somewhat subjective premise that the Party undertaking the experiment or activity “had reason to believe” that it would cause potentially harmful interference.¹²⁷ The highly discretionary nature of this expression means that, if a government in charge of licensing a satellite constellation is the one

¹²⁶ Report of the Dark and Quiet Skies for Science and Society Workshop (2020), p. 157. Available at: <https://www.iau.org/static/publications/dqskies-book-29-12-20.pdf>.

¹²⁷ Bin Cheng, “The 1967 Space Treaty”, *Journal du Droit International*, 95 (1968) No. 3, at p. 626.

to determine whether this activity may cause harmful interference or not, then that government could easily argue that there was no reason to believe that any interference would occur, and therefore there was no need for prior consultation with other States Parties.

Indeed, the wide margin of interpretation of the consultation obligation allowed by Article IX poses a significant obstacle. A commentator has noted that, at the very least, affected States should be provided with information sufficient to take appropriate action to prevent potentially harmful interference with their peaceful activities in outer space. However, an analysis of State practice of Article IX in the field of military activities, in particular ASAT and weapons testing, indicates that consultation with other States prior to these high-risk experiments is seldom if ever practiced.¹²⁸

In practice, there have been no cases so far of States formally demanding international consultations because of activities conducted in outer space that are perceived as “risky” or as causing potential interferences. The only case that came close to this was the Note verbale dated 3 December 2021 from the Permanent Mission of China to the United Nations Office in Vienna addressed to the Secretary-General, whereby China complained of the danger posed to its astronauts by close encounters with Starlink satellites in LEO. The note however was not based on Article IX OST. It invoked instead Article V OST, which provides that “States Parties to the Treaty shall immediately inform the other States Parties to the Treaty or the Secretary-General of the United Nations of any phenomena they discover in outer space, including the Moon and other celestial bodies, which could constitute a danger to the life or health of astronauts”. In accordance with Article V, China informed the Secretary-General of two close encounters with Starlink satellites, which constituted dangers to the life or health of astronauts aboard the China Space Station.¹²⁹

4.6. Conclusions.

It is fair to conclude that, by virtue of OST Article IX, ground-based astronomy should be protected against space activities that are causing “harmful interference” and “adverse changes in the environment of the Earth”, as required by the provision; or that are “prejudicial to the future of scientific investigation and experiment, the well-being of human life, or the interests of another State,” to put it in the words used by the IDI’s Resolution back in 1963; or that are

¹²⁸ Michael Mineiro, *ibidem*; John Goehring, *ibidem*.

¹²⁹

https://www.unoosa.org/res/oosadoc/data/documents/2021/aac_105/aac_1051262_0_html/AAC105_1262E.pdf.

causing “contamination and disturbances,” to use the words used by Ambassador Goldberg during the adoption of the Outer Space Treaty back in 1966.

The impact or effect of space objects on the environment of space is a matter clearly within the responsibility and competence of States that license space activities, in accordance with Article VI of the Outer Space Treaty. In the consideration of whether to license a space activity such as a satellite constellation, the practice of due regard to the corresponding interests of others, the prevention of harmful interferences with other space activities, and the prevention of harmful contamination of outer space through light pollution, should all be important requirements to be imposed on private operators by all nations.

Similarly, any potential harmful interference to the interests of other States should trigger consultations with the potentially affected States, although in this case the obligation is vague –the Treaty does not prescribe any procedure or any outcome for these consultations– and the margin for opting out of the obligation is wider, particularly with regard to the duty of prior consultation. We also suffer here from the lack of any previous State practice in initiating international consultations under Article IX.

An update should be added after the webinar organized by IISL on June 2, 2023. The very pertinent question was asked by some participants concerning which would be the best way to “tighten” or ascertain the meaning of the terms contained in Article IX and how to apply them in practice.

As rightly pointed out during the webinar, it is not desirable trying to amend the Outer Space Treaty in order to make Article IX more precise. Opening now the OST to a new negotiation poses some dangers – some of the main principles contained in the Treaty could also be questioned. As a result, the Treaty and the rule of law in outer space would be weakened instead of reinforced.

As noted during the webinar, the way to interpret the terms and apply properly Article IX would be having a suitable international body to develop some technical rules or standards aimed to prevent harmful interference, in this case optical interference, that are acceptable for all States Parties. This could follow the model of COSPAR’s planetary protection policy that has served to implement in practice Article IX’s provisions against the contamination of celestial bodies and the Earth’s biosphere.

SECTION 5 - NATIONAL LAWS AND REGULATIONS ON LIGHT POLLUTION MITIGATION

5.1 National laws and regulations - Introduction

According to Recommendation 40 of the Dark and Quiet Skies for Science and Society Workshop, addressing international policymakers, “Policymakers are encouraged to contemporaneously develop international agreements, on the one hand, and national laws within their respective legal frameworks, on the other hand, relating to reflected or emitted electromagnetic radiation from satellites, its impacts on science (particularly, but not exclusively, astronomical science), and efforts to mitigate (if not eliminate) the deleterious aspects of such impacts.”¹³⁰

International regulations and guidelines (established within the framework of the International Telecommunication Union) do exist, as well as national laws and regulations, protecting radio astronomy from harmful radio electric interference caused by space objects.¹³¹

However, as of this writing there are no known domestic or national laws addressing the impact of reflected sunlight from space objects, or imposing limits on satellite operators with regard to the optical interference caused by space objects. As a single exception, there is one national law regulating obtrusive space advertising, which does not exactly apply to our problem, but it constitutes an interesting precedent in terms of the protection of the global night sky.¹³²

On the other hand, numerous national laws and regulations for the local protection of dark skies exist around the world addressing the important, related problem of ground-based Artificial Light At Night (ALAN), and forbidding or limiting light pollution in general. These laws reflect an *opinio iuris* of many States in terms of acknowledging the immense value of dark skies, and they constitute a significant precedent for establishing a worldwide protection of the

¹³⁰ Report of the 2020 Dark and Quiet Skies Workshop, at p. 157. Available at: <https://www.iau.org/static/publications/dqskies-book-29-12-20.pdf>.

¹³¹ www.itu.org. On the international protection of radio astronomy, see e.g. [RA.769 : Protection criteria used for radio astronomical measurements \(itu.int\)](#).

¹³² In 2001, a study on the environmental impact of space activities on astronomy was presented by the International Astronomical Union (IAU), with a background paper submitted to the Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space (COPUOS). The study was considering the detrimental effect of obtrusive space advertising on astronomical observations, and underlined how, with increasing activities in space, commercial and non-commercial, a qualitative change in the environmental conditions for astronomy was taking place, causing a gradual loss of the pristine night sky. With this awareness, the IAU encouraged COPUOS member states to adopt legislation prohibiting any form of obtrusive space advertising. The only resulting legislation was the one adopted by the United States, which will be examined in some more detail below under 5.2.

night sky. It is essential to emphasize that, lacking such worldwide protection, the increasing brightness of space objects will be defeating the purpose of all these laws, and rendering them useless in practice.

This section of the Report includes a brief analysis of existing laws protecting the dark skies. The purpose is to show the action that has already been taken towards mitigation of light pollution of the night sky as a general problem across many different jurisdictions. The contents of this particular section are not necessarily Space Law or astronomy-related but are very close to the problem of light pollution of the night sky caused by space objects.

5.2 Regulatory framework for light pollution mitigation

1. Introduction. A substantial number of research findings on the negative effects of light pollution on the environment, biodiversity, astronomy, climate change, energy efficiency, etc. did not go unnoticed within the regulatory framework. The legislation towards light pollution mitigation started to evolve in the second half of the previous century.¹³³ The first dark sky protection law was adopted in Flagstaff, Arizona, USA in 1958. At the initial stage, legal regulations against light pollution were aimed at providing the minimum necessary conditions for the implementation of astronomical activities and maximizing energy efficiency while using outdoor nighttime lighting.¹³⁴ At the dawn of the new century, under the influence of the rapid increase of artificial light at night (ALAN), other issues began to emerge and resulted in a noticeable deterioration in the state of the natural environment. The latter became a call for action to amend the existing lighting regulations to protect the dark skies.

This section provides a brief overview of the current regulatory approaches to light pollution mitigation in different levels and jurisdictions, underlining the measures and principles adopted on this matter. The section also has a list of examples of different regulatory instruments aiming at addressing light pollution issues (Annex). In addition, based on the overview, conclusions and recommendations are drawn to facilitate further improvement of regulatory approaches.

¹³³ See for e.g., *Nightscape*, a Publication of the International Dark-sky Association, issue 90-91, 2013; p. 3 <https://www.darksky.org/wp-content/uploads/2015/06/NS90-91.pdf>; Portee David S.F., (2002), “Flagstaff’s Battle for Dark Skies”, *Griffith Observer*, <http://www2.lowell.edu/users/wes/GriffithObserver1crop.pdf>; Brown J. Michael, (1998), “Light Pollution”, *Environmental Law in New York*, Volume 9, No. 4, p. 60.

¹³⁴ See for e.g., Sec. 18-2 of the Night Sky Protection Act for the City Livingston, Montana (Ord. 1967, 4/3/06); Ordinance No. 440 of the city Flagstaff of 15 April 1958, etc.

2. International Framework. Although light pollution has long been a serious environmental, social and scientific concern, it has only recently been recognized as a transboundary issue, leading to actions within the international regulatory framework.

The first attempts to mitigate light pollution as an international problem were taken during the International Conference in Defence of the Night Sky and the Right to Observe the Stars held in La Palma, Spain on 19th and 20th April 2007. Individuals and representatives from diverse fields, including the International Astronomical Union (IAU), the United Nations Educational, Scientific and Cultural Organization (UNESCO), the United Nations World Tourism Organization (UNWTO), and the Convention on the Conservation of Migratory Species of Wild Animals (CMS), gathered together to draw attention to the protection of the dark skies. The International Declaration in Defence of the Night Sky and the Right to Starlight (Starlight Declaration) was a major outcome of the Conference.¹³⁵ It should be noted, however, that the Declaration is a non-binding document, thereafter, it does not create legally binding obligations. Despite that, it was a major starting point for the regulatory developments in the field of dark sky protection at the international level.

The Declaration highlights the significance of dark skies for historical and scientific development, the importance of the dark skies as the common and universal heritage of humankind, as well as an integral part of the environment essential for its proper functioning. Several principles and objectives were incorporated into the Starlight Declaration to address light pollution. The first principle is the recognition of the right to an unpolluted sky as an inalienable right of humankind, equal to other environmental, social, and cultural rights. Secondly, the Declaration proposed the implementation of light control measures within the environmental protection regulatory framework. Notably, the Starlight Declaration also indicated tourism as a potentially major instrument for a new alliance in defence of the quality of the night sky. Additionally, the Starlight Conference urged for international cooperation for light pollution mitigation, supported and encouraged research in the field of ALAN-induced impacts, and, finally, urged for the promotion of intelligent use of artificial lighting that minimises sky glow and avoids obtrusive visual impact. Upon the Conference, the Starlight

¹³⁵ [UNESCO/UNWTO/IAU/UNEP-CMS/Ramsar-Convention/COE/MaB](#), EC, International Declaration in Defence of the Night Sky and the Right to Starlight, adopted during the Starlight Conference, adopted in April 2007, during the International Conference in Defence of the Night Sky and the Right to Observe the Stars held in La Palma, Spain.

Foundation was established to continue actions towards the development and promotion of the Declaration.

While discussing the activities of international NGO organisations, the International Dark-Sky Association (IDA)¹³⁶ should also be mentioned. Founded in 1988 as an organization focusing on the protection of the dark skies for astronomical activities, it has grown into a global organization that contributes to, among others, amendments to regulatory frameworks concerning light pollution mitigation. The IDA supports changes to the lighting requirements, mainly through the incorporation of the Five Principles: (1) light should be useful; (2) light should be targeted; (3) low light levels; (4) light should be controlled; and (5) usage of the warmer color of lights.¹³⁷

In recent years, the discussion of this problem went beyond NGOs. The first international framework that took real action against light pollution was the Convention on the Conservation of Migratory Species of Wild Animals (the Bonn Convention, CMS) 1979.¹³⁸ The 13th Conference of the Parties (COP13) held on 15-22 February 2020 in Gandhinagar, India marked the recognition of artificial light as a threat to the conservation of wildlife, astronomy and human health. This was expressed in several documents that addressed light pollution. The main outcome was Resolution 13.5 “Light Pollution Guidelines for Wildlife.”¹³⁹ The Guidelines, inter alia, set a detailed procedure for the environmental impact assessment (EIA) for the effects of artificial light, particularly, on marine turtles, seabirds and migratory shorebirds. The latter was seen as a limitation since the scope of protection of the CMS is broader than the taxa of species mentioned in the Guidelines. In that regard, shortly after COP13, the Secretary and the Scientific Council were requested to elaborate and improve the adopted recommendations in terms of the inclusion of other migratory species protected by the Bonn Convention.¹⁴⁰ In March 2022, the draft of the new Guidelines was presented. The generic advice on the reduction of light pollution is the main distinctive feature of the new

¹³⁶ International Dark-Sky Association official website: <https://www.darksky.org/>.

¹³⁷ [Five Principles for Responsible Outdoor Lighting](#). Illumination Engineering Society (IES) and International Dark-Sky Association (IDA), 17 April 2022.

¹³⁸ United Nations Environment Programme (UNEP), Convention on the Conservation of Migratory Species of Wild Animals (CMS), 6 November 1979: <https://www.cms.int/en/legalinstrument/cms>.

¹³⁹ UNEP/CMS/Resolution 13.5 Light Pollution Guidelines for Wildlife and Annex to Resolution 13.5 CMS COP13 (Gandhinagar, February 2020).

¹⁴⁰ Yakushina Y. (2022) The response of the Bonn Convention on Migratory Species to light pollution; IOP Conf. Ser.: Earth Environ. Sci. 1099 012048; DOI 10.1088/1755-1315/1099/1/012048.

document. Importantly, this draft is still under working process and is subject to further elaboration before its adoption during the CMS COP14 in 2023 in Uzbekistan.

The current processes at the CMS agenda confirmed that the international community is concerned about light pollution and is ready to take the necessary steps towards its mitigation. Despite the shortcomings, such as the limited scope of protection and a lack of legal force of the adopted documents, the Convention plays an important role in regulatory developments on this issue. The close connection between all biodiversity-related conventions under the United Nations Environmental Program (UNEP), such as the Convention on Biological Diversity (CBD),¹⁴¹ provides such a possibility. A good example of this would be the current negotiations of the Post-2020 Global Biodiversity Framework taking place during the 15th meeting of the Conference of the Parties to the Convention on Biological Diversity (Part Two) (COP15 CBD) held on 7 – 19 December 2022 in Montreal, Canada. This framework will define targets and pathways for the conservation and sustainable use of biodiversity for the next decade and beyond. It is interesting to pay attention to the 2030 action targets, especially Target 7 related to the reduction of pollution from all sources to levels that are not harmful to biodiversity and ecosystem functions. Some Parties indicated the need to include light among the other sources of pollution.¹⁴² The final decision on whether light pollution will be included in the targets, however, will be known upon the results of COP15.

The brief overview of how the international framework addresses light pollution has shown that although the actions have been started, further developments are needed, especially in terms of binding decisions that will result in the adoption of dark sky protection laws at the national level as a consequence.

3. The European Union Framework. The European Union plays a key role in facilitating and enhancing regulatory provisions concerning, inter alia, environmental protection, climate change and energy efficiency. Despite a broad regulatory framework, the EU has not yet adopted direct measures against light pollution. Nevertheless, the continued increase in night-time illumination across Europe and a number of research findings on adverse impacts of ALAN have led to gradual steps towards dark sky protection at the EU level.

¹⁴¹ United Nations Environment Programme, Convention on Biological Diversity, 22d May 1992: <https://www.cbd.int/doc/legal/cbd-en.pdf>.

¹⁴² CBD/WG2020/4/L.2 26 Post-2020 Global Biodiversity Framework. Draft Recommendations recommendation submitted by the Co-Chairs. Fourth meeting of open-ended working group on the Post-2020 Global Biodiversity Framework in Nairobi, 21-26th June 2022: <https://www.cbd.int/doc/c/079d/0d26/91af171843b6d4e9bee25086/wg2020-04-1-02-annex-en.pdf>

Recently, the EU started to set new ambitious goals through its strategies and action plans. On 12 May 2021, the European Commission adopted the EU Action Plan: "Towards a Zero Pollution for Air, Water and Soil" a key deliverable of the European Green Deal.¹⁴³ The Action Plan defines several targets for the reduction of pollution levels so that it is no longer harmful to the environment and human health. Importantly, the Action Plan mentioned light pollution. The EU Commission encourages further research of ALAN-induced impacts on biodiversity and the inclusion of light pollution as a part of the integrated Zero Pollution Monitoring and Outlook Framework. As a part of the Zero Pollution Monitoring Assessment, on 11 November 2022, the Review and Assessment of Available Information on Light Pollution in Europe was published.¹⁴⁴ The main conclusion was that the terrestrial surface of Europe has experienced a net increase in artificial light exposure, especially in the Eastern regions. The latter confirms the necessity to take joint action against the problem.

Another important step towards light pollution reduction was initiated by the Czech Republic. On 1 July 2022, the Czech Republic took over the presidency of the Council of the European Union. The Ministry of the Environment has announced light pollution as one of its priorities for the Czech Presidency. The most notable event in this regard was an International Light Pollution workshop held in Brno on 26th October 2022.¹⁴⁵ The outcome of the workshop was a jointly adopted document, the "Brno Appeal to reduce light pollution in Europe",¹⁴⁶ calling on the European Commission to reduce light pollution. The Appeal calls upon the acknowledgement of light pollution as an issue of concern that creates additional pressure on the environment and human health. Among the proposed measures, the document indicates the need to address light pollution in the EU environmental policies and legislation, to evaluate the effects of ALAN in permitting procedures such as building permits and EIA, and to ensure the coherence amongst biodiversity, climate and energy policies and aligning them with light pollution control. In addition, the Appeal highlighted that light pollution should be subject to systematic monitoring to prevent and mitigate potential negative effects.

¹⁴³ EU Action Plan: "Towards a Zero Pollution for Air, Water and Soil" (and annexes); Brussels, 12.5.2021 COM (2021): https://ec.europa.eu/environment/pdf/zero-pollution-action-plan/communication_en.pdf.

¹⁴⁴ EEA ETC-HE Report 2022/8: 'Review and Assessment of Available Information on Light Pollution in Europe'. Available online: <https://www.eionet.europa.eu/etcs/etc-he/products/etc-he-products/etc-he-report-2022-8-review-and-assessmentof-available-information-on-light-pollution-in-europe>.

¹⁴⁵ International Light Pollution workshop in Brno: https://www.mzp.cz/en/light_pollution_workshop_2022.

¹⁴⁶ The "Brno Appeal to reduce light pollution in Europe" was adopted during the International Light Pollution workshop held in Brno, Czech Republic, on 26th October 2022: [https://www.mzp.cz/C125750E003B698B/en/light_pollution_workshop_2022/\\$FILE/OPZPURLight_Pollution_2022_Conclusions_EN-20221026.pdf](https://www.mzp.cz/C125750E003B698B/en/light_pollution_workshop_2022/$FILE/OPZPURLight_Pollution_2022_Conclusions_EN-20221026.pdf).

Current lighting requirements adopted at the EU level are focused on energy efficiency and do not address other impacts such as ALAN, and that, in turn, leads to a continuous increase in light pollution. On the other hand, the existing legal and policy instruments, especially from the area of nature conservation, such as the Habitats and Birds Directives, can be used for the protection of dark skies. This was clearly illustrated by a decision of the European Court of Justice in 2016.¹⁴⁷ The Court ruled that Greece did not comply with obligations under the Habitats Directive due to inaction towards reducing ALAN affecting sea turtles. Despite the absence of direct measures towards light pollution reduction, the new environmental challenge has started to become a concern in the political agenda. However, further interpretations of legislative provisions, regulatory amendments, as well as specific regulations against the adverse effects of ALAN, providing for environmentally-friendly requirements for light intensity, colour and radiation geometry, are needed to mitigate light pollution in the EU.¹⁴⁸

4. National Frameworks. Various national jurisdictions, in contrast to the international and the EU levels, have developed and adopted laws and policies directly aimed at the mitigation of light pollution. Due to the lack of a unified framework, the regulatory approaches to ALAN reduction are diverse. Below are some examples to highlight the differences between the approaches.

Germany is one of the most advanced countries in terms of legal recognition of light pollution. Light pollution is mainly addressed within the environmental protection framework. In 2021, the amendments to the Federal Nature Conservation Act (Bundesnaturschutzgesetz),¹⁴⁹ commonly referred to as the Insect Diversity Protection Act (Gesetzes zum Schutz der Insektenvielfalt),¹⁵⁰ were adopted. The new amendments, among others, aim to reduce light pollution since it is seen as a major driver of insect decline. The Act provides for a general ban on new street lighting and illuminated advertising systems in nature reserves, as well as in core and maintenance zones of biosphere reserves. Moreover, it sets a possibility for a restriction on the use of sky beamers and bans insect traps using artificial light sources. The new law also creates an obligation to install new outdoor ALAN with environmentally friendly bulbs. More detailed regulations, concerning the procedures, are adopted by the Ministry of the

¹⁴⁷ [European Commission v Hellenic Republic](#) (10 November 2016).

¹⁴⁸ Schroer, S.; Huggins, B.J.; Azam, C.; Hölker, F. “Working with Inadequate Tools: Legislative Shortcomings in Protection against Ecological Effects of Artificial Light at Night”. *Sustainability* 2020, 12, 2551. <https://doi.org/10.3390/su12062551> [https://www.mzp.cz/C125750E003B698B/en/light_pollution_workshop_2022/\\$FILE/OPZPURLight_Pollution_2022_Conclusions_EN-20221026.pdf](https://www.mzp.cz/C125750E003B698B/en/light_pollution_workshop_2022/$FILE/OPZPURLight_Pollution_2022_Conclusions_EN-20221026.pdf)

¹⁴⁹ [Federal Nature Conservation Act](#) 29 July 2009.

¹⁵⁰ [Insect Diversity Protection Act](#), 18 August 2021.

Environment and the Federal Agency for Nature Conservation (Bundesamt für Naturschutz). These new regulations came into force on March 1, 2022. In addition, Germany also addressed light pollution from wind energy farms. Germany became the first European state to introduce the “on-demand” approach to warning lights for wind energy turbines and made aircraft detection lighting systems (ADLS) compulsory for all wind farms: onshore until 12.31.2022 and offshore until 12.31.2023.¹⁵¹

Croatia has recently introduced a law specially focused on the protection of the dark skies – NN 14/2019 Act on Protection against Light Pollution (Zakon o Zaštiti od Svjetlosnog Onečišćenja).¹⁵² The adopted measures aimed at reducing all forms of light pollution, including skyglow, light trespass, and glare, to protect the environment and human health, considering biological, economic, cultural, health, security, and other factors. The law requires the development of a lighting plan and action plan for the construction and/or reconstruction of outdoor lighting, measures to prevent excessive light emissions, the direction of the light below the horizon, lighting monitoring measures and some other general rules for dark sky protection. More detailed provisions have been and will be enacted by Ordinances. The first adopted ordinance is the Ordinance on Lighting Zones, Permitted Lighting Values and Methods of Managing Lighting Systems.¹⁵³ The Ordinance, inter alia, provides for the establishment of lighting zones with maximally permitted lighting levels and strict requirements for energy-efficient lighting products. Two other required Ordinances, namely, on the Content, Formatting and Drafting the Lighting Plan together with an Action Plan for the construction and/or reconstruction of outdoor lighting and on the Measurement and Monitoring of Environmental Lighting are subject to adoption.

France approaches light pollution from different angles, namely, environmental protection, climate change mitigation and specific measures for dark sky protection. Light pollution is addressed in Law No. 2010-788 of July 12, 2010, on the National Commitment to the Environment (LOI n° 2010-788 du 12 juillet 2010 portant engagement national pour l'environnement).¹⁵⁴ ALAN emissions should be reduced to prevent disturbance of people and

¹⁵¹ General administrative regulation for the labelling of aviation obstacles, Decision of the Federal Council of Germany N15/20, February 14, 2020; § 9 Abs. 8 S.1 EEG 2017 and Energy Collection Act (“[Energiesammelgesetz](#)”) of 20 December 2018, Germany.

¹⁵² NN 14/2019 [Act on Protection against Light Pollution](#), 25 January 2019.

¹⁵³ NN 128/2020 Ordinance on lighting zones, permitted lighting values and methods of managing lighting systems (2020): https://narodne-novine.nn.hr/clanci/sluzbeni/2020_11_128_2442.html.

¹⁵⁴ Section 173 National Commitment to the Environment 12 July 2010 (LOI n° 2010-788 du 12 juillet 2010 portant engagement national pour l'environnement): <https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000022470434>.

the environment, as well as limit energy consumption. Specific requirements are introduced by the Decree concerning the prevention, reduction, and limitation of light pollution (Arrêté du 27 décembre 2018 relatif à la prévention, à la réduction et à la limitation des nuisances lumineuses).¹⁵⁵ The Decree sets several measures for both public and private lighting installations, such as (1) curfews; (2) upward light ratio; and (3) prohibition of light trespass. Interestingly, in the event of non-compliance with the provisions applicable to the lighting installations, administrative sanctions ranging from a formal notice to a suspension of the operation of the light sources can be imposed. These lighting regulations will become mandatory by 2025.

Similar to France, Spain has adopted various acts to address light pollution. The Law on Air Quality and Protection of the Atmosphere (Ley 34/2007, de 15 de noviembre, de calidad del aire y protección de la atmósfera)¹⁵⁶ defines light pollution as a source of atmosphere pollution. The Royal Decree on energy efficiency in outdoor lighting installations (Real Decreto 1890/2008, de 14 de noviembre, por el que se aprueba el Reglamento de eficiencia energética en instalaciones de alumbrado exterior y sus Instrucciones técnicas complementarias EA-01 a EA-07)¹⁵⁷ specifies the lighting requirements. The purpose of the Decree is to establish the technical conditions for the design, implementation, and maintenance of outdoor lighting installations to improve energy efficiency, reduce greenhouse gas emissions, mitigate nighttime glare or light pollution and reduce intrusive or disturbing light. The latter is ensured by several measures, set per different categories of outdoor lighting installations, such as road lighting, lighting of parks and gardens, parking, etc.

Moreover, Spain has an important piece of legislation aimed at protecting the quality of dark skies for astronomical activities in the Canary Islands: The Law on Protection of the Astronomical Quality of the Observatories of the Institute of Astrophysics of the Canary Islands (Ley 31/1988, de 31 de octubre, sobre Protección de la Calidad Astronómica de los Observatorios del Instituto de Astrofísica de Canarias, also known as “Ley del Cielo” or “Sky Law”) together with the accompanying Regulation R.D. 243/1992.¹⁵⁸ Significant public investments have been made by Spain and other nations on astronomical facilities located in

¹⁵⁵ [Decree concerning the prevention, reduction, and limitation of light pollution](#), 27 December 2018.

¹⁵⁶ [Law on Air Quality and Protection of the Atmosphere](#), 15 November 2007.

¹⁵⁷ [Royal Decree 1890/2008 on energy efficiency in outdoor lighting installations](#), 14 November 2008.

¹⁵⁸ [Law on Protection of the Astronomical Quality of the Observatories of the Institute of Astrophysics of the Canary Islands](#), 31 October 1988. More information on the “Sky Law” is available in English at: <https://www.unoosa.org/documents/pdf/copuos/stsc/2022/Part1.pdf>.

the Canary Islands, and this legislation has the goal to preserve the quality of the night sky in that area, mainly by imposing very strict rules on outdoor lighting. This law sets several requirements, such as: (1) prevention of light emissions above the horizon; (2) lighting control; (3) curfews; (4) control of lighting spectrum; (5) luminaires and lamps certification and other. The Law also restricts activities that might be a source of atmospheric pollution and degrade the quality of the local atmosphere, controls all potential sources of radioelectric contamination, and regulates air traffic over the Observatories, avoiding overflights. The Law sets up a Technical Office (OTPC) which is tasked with daily supervision and ensuring compliance with the rules. Implementation is also assured thanks to the support of the Spanish Government and the local municipalities. Spain has some other pieces of legislation on light pollution prevention at the regional level, such as Cantabria (Law No. 6/2006, Light Pollution Prevention Law) and Navarra (Law No. 10/2005, Law Regulating Lighting for the Protection of the Nightlife).

Huge investments on astronomical facilities have also been made in Chile. That country already has over 40% of the world's large telescopes, and the projected growth implies that Chile may be hosting almost 80% of the optical and radio astronomical observation facilities of the world by the year 2025. In this context, the need to protect the quality of the dark skies was recognized early on. Chile has an Emission Law for the Regulation of Luminic Pollution (DS 686/1998), which has been applied in the Northern Chilean territory since 1998. The latest version, which dates from the year 2020, incorporated the recommendations contained in the report of the Workshop on Dark and Quiet Skies that was held online in 2020.¹⁵⁹

US Congress passed in 2001 legislation prohibiting American companies and individuals from conducting “obtrusive advertising in outer space”. Now contained in the United States Code, it mandates that no license will be issued and no launch will be permitted for activities that involve “obtrusive space advertising.”¹⁶⁰ The latter is defined as “advertising in outer space that is capable of being recognized by a human being on the surface of the Earth without the aid of a telescope or other technological device.”¹⁶¹ Rationale for this law included aesthetic reasons as well as the protection of the night sky for astronomical observations.¹⁶² Besides this

¹⁵⁹ Statement made by the Delegation of Chile during the 59th session of the COPUOS STSC, Ambassador Belen Sapag, 14 Feb. 2022. Paper on file with the authors. See also at this respect: <https://ui.adsabs.harvard.edu/abs/2015IAUGA..2255571S/abstract>.

¹⁶⁰ 51 U.S. Code § 50911. See at: <https://www.law.cornell.edu/uscode/text/51/50911>.

¹⁶¹ 51 U.S.C. § 50902. See at <https://www.law.cornell.edu/uscode/text/51/50902> at (12).

¹⁶² <https://foundationsoflawandsociety.wordpress.com/2016/12/04/51-usc-%C2%A7-50911-space-advertising/>.

federal law, a number of US states plus Washington DC and Puerto Rico have enacted laws to reduce light pollution of the night sky at the local level. Federal agencies are now also taking affirmative steps to protect the sky at night from light pollution.¹⁶³

5. Conclusions and Recommendations. The conducted overview confirmed that light pollution is a growing concern in the legal and political agenda. Various jurisdictions started to adopt provisions to protect dark skies in different regulatory areas and levels. It is important to continue this trend and further facilitate the legal recognition of light pollution as an environmental problem.

The adopted regulations should especially provide for mandatory monitoring and lighting control measures to allow assessment of ALAN levels, as well as sanctions for non-compliance with the new lighting requirements.

Furthermore, acknowledging the transboundary character of the challenge, joint action to provide for a unified approach and binding obligations to mitigate ALAN levels at the international and the EU levels is necessary.

¹⁶³ <https://baas.aas.org/pub/2021i0205/release/1?readingCollection=b956c163>.

Annex

The list is provided to show examples of regulatory instruments that directly and indirectly address light pollution at different levels. The list is intentionally incomplete.

N	Name	Country/Framework	Measures
International level			
1	Resolution 13.5 Light Pollution Guidelines for Wildlife and its Annex (COP13 Convention on Migratory Species of Wild Animals) (2020)	UNEP CMS	Adverse impacts of ALAN were recognized. Encouraged the Parties to develop measures to mitigate light pollution. The Guidelines provide the theoretical, technical and practical information required to assess the effects of artificial light on wildlife and the management tools to minimise and mitigate these effects.
2	Resolution 8.6: Bats and Light Pollution (EUROBATS) (Doc.EUROBATS.StC14-AC23.18.Rev.1) adopted during the 14th Meeting of the Standing Committee and 23rd Meeting of the Advisory Committee (2018)	UNEP CMS EUROBATS	Recommended taking into account that artificial light has negative impacts on bats. Proposed the Guidelines on Environmental Impacts Assessment (EIA) procedures to address artificial light impacts on bats in lighting projects.
3	UNESCO/UNWTO/IAU/UNEP-CMS/Ramsar-Convention/COE/MaB, EC , International Declaration in Defence of the Night Sky and the Right to Starlight (2007)	International Declaration	Encouraged to develop measures to protect the dark sky due to its value for the environment, cultural heritage, science, history, human health and beyond.
European Union Level			

4	Directive 2000/55/EC of the European Parliament and of the Council of 18 September 2000 on Energy Efficiency Requirements for Ballasts for fluorescent Lighting (2000)	EU	Supports the use of energy-efficient light.
5	Commission Regulation (EU) 2019/2020 of 1 October 2019 on Ecodesign Requirements for Light Sources and Separate Control Gears (2019)	EU	Provides for several environmental lighting requirements that indirectly can facilitate light pollution reduction, such as shielding, as well as indicates the environmentally-friendly lighting metric, in terms of intensity, geometry and colour.
6	European Parliament Resolution of 9 June 2021 on the EU Biodiversity Strategy for 2030: Bringing nature back into our life (2021)	EU	Recognized harmful effects of light pollution. Calls the EU Commission to set ambitious targets for the reduction of ALAN levels.
7	EU Action Plan: "Towards a Zero Pollution for Air, Water and Soil" (and annexes); Brussels, 12.5.2021 COM (2021)	EU	Encourages further research of ALAN-induced impacts on biodiversity and the inclusion of light pollution as a part of the integrated Zero Pollution Monitoring and Outlook Framework.
8	Brno Appeal to reduce light pollution in Europe , adopted during the International Light Pollution workshop held in Brno, Czech Republic, on 26th October 2022	EU	Encourages the EU Commission to take action towards light pollution mitigation at the EU level.
National jurisdictions			
9	Federal Nature Conservation Act of 29 July 2009 amended by the Insect	Germany	Light pollution reduction is a part of nature conservation legislation.

	Diversity Protection Act of 18 August 2021		
10	NN 14/2019 Act on Protection against Light Pollution 25 January 2019 + Ordinances	Croatia	Broad regulatory framework to address light pollution to protect the environment, human health, cultural heritage and ensure energy efficiency.
11	Law No. 2010-788 of July 12, 2010 , on the National Commitment to the Environment (2010) Decree concerning the Prevention, Reduction, and Limitation of Light Pollution 27 December 2018	France	Light pollution should be reduced to prevent disturbance of people and the environment, as well as limit energy consumption. For these purposes several measures are adopted, such as: curfews; upward light ratio; CCT limitations; etc.
12	Law on Air Quality and Protection of the Atmosphere (2007) Royal Decree on energy efficiency in outdoor lighting installations (2008) Law on Protection of the Astronomical Quality of the Observatories of the Institute of Astrophysics of the Canary Islands (1988)	Spain	Light pollution is recognized as a concern for the environment, human health and astronomy. Several legal acts were adopted to ensure an excellent quality of dark skies to allow astronomical activities.
13	Decree on limit values due to light pollution of environment of 30 August 2007	Slovenia	Strong dark sky protection framework with a number of measures, such as limitations of lighting intensity, upward light output ratio and curfews. Currently, several amendments to the Decree are being discussed,

			including the obligation to reduce or completely switch off ALAN.
14	<p>Environmental Activities Decree concerning rules about activities in the physical living environment (2018)</p> <p>Environmental Activities Management Decree concerning general rules for the companies (2007)</p>	Netherlands	The regulations are mainly focused on the reduction of lighting nuisance introduced by the greenhouse horticulture sector and sports lighting.
15	<p>Act on Urgent measures in terms of energy saving for outdoor lighting and the fight against light pollution No. 751 (1996)</p> <p>Regional laws against light pollution: Lombardia 17/00, Emilia-Romagna 113/03, Marche 10/02, Lazio 23/00, Campania 13/02, Veneto 22/97, Toscana 37/00, Piemonte 31/00, Valle d'Aosta 17/98, Basilicata 41/00, Abruzzo 12/05, Umbria 20/05, Puglia 15/05, Friuli-Venezia Giulia 15/07, Liguria 22/07</p>	Italy	Light pollution is considered as any form of illumination of artificial light outside the areas intended to be lit, in particular towards the sky.
16	<p>Clean Neighbourhoods and Environment Act (2005)</p>	UK	The law does not tackle all forms of light pollution, focusing only on lighting nuisance.
17	<p>Act of the Czech National Council on Nature and Landscape Protection (1992)</p> <p>Methodological guidelines for the Environmental Impact Assessment (EIA) to prevent and reduce light pollution (2020)</p>	Czech Republic	The Czech Republic was the first EU country that adopted dark sky protection legislation back in 2022. The first regulations were focused on the reduction of light pollution in the territory of national parks. Some of the new measures adopted

			in 2020 include, inter alia, the use of lighting technologies friendly for the night environment; the light should be directed where it is necessary; low light intensity, etc.
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SECTION 6 - LIGHT POLLUTION OF THE NIGHT SKY AND LONG-TERM SUSTAINABILITY OF SPACE ACTIVITIES

6.1. Protecting Astronomy and Dark Sky from Light Pollution as part of Space Sustainability

The long-term sustainability (LTS) of outer space activities 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 as well.¹⁶⁴

Thus space sustainability basically reflects the capability of humanity to continue using outer space for peaceful purposes and socio-economic benefits in the long term.¹⁶⁵ It largely focuses on preservation of outer space so that the communities on Earth remain benefitted from space activities.

It is a principle that ensures a balance between economic and scientific development as well as the need to protect the outer space environment for the benefit and interest of mankind of both present and future generations.

Space sustainability focuses on the concept of *Intergenerational Equity* that also includes *Intragenerational Equity*. The former emphasizes on preserving the equitable access to outer space between two different generations namely the present and the future, while the latter focuses on the protection of rights to a beneficial environment for the interests of both developed and developing Countries. This principle has been acknowledged by the International Court of Justice (ICJ) in its *Advisory Opinion of Legality of the Threat or Use of Nuclear Weapons*.¹⁶⁶

When dealing with light pollution affecting astronomy, *Intergenerational Equity* can be applied to obligate the current generation to ensure that the natural characteristics of dark skies remain preserved for the benefits of the future generations. While *Intra-generational Equity* can be applied to mandate both the developed and developing countries to find a balance in

¹⁶⁴ Definition, objectives and scope of the guidelines, UNCOPUOS, Long Term Sustainability of Outer Space Guidelines (June 2019) at 5 (hereinafter, LTS Guidelines), available at: https://www.unoosa.org/documents/pdf/PromotingSpaceSustainability/Publication_Final_English_June2021.pdf

¹⁶⁵ Space Sustainability, Secure World Foundation, available at <https://swfound.org/our-focus/space-sustainability/>.

¹⁶⁶ (1996) ICJ Rep 226, at 244.

safeguarding the dark skies of Earth in the interest of the current generations, considering that there are many countries whose right to explore, use and perform scientific investigation of outer space may get affected due to light pollution. For some countries, astronomy might be the only means to access outer space, considering the cost and access to technologies and capabilities.

Astronomy plays a crucial role in scientific investigation and discovery. In fact, according to the United Nations, education and research activities in Astronomy and Astrophysics are considered basic space science and are among the initial steps for countries seeking to establish their own capacities in space technology and its application.¹⁶⁷ Astronomy is also regarded as a crucial activity to ensure the sustenance and survival of earth and its inhabitants. Astronomy plays an essential role in detecting Near-Earth Objects and other possible threats as an integral part of Space Situational Awareness and Planetary Defense. For example, NASA's Planetary Defense Coordination Office sponsors projects through its Near-Earth Object (NEO) Observations Program that employs a variety of ground- and space-based telescopes to search for NEOs, determine their orbits, and measure their physical characteristics.¹⁶⁸ If the observations of these telescopes get affected due to numerous light trails of satellites, then measures for Planetary Defense may get affected, causing a direct threat to the safety of earth.

Reiterating the importance of Astronomy, several international documents have called for States to preserve the space environment while conducting their space activities in order to safeguard Astronomy. One of the first such documents that called for States to be mindful of Astronomy while conducting space activities was the Resolution adopted by the IAU General Assembly in 1961.¹⁶⁹

In 1999, the UNISPACE III Conference emphasized that users of outer space should consider possible consequences of their activities to prevent irreversible actions affecting future utilization of Near-Earth/Outer Space, especially activities such as Astronomy.¹⁷⁰

Another document that emphasized on protecting astronomy from human impacts was the IAU background paper submitted to UNCOPUOS in 2001 on "Obtrusive space advertising and

¹⁶⁷ United Nations Program on Space Applications, United Nations Office for Outer Space Affairs, available at https://www.unoosa.org/pdf/publications/ST_SPACE_52_Rev1.pdf.

¹⁶⁸ NASA, Planetary Defense Coordination Office: <https://www.nasa.gov/specials/pdco/index.html>.

¹⁶⁹ Resolutions adopted by the XI General Assembly of the International Astronomical Union (1961), available at https://www.iau.org/static/resolutions/IAU1961_French.pdf.

¹⁷⁰ Report of the Third United Nations Conference on the Exploration and the Peaceful Uses of Outer Space, UN Doc. A/CONF.184/6 (October 19, 1999), available at https://www.unoosa.org/pdf/reports/unispace/ACONF184_6E.pdf.

astronomical research”.¹⁷¹ This subject was subsequently included as an agenda item at the COPUOS STSC in 2002,¹⁷² only to be later removed in the following year.¹⁷³

Following rising concerns of light interferences caused by satellite constellations, in 2020, the UNCOPUOS STSC heard the presentation made by IAU on “Impact of Mega-constellations of communications satellites”¹⁷⁴ and further the UN/IAU Dark and Quiet Skies included “Light Interferences caused by Satellite constellations” as an area of study. Subsequently, the two Dark and Quiet Skies Conferences reports were published in 2021 and 2022, offering some interesting policy recommendations.¹⁷⁵ The reports were also presented at the UNCOPUOS STSC session in February 2022 under the agenda item titled “General exchange of views on dark and quiet skies for science and society” and progressively some delegations also expressed their view for the inclusion of this item in the future sessions of the Subcommittee.¹⁷⁶

The presence of statements, reports, and positive initiatives are concrete indications of how serious the space community views this issue. While it is to be hoped that there will definitely be steps taken in the future to address this issue, however currently there is a lack of legal norms to protect dark skies from the light pollution caused by satellite constellations.

6.2. There is a lacuna in the current Space Law regime in addressing light pollution caused by satellite constellations

The 1967 Outer Space Treaty, often regarded as the Magna Carta of Space regulation, in its Article I defines outer space as “*the province of Mankind*” and states that all space activities are to be conducted “*for the benefit and in the interest of all countries*”. Under Article II, the Treaty emphasized on equal rights for all countries to access outer space by proscribing any exclusive appropriation of outer space by any State. Furthermore, as described in Section 4 of this Report, Article IX of the Treaty emphasizes on conducting Space operations in a non-interfering manner through consultation mechanisms. These provisions of the Outer Space

¹⁷¹ Obtrusive space advertising and astronomical research, Background paper by the International Astronomical Union. UN Doc. A/AC.105/777, available at https://www.unoosa.org/pdf/reports/ac105/AC105_777E.pdf.

¹⁷² Report of the Scientific and Technical Subcommittee, UN Doc. A/AC.105/786 (March 15, 2002), available at https://www.unoosa.org/pdf/reports/ac105/AC105_786E.pdf.

¹⁷³ Report of the Scientific and Technical Subcommittee, UN Doc. A/AC.105/804 (March 5, 2003), available at https://www.unoosa.org/pdf/reports/ac105/AC105_804E.pdf.

¹⁷⁴ Report of the Committee on the Peaceful Uses of Outer Space, U.N. GAOR 57th Sess., UN Doc. A/AC.105/1224 at p.29 (2020).

¹⁷⁵ Dark and quiet skies II for Science and Society Working Group Report II (January 11, 2022) available at <https://www.iau.org/news/announcements/detail/ann22002/>

¹⁷⁶ Report of the Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space, UN GAOR 65th Sess., UN Doc. A/AC/105/1258 p.36 (February 23, 2022)

Treaty ensure that outer space and its benefits remains open to all countries and all peoples, irrespective of their capacities to further space exploration, and that space activities are performed in a non-interfering manner, thereby emphasizing on space sustainability.

With respect to the terms “*benefits and in interest*” under the Article I of the OST, it was proposed that these terms are to be interpreted in a general sense rather than attach a specific or monetary value to it.¹⁷⁷ Thus extending such an interpretation of Article I to the operation of satellite constellations, it can be implied that operators of satellite constellations are under an obligation to protect the dark skies from light interference for astronomical activities, at least for the general benefit and interest of the countries and communities on Earth.

There has been some discussion on whether Astronomy itself constitutes a space activity under the scope of the OST. Despite suggestions to consider Astronomy as a space activity under the OST, it is evident that the Treaty does not specifically address the issue of light pollution caused by satellite constellations in the night sky.¹⁷⁸

It remains to be determined whether the term “harmful interference” under Article IX of the Treaty also includes light interference caused by the satellite constellations.¹⁷⁹ This lack of definition of the term has also been noted by statements made by Japan at the sessions of the Open Ended Working Group on reducing space threats through norms, rules and principles of responsible behaviors under the UNGA First committee in 2022.¹⁸⁰

While the Vienna Convention on the Law of Treaties (VCLT) in its Article 31 states that ‘*subsequent practices in application of the treaty can be taken into account for*

¹⁷⁷ Stephen Gorove, “Implications of International Space Law for Private Enterprise”, 7 *Annals Air & Space L.* 319, 321 (1982).

¹⁷⁸ Giuliana Rotola & Andrew Williams, “Regulatory Context of Conflicting Uses of Outer Space: Astronomy and Satellite Constellations”, *Air & Space Law* 46, no. 4&5, pp. 555-67 (2021).

¹⁷⁹ Sergio Marchisio, “Article IX”, in Hobe, Stephan/Schmidt-Tedd, Bernhard/Schrogl, Kai-Uwe (eds.), *Cologne Commentary on Space Law (CoCoSL)*, Volume I, Carl Heymanns, Cologne (2009); but see within this Report the Section 4 on Article IX, which intends to clarify its interpretation and its application to light interference.

¹⁸⁰ Statement by Japan at the First Session of the Open-Ended Working Group on reducing space threats through norms, rules and principles of responsible behaviours (May 9, 2022), available at <https://documents.unoda.org/wp-content/uploads/2022/05/Statement_JPN_Open-ended-working-group-on-reducing-space-threats_1st-session.pdf>; statement delivered by Ambassador Ichiro Ogasawara of the delegation of Japan to the Conference on Disarmament, Second Session of the Open-Ended Working Group on reducing space threats through norms, rules and principles of responsible behaviours (September 12, 2022) available at https://documents.unoda.org/wp-content/uploads/2022/09/Japan-statement-at-second-session-OEWG-space_2022.pdf.

interpretation',¹⁸¹ so far there is an absence of State practice to clarify whether light interference constitutes harmful interference under Article IX of the Outer Space Treaty.

Thus any initiatives and guidelines that promote practices of preserving Astronomy from interference from satellite constellations will be a welcome step, especially if such practices are recognized as consistent with the Outer Space Treaty. Both the UNCOPUOS Space Debris Mitigation Guidelines of 2007 and the UNCOPUOS LTS Guidelines of 2019 emphasize that space activities are to be conducted in consideration of or consistent with the OST.¹⁸²

It is for such a reason that the role of the UNCOPUOS Long Term Sustainability Guidelines in addressing this issue can also be analyzed, especially when practices towards the implementation of these Guidelines can help in clarifying the future interpretation and evolution of existing OST provisions and their jurisprudence.

6.3. The UNCOPUOS LTS Guidelines

The LTS Guidelines were adopted by COPUOS in 2019, after 9 years of deliberation through the Working Group on the Long Term Sustainability of Outer Space Activities that was convened under the COPUOS STSC in 2010 and chaired by Mr. Peter Martinez of South Africa.¹⁸³ The Guidelines were adopted considering the need to preserve the outer space environment from the challenges and hazards posed by space debris, space weather, and an increase in the number of satellites and space objects from space operators in the orbits around the Earth that are considered to be finite resources.

These are 21 guidelines that are voluntary and not legally binding under International Law.¹⁸⁴ They have been made so to facilitate flexibility for respective national thresholds and space policy considerations.

¹⁸¹ Art. 31 (3), Vienna Convention on Law of Treaties, entered into force May 23, 1969, 1155 U.N.T.S. 331.

¹⁸² Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space (2007), available at https://www.unoosa.org/pdf/publications/st_space_49E.pdf; Guidelines for the Long-term Sustainability of Outer Space Activities of the Committee on the Peaceful Uses of Outer Space (2019), available at https://www.unoosa.org/res/oosadoc/data/documents/2021/stspace/stspace79_0_html/st_space79E.pdf.

¹⁸³ Report of the Committee on the Peaceful Uses of Outer Space Scientific and Technical Subcommittee on its forty-seventh session, UN Doc. A/AC.105/958 (February 8-19, 2010), at p.26.

¹⁸⁴ Status of the Guidelines, UNCOPUOS LTS Guidelines, available at https://www.unoosa.org/res/oosadoc/data/documents/2021/stspace/stspace79_0_html/st_space79E.pdf.

The LTS Guidelines orient States, IGOs and private actors to ensure safety and security of the outer space environment and for such purposes promote international cooperation and engage in scientific development and capacity building.

There are 4 sections, namely:

- A- Policy and Regulatory Framework for Space Activities
- B- Safety of Space Operations
- C- International Cooperation, Capacity Building and Awareness
- D- Scientific and Technical Research and Development

The essential basis of the LTS Guidelines is to promote national implementation of these guidelines by State actors and IGOs through necessary rules, policies, programs, partnerships, regulations and legislations to facilitate safety and sustainability in outer space.

Since the LTS guidelines were adopted, various States have already begun implementing the Guidelines and have also shared their experiences and actions through Statements made at the COPUOS Plenary as well as at the STSC sessions each year. There is also “The Awareness-raising and capacity-building related to the implementation of the Guidelines for the Long-term Sustainability of Outer Space Activities” project initiated by the United Nations in partnership with the UK Government, that showcases how the LTS Guidelines have been implemented by various stakeholders so far.

6.4. Relevant Guidelines in the existing LTS framework addressing satellite constellations

There are not any explicit references to mitigating the impact of light interference caused by satellite constellations on Astronomy in the current set of LTS Guidelines: the final draft of 21 LTS Guidelines was agreed in February 2018, whereas the issue of light pollution caused by satellite constellations began to gather impetus in 2019. However, some of the existing Guidelines offer a good foundation to include practices that could be used to avoid or mitigate light interferences. These Guidelines are:

A.4. Ensure the Equitable, Rational and Efficient Use of the Radio Frequency Spectrum and the various Orbital Regions Used by Satellites

Guideline A.4¹⁸⁵ suggests that Member States implement measures to prevent harmful radio interferences and commit to the obligations assumed under the Radio Regulations and Constitution of ITU. Considering that radio frequencies and orbital slots are finite resources, the States shall adhere to the equitable access principle under Article 44 of the ITU Constitution¹⁸⁶ and avoid harmful interferences with reception and transmission of radio signals of other Member States under Article 45 of the ITU Constitution.¹⁸⁷

This guideline encourages States to ensure that the skies are quiet and free of radio interferences and that the orbital regions are used by satellites in an efficient manner.

In the future, the guideline can also be expanded to include the operators to prevent the impact of light interferences of satellite constellations as a part of a rational and efficient use of the orbital space around earth.

B.8. Design and Operation of Space Objects Regardless of their Physical and Operational Characteristics

This guideline¹⁸⁸ encourages States and IGOs to promote design approaches that increase the trackability of space objects and also encourages manufacturers and operators of space objects, to design objects in consonance with international and national space debris mitigation standards and/or guidelines, thereby limiting the long-term presence of space objects.

In the future, this particular Guideline can be expanded to focus on the design and operation of space objects to minimize their apparent magnitude in orbit. For example, the Darksats and Visorsats launched by Starlink did reduce the brightness of the satellites, and such measures in the future could be dealt with under the design and operation of space objects to mitigate light pollution.

C- International Cooperation, Capacity Building and Awareness

Considering the concept of intergenerational equity embodied by space sustainability, the guidelines under section C are the ones that make the LTS guidelines a living document, encouraging engagement and capacity building between established and emerging spacefaring

¹⁸⁵ Guideline A.4, UNCOPUOS LTS Guidelines, 2019.

¹⁸⁶ Constitution and Convention of the International Telecommunication Union entered into force 1 January 2000 U.N.T.S 1825, 1826, Art. 44

¹⁸⁷ *ibid* Art. 45.

¹⁸⁸ Guideline B.8, UNCOPUOS LTS Guidelines, 2019.

countries to make the national implementation practices of the LTS guidelines more accessible, inclusive and global.¹⁸⁹

This entire section deals with international cooperation in support of the Long Term Sustainability of Outer Space, sharing experiences related to LTS, and developing new procedures for information exchanges, promoting and supporting capacity building and raising awareness of space activities for societal benefits as well as conveying the importance of long term sustainability of outer space.

In the future, Section C of the LTS guidelines will become imperative to further the outreach activities that are necessary to build global consensus and share technical assistance for mitigating the visual impact caused by satellites in the night sky. The stakeholders could include various organizations such as the IAU, UNESCO World Heritage Committee, ITU, astronomical observatories around the world, and international, multilateral or bilateral initiatives between States and Intergovernmental Organizations.

D.1.- Promote and Support Research into and the Development of Ways to Support Sustainable Exploration and Use of Outer Space

This guideline is not restricted to any particular issues and focuses on long term sustainability as a broad objective.¹⁹⁰

Under this Guideline, new research and development could be promoted in the future by States and IGOs through the creation of scientific and inter-agency groups (akin to the Inter-Agency Space Debris Coordination Committee), working groups, and advisory bodies to review and research on new, efficient, and cost effective measures and redresses towards mitigating light pollution caused by satellites.

While these existing Guidelines can serve as an excellent foundation to include new practices within them, there could also be initiatives under the current UNCOPUOS Working Group on long-term sustainability to draft, negotiate and adopt new LTS guidelines on aspects such as:

- Designing satellites with reduced reflectivity, and generally regulating the brightness (in terms of apparent magnitude) of satellite constellations, both at the orbital positioning stage as well as during the orbiting stage, so that they become undetectable,

¹⁸⁹ Guidelines C.1 to C.4, UNCOPUOS LTS Guidelines, 2019.

¹⁹⁰ Guideline D.1, UNCOPUOS LTS Guidelines, 2019.

including the mandate for conducting de-orbiting procedures to minimize or eliminate reflection of light.¹⁹¹

- Limiting the orbital altitude of satellite constellations at 600 kilometers as per the recommendations of the SATCON Report and Dark and Quiet Skies Workshop.¹⁹²
- Facilitating space situational awareness through the exchanges and transfer of reliable information and data between key stakeholders such as observatories, satellite constellation operators, and authorizing states, and the creation of a database.¹⁹³
- Raising awareness of the impacts of satellite constellations on the night sky, the mitigation measures through which these impacts can be addressed, and their costs. These can be raised amongst various stakeholders such as astronomers, engineers, designers, investors, regulators, manufacturers and operators. etc.¹⁹⁴

6.5 The utility of LTS Guidelines as norms to address light interference

6.5.1 The LTS Guidelines are adopted through a Bottom-Up approach, offering a platform for all stakeholders. They were a product of multi-stakeholder consultation involving the member States, industries, and domain experts at various stages of drafting, negotiation and adoption. The emphasis was first laid by Mr Gerard Brachet, the then chairman of UNCOPUOS, who in his presentation at the First Committee of the United Nations General Assembly briefed the delegates on the need for “rules of good conduct” for space safety and sustainability, while alerting that there was a lack of consensus on reopening the Outer Space Treaty or designing a new international convention for that purpose.¹⁹⁵ He went on to suggest that a bottom-up approach based on technical guidelines might help in the formation of rules of good conduct facilitating space safety.¹⁹⁶ Subsequently the formation of an informal working group called the Paris informal working Group led to France inviting representatives from spacefaring nations, developing countries, commercial telecommunication satellite operators, UNOOSA, ITU, World Meteorological Organization and International Space

¹⁹¹ Recommendations to Keep Dark and Quiet Skies for Science and Society (2021) presented during the 58th session of the United Nations Committee on Peaceful Uses of Outer Space Scientific and Technical Subcommittee, UN Doc. A/AC.105/C.1/2021/CRP.17*, at para 24-26, available at <https://www.iau.org/static/publications/uncopuos-stsc-crp-8jan2021.pdf>.

¹⁹² *Ibidem*.

¹⁹³ *Ibidem*.

¹⁹⁴ *Ibidem* at para 23.

¹⁹⁵ United Nations, Press Release, First Committee of the United Nations General Assembly (October 22, 2007), available at <https://www.un.org/press/en/2007/gadis3349.doc.htm>.

¹⁹⁶ *Ibidem*.

Environment Service, for an informal meeting pertaining to the topic of Long Term Sustainability.¹⁹⁷ All of these were pivotal to adoption of the agenda of “Long Term Sustainability” at UNCOPUOS. Similarly, when the Working Group for the LTS Guidelines was formed, the committee agreed to Terms of References, Objectives and Outputs, Method of Working for Working Group,¹⁹⁸ and also establishment of 4 Expert groups to draft the guidelines.¹⁹⁹ This holds true even for the Current Working Group for LTS Guidelines. Thus at the COPUOS Working Group, any new Guidelines or an amendment or expansion of the existing Guidelines with an aim to mitigate light interference caused by satellites would be drafted based on the deliberations, experiences, practices and consensus of the COPUOS members, including the views and experiences of the relevant industrial stakeholders.

6.5.2 The LTS Guidelines are voluntary norms that offer flexibility to each country. The LTS Guidelines clearly state that they are voluntary and non-binding norms. The Guidelines offer flexibility for each state to implement them at a varying level of degree based on their capabilities and domestic policies. This can be resonated with various delegates of the STSC during the development of the Guidelines, emphasizing on strict compliance albeit on a voluntary basis, with each state permitted to initiate measures based on their domestic legal framework.²⁰⁰ Similarly, there were delegates at the STSC 2018 and 2020 sessions who expressed that the Guidelines should not become instruments for countries that have traditionally managed space technology to impose restrictions on other States.²⁰¹ Thus considering the sensitivities associated with each countries’ space-faring rights, non-binding and flexible norms such as the LTS Guidelines would be an ideal instrument for implementation of mitigation measures of light pollution of the night sky.

6.5.3 The LTS Guidelines fill the gaps of the existing space treaties and can serve as a basis for further development and evolution into binding Laws and Treaties. Soft Law instruments have been used to regulate space activities and emerging issues in the absence of

¹⁹⁷ Gerard Brachet, “The origins of the long-term sustainability of outer space activities initiative at UN COPUOS”, *Space Pol.* 28 (2012) 161-165, at 163.

¹⁹⁸ Working paper submitted by the Chair of the Working Group, Terms of reference and methods of work of the Working Group on the Long-term Sustainability of Outer Space Activities of the Scientific and Technical Subcommittee, UN Doc. A/AC.105/C.1/L.307/Rev.1.

¹⁹⁹ Report of the Scientific and Technical Subcommittee on its forty-eighth session, UN Doc. A/AC.105/987 (March 7, 2011), p.48.

²⁰⁰ Report of the Scientific and Technical Subcommittee on its fifty-fourth session, UN Doc. A/AC/105/1138 (February 21, 2017); Report of the Scientific and Technical Subcommittee on its fifty-fifth session, UN Doc A/AC.105/1167 (February 14, 2018).

²⁰¹ Report of the Scientific and Technical Subcommittee on its fifty-seventh session, UN Doc. A/AC.105/1224 (February 19, 2020), available at: https://www.unoosa.org/res/oosadoc/data/documents/2020/aac_105/aac_1051224_0_html/V2001426.pdf.

a new treaty since 1979, considering that “treaty making” takes time, political will, and consensus-based decision-making at UNCOPUOS.²⁰² For example, the Space Debris Mitigation Guidelines offered regulation of space debris, an area that was not adequately addressed by the Outer Space Treaty when it was adopted in 1967. Similarly, the LTS Guidelines can become an useful instrument to address the gaps of the Outer Space Treaty vis-a-vis topics such as light pollution caused by satellite constellations. The role of soft law and non-binding guidelines such as the UNCOPUOS LTS Guidelines cannot be ignored when it comes to furthering binding treaties in the future. According to former chair of the UNCOPUOS LTS Working Group, Dr. Peter Martinez, soft law rules provide a pragmatic option to make progress and achieve consensus, and he points out that soft law instruments such as the 1961 UNGA Resolution and 1963 UN Declaration paved the way for codification of the Outer Space Treaty.²⁰³ He states that soft-law instruments help States to socialize adherence to technical standards and recommended practices.²⁰⁴ He concludes that both binding and non-binding instruments are necessary for development of measures and standards.²⁰⁵ Thus the LTS Guidelines can lead to the development of binding treaties or norms in the future.

6.5.4 The LTS Guidelines can become binding Customary International Law in the future.

The ICJ Statute lists “custom” as a source of International Law and distinguishes two important components to it, namely State practice and *Opinio Juris*. The Court has further held that uniformity of practice is an important feature for any practice to be regarded as a custom, while the time duration of the practice is not necessarily a point of pertinence.²⁰⁶ Considering that various LTS Guidelines are being uniformly and widely implemented by numerous countries through their national legislations and policies,²⁰⁷ it is only a matter of time until the Guidelines crystallize into Customary International Law.

²⁰² Pierfrancesco Breccia, “Article III of Outer Space Treaty and Its Relevance in the International Space Legal Framework”, 59 Proc. Int'l Inst. Space L. 17, 23 (2016).

²⁰³ Statement by Dr Peter Martinez, Open-ended working group on reducing space threats through norms, rules and principles of responsible behaviors, Secure World Foundation, Panel on Voluntary mechanisms and regimes applicable to outer space (May 13, 2022) available at <https://swfound.org/media/207364/p-martinez-owwg-statement-may-13-2022-1.pdf>.

²⁰⁴ *ibidem*.

²⁰⁵ *ibidem*.

²⁰⁶ ICJ, *North Sea Continental Shelf* Case (1969). <https://www.icj-cij.org/case/52>.

²⁰⁷ UNOOSA, The Awareness-raising and capacity-building related to the implementation of the Guidelines for the Long-Term Sustainability of Outer Space Activities (LTS Guidelines), available at <https://spacesustainability.unoosa.org/>.

6.6 LTS 2.0 – A chance for addressing the challenge of light interference in Astronomy?

Following the successful adoption of LTS Guidelines in 2019, UNCOPUOS decided to establish, under a five-year work plan, a new working group under the agenda item on the long-term sustainability of outer space activities of its STSC.²⁰⁸ UNCOPUOS also initiated a new phase of the LTS discussions called the LTS 2.0 for identifying and studying challenges and considering possible new guidelines for the long-term sustainability of outer space activities. In 2020, the STSC considered a presentation by the IAU regarding the impact of satellite constellations on Astronomy on its agenda for “Long Term Sustainability of Outer Space Activities.”²⁰⁹ In the STSC 2021 session, under agenda item 13 called “Future role and methods of work of the Committee,” two Conference room papers were submitted on this topic, one by Chile, Ethiopia, Jordan, Slovakia, Spain and IAU²¹⁰ and another one by Canada, Japan and the United States, containing proposals for introducing a single issue/item for discussion at the fifty-ninth session of the Subcommittee on a general exchange of views regarding satellite system effects upon terrestrial-based astronomy.²¹¹

Importantly, some delegations at the STSC 2021 session also expressed the view that sustainability issues relating to the topic of dark and quiet skies could be considered within the framework of the new LTS working group.²¹² The STSC also agreed to organize an industry symposium on the topic of dark and quiet skies by the UNOOSA at the fifty-ninth session of the STSC 2022.²¹³

²⁰⁸ COPUOS, Report of the Committee on the Peaceful Uses of Outer Space (2019), UNGAOR Seventy-fourth Sess. UN Doc. A/74/20 at p.22 available at

https://www.unoosa.org/res/oosadoc/data/documents/2019/a/a7420_0_html/V1906077.pdf.

²⁰⁹ COPUOS, “Report of the Scientific and Technical Subcommittee on its fifty-seventh session” (2020), UN Doc. A/AC.105/1224 at p. 189(c). Available at

https://www.unoosa.org/res/oosadoc/data/documents/2020/aac_105/aac_1051224_0_html/V2001426.pdf.

²¹⁰ Submission by Chile, Ethiopia, Jordan, Slovakia, Spain and the International Astronomical Union, “Recommendations to Keep Dark and Quiet Skies for Science and Society”, Scientific and Technical Subcommittee of COPUOS, Fifty-eighth session, UN Doc. A/AC.105/C.1/2021/CRP.17* (April 19, 2021) available at

https://www.unoosa.org/res/oosadoc/data/documents/2021/aac_105c_12021crp/aac_105c_12021crp_17_0_html/AC105_C1_2021_CRP17E.pdf.

²¹¹ Submission by Canada, Japan and the United States of America, Proposal for a single Issue/Item for discussion at the fifty-ninth session of the Scientific and Technical Subcommittee in 2022 on a “General Exchange of Views regarding Satellite System Effects upon Terrestrial-Based Astronomy”, UN Doc. A/AC.105/C.1/2021/CRP.24 (April 27, 2021), available at

https://www.unoosa.org/res/oosadoc/data/documents/2021/aac_105c_12021crp/aac_105c_12021crp_24_0_html/AC105_C1_2021_CRP24E.pdf.

²¹² COPUOS, “Report of the Scientific and Technical Subcommittee on its fifty-eighth session” (2021), UN Doc. UN Doc. A/AC.105/1240 at 228.

²¹³ *Ibid* at 274.

Thus, any effort to add “Dark and Quiet Skies/impact of light pollution caused by satellites on Astronomy” to the agenda for the New Working Group under LTS 2.0 in order to either revise existing LTS guidelines or adopt new LTS Guidelines to address this issue of light pollution looks promising, considering that UNCOPUOS STSC as aforementioned, has created a new working group on long-term sustainability with a renewed mandate and a new elected Chair Dr. Umamaheswaran R. from India, under agenda item 12 of the Subcommittee.²¹⁴ As a positive sign, in November 2022 there were a series of inputs by countries and organizations to the working group, seeking to consider the impact of satellite constellations on Astronomy.²¹⁵

Thus the next 5 years of the new LTS working Group remain crucial for any addition of a new guideline to deal with the issue of light pollution. However, one must be wary that any endeavor to suggest new LTS guidelines must not stall or complicate the current process of countries to implement the existing LTS guidelines.

A final reflection should be added to the present Section, in view of recent developments that took place during the 60th session (February 2023) of the COPUOS STSC.²¹⁶ Although in the longer term it would indeed be useful to have one or several LTS Guidelines addressing the impact of light pollution caused by space objects, in the immediate term, however, a different approach may be preferable. The LTS Working Group is already overburdened with issues to address, and many stakeholders do not think that it could absorb a complex technical discussion about a new item such as light pollution of the night sky. For that reason, the vast majority of

²¹⁴ *Ibid* at 195.

²¹⁵ See e.g. Replies received from India, Inputs to the Working Group on the Long-term Sustainability of Outer Space Activities of the Scientific and Technical Subcommittee of COPUOS: Summary (September 28, 2022) *in* Information and views for consideration by the Working Group on the Long-term Sustainability of Outer Space Activities, UNCOPUOS STSC, UN Doc. A/AC.105/C.1/L.409/Add.1* p. 2 (September 29, 2022), available at https://www.unoosa.org/res/oosadoc/data/documents/2022/aac_105c_11/aac_105c_11_409add_1_0_html/2222533E.pdf; Proposals of France in support of the second Working Group on the Long-term Sustainability of Outer Space Activities (November 8, 2022) *in* Information and views for consideration by the Working Group on the Long-term Sustainability of Outer Space Activities, UNCOPUOS STSC, UN Doc. A/AC.105/C.1/L.409/Add.2 p.6 (November 9, 2022), available at https://www.unoosa.org/res/oosadoc/data/documents/2023/aac_105c_11/aac_105c_11_409add_2_0_html/2225222E.pdf; Input by the European Organization for Astronomical Research in the Southern Hemisphere in response to the invitation to the informal consultations of the Working Group on the Long-term Sustainability of Outer Space Activities (November 9, 2022) *in* Information and views for consideration by the Working Group on the Long-term Sustainability of Outer Space Activities, UNCOPUOS STSC, UN Doc. A/AC.105/c.1/L/409/Add.3 p.17 (November 28, 2022), available at https://www.unoosa.org/res/oosadoc/data/documents/2023/aac_105c_11/aac_105c_11_409add_3_0_html/V2218508.pdf.

²¹⁶ The discussions held on the topic of dark and quiet skies during the 60th session of the STSC can be found at the Draft Report of the session, UN Doc. A/AC.105/C.1/L.406/Add.5, paragraphs 18 to 37: https://www.unoosa.org/res/oosadoc/data/documents/2023/aac_105c_11/aac_105c_11_406add_5_0_html/AC105_C1_L406Add05E.pdf.

Member States of COPUOS are advocating instead for the creation of a separate group of experts under the STSC. This expert group would include interested member States and have a balanced representation of private satellite operators and the scientific and academic community. The group would work in detail for three years on the topic of light pollution caused by satcons, and then report back on its findings to both the STSC and the LTS Working Group of COPUOS.²¹⁷ Unfortunately, consensus could not be reached during the 66th plenary session of COPUOS (June 2023) with regard to keeping this item in the agenda of the STSC. It can only be hoped that this important item will continue to be debated in COPUOS and that the expert group will eventually be created.

²¹⁷ *Ibidem*, at para 30 *et seq.*

SECTION 7 – TOWARDS AN INTERNATIONAL PROTECTION OF THE NIGHT SKY

7.1 Protection of Dark Skies as Cultural and Natural Heritage

Light pollution is a worldwide issue, with an estimated 80% of the world's population living under light-polluted skies.²¹⁸ It is alarming to see that it is on a fast-growing trajectory, with a global average increase of 2% annually - which is almost double the rate of population growth.²¹⁹

Light pollution became a cause of concern in urban areas about a century ago, and policy development to protect astronomical observation started in the early 20th century.²²⁰ However, light pollution can still be said to be in its “attention cycle” before it garners mass public support and leads to establishment of a regulatory regime.²²¹

There are a few court decisions internationally which have recognised light pollution as a cause of concern and have adjudicated related claims.²²² In other instances there are a number of countries which have framed legislations aimed at reducing it.²²³

“Rights of nature” movement seeks recognition of the right of the natural environment to continue as it exists in its natural form.²²⁴ The movement argues that the continued existence of the human race is only possible with the protection of nature, while seeking a legal personality being accorded to certain natural objects similar to that of a legal person. It also

²¹⁸ Fabio Falchi et al., “The new world atlas of artificial night sky brightness”, *Science Advances* (10 Jun 2016) Vol 2, Issue 6. <https://www.science.org/doi/10.1126/sciadv.1600377>.

²¹⁹ R.F.Green, C.B. Luginbuhl, R.J. Wainscoat, et al. (2022), “The growing threat of light pollution to ground-based observatories”. *Astron Astrophys Rev* 30, 1 (2022). <https://doi.org/10.1007/s00159-021-00138-3>.

²²⁰ K. Riegel (1973). “Light Pollution: Outdoor lighting is a growing threat to astronomy”. *Science*, 30 Mar 1973, Vol. 179, Issue 4080, pp. 1285-1291: <https://www.science.org/doi/10.1126/science.179.4080.1285>; as cited in J.C. Barentine “Who Speaks for the Night? The Regulation of Light Pollution in the ‘Rights of Nature’ Legal Framework”. *IJSL* 2020, 22, 28–36. <https://doi.org/10.26607/ijsl.v22i2.104>.

²²¹ It is the stage where a new problem is recognized, leading to awareness among people and followed by proposed solutions from experts which ultimately gather public support with demands for implementation of the solution. See Anthony Downs, “Up and Down with Ecology—the Issue-Attention Cycle”, *The Public Interest*; New York Vol. 28 (Summer 1972), pp. 38 ff: https://sciencepolicy.colorado.edu/students/envs_5720/downs_1972.pdf.

²²² Karolina M. Zielińska-Dabkowska et al. (2020). "Assessment of Citizens' Actions against Light Pollution with Guidelines for Future Initiatives" *Sustainability* 12, no. 12: 4997. <https://doi.org/10.3390/su12124997>.

²²³ M. Morgan-Taylor, (2014) “Regulating Light Pollution in Europe: Legal Challenges and Ways Forward”. In J. Meier et al. (eds.), *Urban Lighting, Light Pollution and Society*, pp. 159-176. New York: Routledge, as cited in J.C. Barentine, “Who Speaks for the Night? The Regulation of Light Pollution in the ‘Rights of Nature’ Legal Framework”. *IJSL* 2020, 22, 28–36. <https://doi.org/10.26607/ijsl.v22i2.104>.

²²⁴ Christopher D. Stone, “Should Trees Have Standing?—Towards Legal Rights for Natural Objects.” *Southern California Law Review* 45 (1972): <https://iseethics.files.wordpress.com/2013/02/stone-christopher-d-should-trees-have-standing.pdf>; Oliver Houck, “Noah’s Second Voyage: The Rights of Nature as Law”. *Tulane Environmental Law Journal*, 31(1) (2017), 1: <https://www.occompt.com/wordpress/wp-content/uploads/2019/08/2019-08-08-Noahs-Second-Voyage-The-Rights-of-Nature-as-Law.pdf>.

introduced the idea that lawsuits on behalf of nature should be admitted, while challenging the fundamental notion of nature as a property at the disposal of humankind.²²⁵

Presently more than 22 countries worldwide have specific laws recognising the right to nature. In some countries, non-living natural objects, like rivers, lakes, or woods, have been allowed to be under the safeguard of appointed “guardians”.²²⁶

The right to nature could also encompass a dark night sky devoid of light pollution on the premise that a dark sky has more of an intrinsic value than its commercial utility.²²⁷

The night sky is a global common and may also be termed a cultural asset of mankind owing to the rich history of astronomical discoveries made possible by mankind gazing at the stars in a night sky.²²⁸ It could therefore be considered an intrinsic part of the “common heritage of mankind”.²²⁹ What exactly are the constituents of common heritage of mankind (CHM) lacks global consensus, but the six features attributable to common heritages propounded by John Noyes may serve useful:

- i. Acquisition or exercise of sovereignty should be prohibited.
- ii. The rights are vested in the humankind as a whole group.
- iii. It is reserved only for peaceful purposes.
- iv. Natural environment protection is achieved.
- v. Equitable sharing of these resources keeping in mind the needs of developing states.
- vi. Governance of the heritage is by common regime which is not exclusive.²³⁰

Due to its very nature, all these above features may not be applicable to the night sky strictly. However, the concept of CHM can be used as a cue for protection of the ‘natural environment’

²²⁵ Lidia Cano Pecharroman (2018). “Rights of Nature: Rivers That Can Stand in Court”. *Resources*, 7(1), 13. <https://www.mdpi.com/2079-9276/7/1/13>.

²²⁶ Cano Pecharroman, *ibidem*.

²²⁷ Taylor Stone (2018). “The Value of Darkness: A Moral Framework for Urban Nighttime Lighting”. *Science and engineering ethics*, 24(2), 607–628. <https://doi.org/10.1007/s11948-017-9924-0>.

²²⁸ Cipriano Marin (2011). “Starlight: a common heritage. The Role of Astronomy in Society and Culture”, *Proceedings of the International Astronomical Union*, 260, 449–456, available at: <https://adsabs.harvard.edu/full/2011IAUS..260..449M>. See also A. Venkatesan *et al.*, “The impact of satellite constellations on space as an ancestral global commons”, *Nature Astronomy* Vol. 4 (November 2020), pp. 1043-1048: <https://www.nature.com/articles/s41550-020-01238-3>.

²²⁹ Ambassador of Malta to the United Nations Arvid Pardo used the term “common heritage of mankind” for the first time during a United Nations session in 1967.

²³⁰ John E. Noyes (2011). “The Common Heritage of Mankind: Past, Present, and Future”. *40 Denver Journal of International Law and Policy*, at pp. 450-1. Available at: <https://digitalcommons.du.edu/cgi/viewcontent.cgi?article=1156&context=djilp>.

of the night sky and for formation of a global model for its governance with the wide participation of civil society.

At the international level, there have been several policy development attempts for the protection of the night sky. One such attempt was the Universal Declaration of Human Rights for Future Generations, adopted in La Laguna (Tenerife, Spain) in 1994, which declared that “Persons belonging to future generations have the right to an uncontaminated and undamaged Earth, including pure skies; they are entitled to its enjoyment as the ground of human history of culture and social bonds that make each generation and individual a member of one human family.”²³¹

In 2007, the participants of the International Conference in Defense of the Quality of Night Sky and the right to observe stars (La Palma, Spain), jointly with representatives of UNESCO, the UN World Tourism Organization, the IAU, and other international agencies, adopted the Starlight Declaration:

“An unpolluted night sky that allows the enjoyment and contemplation of the firmament should be considered an inalienable right equivalent to all other socio-cultural and environmental rights. Hence the progressive degradation of the night sky must be regarded as a fundamental loss. (...) Protection of the astronomical quality of areas suitable for the scientific observation of Universe must be given priority in national and international scientific and environmental policies.”²³²

Additionally, there have been some international initiatives for the protection of Astronomy and astronomical heritage sites. A significant event was the 34th session of the UNESCO World Heritage Committee held in Brazil in 2010, where for the first time astronomy was considered to be part of the World Heritage.²³³ This session led to the foundation of a thematic study on heritage sites of Astronomy and Archaeo-astronomy, which presented the roadmap for recognition of astronomical heritage.²³⁴ It also included some examples of astronomical

²³¹ Cited at: <https://www.starlight2007.net/theinitiative.html>.

²³² Available at: [Starlight Declaration - La Palma 2007 \(starlight2007.net\)](https://www.starlight2007.net). The Declaration and its context are also cited at Emma Marris, “In search of dark nights”. *Nature* (2010). <https://doi.org/10.1038/news.2010.339>.

²³³ <https://whc.unesco.org/en/sessions/34COM/>.

²³⁴ ICOMOS & IAU (2010). “Heritage Sites of Astronomy and Archaeoastronomy in the context of the UNESCO World Heritage Convention: A Thematic Study”. Paris, 272pp. ICOMOS-IAU Thematic study, available at: https://openarchive.icomos.org/id/eprint/267/1/ICOMOS_IAU_Thematic_Study_Heritage_Sites_Astronomy_2010.pdf.

sites of special significance, while noting that “Astronomy represents a rich and significant part of humanity’s shared cultural and natural heritage”.²³⁵

The UNESCO committee meeting was preceded by the International Year of Astronomy observed in 2009 to commemorate the 500th year of Galileo’s first astronomical discovery, which brought into focus and celebrated Astronomy and its rich contributions to mankind. One of the declared goals of the IYA 2009 celebration was to “Facilitate the preservation and protection of our global cultural and natural heritage of dark skies... through the awareness of the importance and preservation of the dark skies and astronomical sites for the natural environment and humanity heritage”.²³⁶

Moreover, UNESCO’s official website has a dedicated webpage on “Astronomy and World Heritage”, whereby it is declared that, “The sky, our common and universal heritage, is an integral part of the total environment that is perceived by mankind.”²³⁷

These international initiatives are in the right direction leading to creation of awareness and recognition of the problem caused by light pollution. Although any binding legislative attempt for night sky protection at the international level is yet to be seen, these initiatives suggest that such attempts are very likely in the near future.

7.2 Protection of Astronomy as a Cultural Human Right

7.2.1. Introduction: Astronomy as a Cultural Right.

The previous Sub-section dealt with the efforts the global community has taken to promote night sky as a World Heritage. This part will shed light on the possibility of considering

²³⁵ *Ibidem*. See also <https://www.iau.org/news/pressreleases/detail/iau1006/>.

²³⁶ IYA2009 Goals & Objectives, Astronomy 2009: <https://www.astronomy2009.org/general/about/goals/index.html>.

²³⁷ <https://whc.unesco.org/en/astronomy/>. It is important to note however that the sky itself, or the dark night sky, or celestial objects, or starlight as such cannot be nominated to the World Heritage List within the framework of the 1972 UNESCO Convention concerning the Protection of the World Cultural and Natural Heritage. According to this Convention, only sites or monuments that are under the geographical territory and thus the jurisdiction of the States parties to the Convention can be protected. UNESCO cannot recognize the night sky as world heritage and therefore set up any protection because this is outer space, which is outside the jurisdiction of any country. This means that the elaboration and adoption of a new convention would be necessary in order to establish an international protection of the night sky under the auspices of UNESCO.

Astronomy (understood as stargazing generally, not just as a scientific discipline) as an activity that can be protected as a cultural right under the International Covenant on Economic, Social and Cultural Rights (ICESCR), and subsequently analyze the potential of a Lex Ferenda that can emerge under International Law to achieve recognition of a human right to an unobstructed view of the sky.

The 1994 Universal Declaration of Human Rights of Future Generation has reiterated that it is the right of future generations to have pure skies on the Earth.²³⁸

The 2007 United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) emphasized the right of Indigenous peoples to practise and revitalize their cultural traditions and customs, as well as the right to manifest, practise, develop and teach their spiritual and religious traditions, customs and ceremonies.²³⁹ Those rights (including cultural rights) of Indigenous' peoples could be interpreted as including the preservation of natural dark skies for the Indigenous peoples who strongly associate their lives and traditions with them.

Indeed, light pollution of the night sky by satellite constellations may have disastrous consequences for Indigenous groups by damaging their cultural and spiritual traditions involving the sight of stars.²⁴⁰ Once such instance has been shared in the empirical research by Joshua Sokol wherein he reports of first-hand account from an Indigenous person who is deeply disturbed with hindrances caused by moving small satellites when he is engaged in ceremonies of gazing at stars as the tradition to connect with his ancestors.²⁴¹

It is not uncommon for States to consider protecting areas in outer space as Heritage Sites. For example, the Moon Landing Sites of Apollo Missions have been established as heritage under the One Small Step Act passed by US Congress in 2020.²⁴² Further, Section 9 of the Artemis Accords talks about preserving Outer Space Heritage such as landing sites, artifacts, spacecrafts and other evidence of activities on celestial bodies.²⁴³ While one of the reasons to

²³⁸ Universal Declaration of Human Rights for Future Generation, UNESCO Executive Board, 145th session, Doc no. 145 EX/41, Sept 22 1994; Art. 1: "Persons belonging to future generations have the right to an uncontaminated and undamaged Earth, including pure skies." Cited at: <https://www.starlight2007.net/theinitiative.html>.

²³⁹ <https://www.un.org/development/desa/indigenouspeoples/declaration-on-the-rights-of-indigenous-peoples.html>. See Articles 11.1 and 12.1.

²⁴⁰ Ciara Finnegan, "Indigenous Interests in Outer Space: Addressing the Conflict of Increasing Satellite Numbers with Indigenous Astronomy Practices", *Laws* 2022, 11(2), 26; <https://doi.org/10.3390/laws11020026>.

²⁴¹ Sokol, J. (2021, October 8). "The fault in our stars". *Science*, 374(6564), 142–147: <https://doi.org/10.1126/science.acx9260>.

²⁴² S.1694 - One Small Step to Protect Human Heritage in Space Act (2020).

²⁴³ NASA. 2020. The Artemis Accords. Available online: <https://www.nasa.gov/specials/artemis-accords/img/Artemis-Accords-signed-13Oct2020.pdf>.

do that was to respect the sites that witnessed the Apollo Missions on the Moon, the other reason was to preserve the accomplishment of humans on the Moon as a heritage for the future generations.²⁴⁴ Such a preservation invokes the right of these future generations to experience the heritage of mankind's first lunar adventure.

Extending the analogy, if Article I of the OST treats Astronomy under the "Freedom to Explore and Use Outer Space," then Astronomy can be considered as an activity that is worthy to be preserved as an accomplishment of human discovery and exploration.

Astronomy is in fact one of the earliest activities every single culture and civilization on earth undertook. Focusing on protecting the activity of Astronomy more than specific dark heritage sites will be a crucial step to extend it to all humankind.

Just like the US is aiming to preserve the landing sites of Apollo on the Moon as a Heritage, New Zealand is aiming to preserve the ecological and cultural value of its Dark Skies and also be certified as a "Dark Sky Nation" by the International Dark-Sky Association (IDA).²⁴⁵ This initiative is led by the indigenous Maori people, who deem the observation of a dark sky as an essential part of their culture and beliefs.²⁴⁶

It is also worthy to note that the small island-nation of Niue has already been certified as a dark sky country in 2020 by the IDA.²⁴⁷

Thus some countries are envisaging to protect Astronomy as a cultural right for their indigenous communities and for other purposes. It will not be long before other countries join New Zealand in extending such similar protections.

Once more and more countries start adopting legislation that deems Astronomy (or stargazing generally) as a cultural right, a possible result could be the formation of a customary international rule that would bind all countries to protect Astronomy, considering that

²⁴⁴ Gary Peters, "House Passes Peters Bipartisan Legislation to Protect the Apollo Landing Sites" (December 16, 2020): <https://www.peters.senate.gov/newsroom/press-releases/house-passes-peters-bipartisan-legislation-to-protect-the-apollo-landing-sites>.

²⁴⁵ Rina Diane Caballar, "What's a 'dark sky nation' and why does New Zealand want to become one?" National Geographic (November 2, 2022).

²⁴⁶ *ibidem*.

²⁴⁷ *ibidem*.

uniformity of practice is more important than the duration of practice for the emergence of customary International Law.²⁴⁸

7.2.2 Envisaging a Lex Ferenda under IHRL or under the *Corpus Juris Spatialis*.

Article III of the Outer Space Treaty extends the applicability of International Law to outer space activities. The possibility of human rights being applicable to realms of outer space is a point worth contemplation. In the future, as humans become an interplanetary species and establish extraterrestrial settlements, there are possibilities of Human Rights to be claimed in outer space and celestial bodies.²⁴⁹ However, it is important to analyze whether Astronomy as a human activity can be protected under the Outer Space Treaty or under International Human Rights Law (IHRL).

The question is whether the ICESCR or any similar convention could be extended to outer space activities to limit or regulate the operations of satellite constellations, in order to protect Astronomy (or stargazing generally) as a cultural right.

The ICESCR has five parts comprising 31 articles.²⁵⁰ Some of the social and cultural rights covered under the Covenant are Right to Work, Right to Marriage, Right to an adequate Standard of Living, Right to a Physical and Mental Health, Right to Education, right to Take Part in Cultural Life, etc.²⁵¹ For a covenant that is covering different aspects of human life, an impetus on including the right to unhindered astronomical observations may be vital for the holistic development of mankind.

The ICESCR currently has 171 parties,²⁵² being a legally binding instrument for all those States that have ratified it. Considering that light pollution emitted from satellite constellations is a transboundary issue, it is essential to have a multilateral initiative on such an issue. This would be a top to bottom approach.

²⁴⁸ Malcolm N Shaw, *International Law*, pp. 76-78 (6th Edn., 2008).

²⁴⁹ Tanja Masson-Zwaan & Mahulena Hofmann, *Introduction to Space Law* (4th Edn., 2019), p. 7.

²⁵⁰ International Covenant on Economic, Social and Cultural Rights, (December 16, 1966), available at <https://www.ohchr.org/en/instruments-mechanisms/instruments/international-covenant-economic-social-and-cultural-rights>.

²⁵¹ *ibidem*.

²⁵² https://treaties.un.org/Pages/ViewDetails.aspx?src=IND&mtmsg_no=IV-3&chapter=4&clang=en.

ICESCR contains a provision that seems to support the idea of protecting stargazing in general, and basic scientific research such as Astronomy in particular, as a fundamental human right of a cultural nature. According to Article 15:

- “1. The States Parties to the present Covenant recognize the right of everyone: (a) To take part in cultural life; (b) To enjoy the benefits of scientific progress and its applications; (...)
2. The steps to be taken by the States Parties to the present Covenant to achieve the full realization of this right shall include those necessary for the conservation, the development and the diffusion of science and culture.
3. The States Parties to the present Covenant undertake to respect the freedom indispensable for scientific research and creative activity.”

The utility of establishing Astronomy as a cultural right under ICESCR would enable countries to reassess and inspect the possibilities of enacting enabling provisions as part of their national framework to protect and enhance the quality of astronomical activities. The rationale behind enacting them as a cultural right would ensure that it is extended to all people and not only to those scientific and astronomical communities working through observatories.

Ideally, the ICESCR might have a protocol adopted by the States Parties declaring Astronomy as a cultural right. There is more probability of this being achieved under the Human Rights Framework than under International Space Law. Both the ICESCR and the Outer Space Treaty were adopted in 1966, however the ICESCR has evolved and expanded through protocols whereas there remains to be seen if the Outer Space Treaty will ever have a Protocol or an Amendment,²⁵³ although there have been soft law instruments expanding the practice and implementation of the Treaty. It must also be emphasized that any attempt to have Astronomy declared as a cultural right under a convention must have participation from active space-faring countries. This is to ensure that it does not end up like the 1979 Moon Agreement, which failed to receive ratification owing to its interpretation of rights associated with the extraction of natural resources from the Moon and other celestial bodies.

Alongside UNESCO, UNCOPUOS can also be looped in considering that its STSC has an agenda on Dark and Quiet Skies and that the Working Group on LTS has countries discussing

²⁵³ Article XIII Outer Space Treaty.

on mitigating the impact of satellite constellations on Astronomical Observations. Further, it also remains to be seen if there could be a COPUOS resolution, declaration of principles, or set of guidelines that will protect Astronomy as a cultural right and subsequently direct or guide States to supervise their satellite operators to initiate relevant measures to prevent light interference, as a part of their licensing and authorization measures.

If policymakers and diplomats consider a bottom to top approach as a key mechanism of regulation, then it will be appropriate if UNCOPUOS, UNESCO, or other international bodies come up with working groups or agenda items to provide a platform for countries to raise awareness, share their enabling provisions on protecting Astronomy as a cultural right, and engage in capacity building activities. The Open-Ended Working Group on Reducing Space Threats at the UNGA First Committee,²⁵⁴ the UNOOSA LTS Guidelines initiatives,²⁵⁵ or the Reporting Mechanism under ICESCR²⁵⁶ are certain examples to this end.

SECTION 8 - THE ROLE OF SELF-REGULATION

8.1 Mitigating measures Taken So Far

Shortly after the first launches of Starlink satellites in 2019, the astronomical community undertook an effort to approach the corporations that are establishing the largest constellations of satellites, in particular SpaceX, OneWeb, and Amazon. As a result, all three companies have been in contact with astronomers and have engaged in a dialogue with the astronomical community, with an aim to collaborate and find ways to mitigate the problem of light pollution of the night sky caused by the constellations.

²⁵⁴ UNODA, Open-ended working group on reducing space threats through norms, rules and principles of responsible behaviours available at <https://meetings.unoda.org/open-ended-working-group-reducing-space-threats-2022>.

²⁵⁵ UNOOSA, Awareness-raising and capacity-building related to the implementation of the Guidelines for the Long-term Sustainability of Outer Space Activities, available at <https://spacesustainability.unoosa.org/about>.

²⁵⁶ OHCHR, Reporting guidelines, Committee on Economic, Social and Cultural Rights, available at <https://www.ohchr.org/en/treaty-bodies/cescr/reporting-guidelines>.

The primary concern of astronomers so far has been SpaceX's Starlink constellation. With a constellation of many thousands of satellites, hundreds could be in view at any given time, producing streaks in images that could ruin those observations. Undoubtedly there will be an impact, and the goal right now is to mitigate that impact as much as possible.²⁵⁷

Standards for mitigation were first outlined by the two Satellite Constellations (SATCONS) workshops organized in 2020 and 2021 by the US National Optical-Infrared Astronomy Research Laboratory (NOIRLab) and the American Astronomical Society (AAS) to bring together astronomers, operators, and policy-makers to discuss the impact of large satcons on astronomy and society.²⁵⁸

There are several mitigating measures that companies can take to minimize the problem. The most obvious measure is to make satellites less reflective to minimize their visual impact in the night sky. SpaceX has worked to reduce the brightness of Starlink satellites in several ways. The first step was to give them a different orientation so that they would reflect less sunlight downwards, by pointing the solar panels away from the sun at key times. SpaceX is using a roll maneuver twice per orbit that puts the solar panel in line with the Sun, presenting a "knife's edge" to reduce reflections, and ultimately keeping it hidden from the ground.²⁵⁹

Another early approach taken at the request of astronomers was to paint in black the bottom part of the satellites so that they would reflect less sunlight. The US and other countries have been using these low-tech invisibility cloaks for decades for many military satellites in order to make their detection more difficult.²⁶⁰

Accordingly, SpaceX put a dark coating on the earth-facing parts of one Starlink satellite, dubbed "Darksat", launched in January 2020. However, while the experimental darkening made the satellite less visible to backyard astronomers, the dimming was not enough to help professional observatories. In any case, this technique had to be abandoned because the black

²⁵⁷ Young, Monica, "The New Space Race", *Sky & Telescope*, March 2020, p. 16; Rawls, Meredith and Hall, Jeffrey, "The satellite-streaked sky", *Astronomy*, March 2023, pp. 14ff; Foust, Jeff, "Stars and Starlink", *The Space Review*, March 30, 2020: <https://www.thespacereview.com/article/3911/1>.

²⁵⁸ <https://noirlab.edu/science/events/websites/satcon2/publications>.

²⁵⁹ <https://planet4589.org/astro/starsim/fas.pdf>; <https://skyandtelescope.org/astronomy-news/details-spacex-starlink-visorsat/>.

²⁶⁰ Foust, *ibidem*: <https://www.thespacereview.com/article/3911/1>.

paint made the satellite absorb more sunlight and become thermally “hot”, which affected its primary function as an internet transmitter.²⁶¹

After April 2020, a “sunshade” or what amounts to a sun umbrella was instead added to each of the Starlink satellites, shielding the spacecraft from the Sun, and thus preventing sunlight from being reflected downwards. The sunshade is securely attached to the comsat and it does not need to be deployed, so it is a simple solution, while avoiding the thermal balance problems. This other technique was nicknamed “Visorsat”. Preliminary analyses showed that, at least during the night hours, Visorsats became virtually invisible to the naked eye.²⁶² Since 2022, however, SpaceX have stopped the production of the visor sunshades, due to the interference of the visor with the satellite optical laser cross-communications links that are used on the next generation of Starlink satellites to further reduce latency in the service. The company is now working on a new dielectric coating, which aims to reflect any incident sunlight in one particular direction away from Earth.²⁶³

Other mitigating measures that have been discussed with –but not necessarily adopted by– the operators of satellite constellations were to reduce the number of satellites placed in LEO for each constellation, and limit the orbital altitudes of constellations. Constellations orbiting below about 600 kilometers are less damaging to ground-based observatories than those flying higher. This is so because the lower altitude reduces both the number of satellites above the horizon and the night interval during which some of them are detectable.²⁶⁴

As an additional measure, SpaceX started making public the orbital elements of all its already launched spacecraft in order to help astronomers track and avoid them; and it is also now providing predictive data before every new launch for the same purpose. Starlink trajectories are published through the websites space-track.org and celestrak.com, which many astronomers use in timing their observations to avoid satellite streaks.²⁶⁵ However, while useful for general observation planning, the accuracy of these trajectories are still not enough for precise observation planning or for determining whether spectroscopic observations are

²⁶¹ <https://skyandtelescope.org/astronomy-news/starlink-astronomers-update/>.

²⁶² <https://spacenews.com/oneweb-to-resume-launches-in-fourth-quarter/>.

²⁶³ <https://planet4589.org/astro/starsim/fas.pdf>; <https://skyandtelescope.org/astronomy-news/newest-starlink-satellites-have-gotten-brighter-again/>.

²⁶⁴ Report of the 2020 Dark and Quiet Skies Workshop, pp. 135-36. Available at: <https://www.iau.org/static/publications/dqskies-book-29-12-20.pdf>.

²⁶⁵ Hainaut, Olivier R. and Williams, Andrew P. “Impact of satellite constellations on astronomical observations with ESO telescopes in the visible and infrared domains”, *A&A* Volume 636, April 2020. <https://www.aanda.org/articles/aa/abs/2020/04/aa37501-20/aa37501-20.html>.

contaminated. More accurate trajectories are also key to identifying occultations of stars by the satellites themselves, which can be misinterpreted as other phenomena.²⁶⁶ Nevertheless, although satellites physically blocking the view of a celestial body is a potential nuisance, it is very rare, and it is not nearly as problematic as the effects of reflected sunlight.²⁶⁷

Astronomers themselves can adopt some measures to mitigate the effects of ‘mega-constellations.’ They can model and study carefully the effects that future satellite constellations may have on ground-based observatories, and design possible countermeasures. They may schedule their observations out of the twilight hours, which are the worst hours in terms of satellite interference, but this will reduce the time available for large telescopes, which is in very high demand. They may deploy additional telescopes and in this way increase the number of observations for each relevant part of the sky, but such measure obviously comes at a cost. They may program their observations so as to look every time in a direction that will avoid catching the streaks of satellites in their images. However, as noted above, this requires a very accurate knowledge of the position of the satellites and their times of overflight. Besides, some telescopes such as the Vera Rubin Observatory in Chile are designed with a wide-field aperture in order to survey large areas of the sky, instead of pointing to specific targets; for these instruments, the tactic of “looking elsewhere” will not work.

Another measure is to use software that erases the satellite trails from celestial images after these images have been taken. Removing trails of satellites and airplanes in astrophotos is possible, and software and techniques exist that are already well established in this regard. However, the brightest satellites generate echoes or noise bands that saturate the extremely sensitive detectors that astronomers use, leading to images that must be completely discarded. Additionally, any adjustment taken by the professional observatories will cost money, both in operational time and in the additional researcher effort needed to sort out less uniform data contaminated by satellites.²⁶⁸

²⁶⁶ Steinhardt, C.L., Andersen, M.I., Brammer, G.B. *et al.* “A more probable explanation for a continuum flash towards a redshift ≈ 11 galaxy”. *Nat Astron* 5, 993–994 (2021). <https://doi.org/10.1038/s41550-021-01473-2>.

²⁶⁷ <https://www.thespacereview.com/article/3911/1>; <https://skyandtelescope.org/astronomy-news/starlink-astronomers-update/>; <https://skyandtelescope.org/astronomy-news/details-spacex-starlink-visorsat/>.

²⁶⁸ <https://www.spacex.com/updates/starlink-update-04-28-2020/index.html>; <https://skyandtelescope.org/astronomy-news/details-spacex-starlink-visorsat/>. For a quick appreciation of the growing visual impact that satellites are having on the night sky, see NASA, Astronomy Picture of the Day for 2022 June 14, at: <https://apod.nasa.gov/apod/ap220614.html>.

While not the focus of this working group, the impact of satellite constellations on ground-based radio astronomy is also very significant. If the full SpaceX, OneWeb, Kuiper and GuoWang constellations are deployed, there could be ~5,000 satellites overhead at any one place on Earth. All these satellites will likely be intentionally transmitting in the radio spectrum and also releasing unintentional transmission or “noise” as a result of the onboard electronics. Radio observatories can no longer rely on ground-based radio quiet zones regulated at national level.²⁶⁹ While several satellite companies have taken voluntary mitigations also with regard to ground-based radio astronomy, such as avoiding using frequency bands directly adjacent to the radio astronomy protected bands, or committing to protect specific geographic zones and avoid directly illuminating radio observatory sites, these measures require certain technologies not always accessible to all companies. And in any case, these mitigating measures do not address the increasing background noise outside of the protected radio astronomy bands.

8.2 Space Sustainability initiatives

The topic of space sustainability is of growing importance for the space sector. As the number of activities in Low Earth Orbit grow, governments are increasingly recognising the dangers of orbital crowding and industry is recognising that space debris, conjunction alerts, and even collisions are a threat to the overall business model. There are a number of industry-led and non-governmental initiatives to address various dimensions of safety and sustainability in LEO.

One such initiative that has been pushed by some governments, non-profit organizations, and private stakeholders aims to establish a voluntary system of “rewards” or “ratings” to industry. From a project initiated at the World Economic Forum and developed with involvement of ESA, the École Polytechnique Fédérale de Lausanne (EPFL) took on the leadership of the Space Sustainability Rating (SSR), which was publicly launched at a “Space Sustainability Summit” event in London in June 2022.²⁷⁰ At this event, major companies including Inmarsat and OneWeb released sustainability white papers. The UK government recently announced a

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https://www.spacedaily.com/reports/Radio_interference_from_satellites_is_threatening_astronomy_but_there_are_solutions_999.html.

²⁷⁰ <https://spacesustainabilityrating.org/>.

sustainability ‘kite mark’, or standard of safety and quality aiming to influence the insurance industry to factor sustainability metrics into their costs.²⁷¹

The proposed SSR concept still works within the framework of self-regulation, but it adds a new layer of incentives to promote safe and responsible behaviour in orbit. It creates a voluntary system of compliance with existing international standards, guidelines, and best practices that operates on the basis of mutual encouragement and corporate responsibility. The goal is to keep the globally shared orbital environment sustainable and safe in the long term. SSR envisages a future where environmental review would be taken into consideration in the early stages of design and development of space objects and satellite constellations. Similarly, SSR provides an incentive to operate missions considering their impact to the orbital environment and to the activities of other operators.²⁷²

While the broader developments in space sustainability occurred somewhat independently from the discussion on dark and quiet skies, the emphasis on sustainability has opened up a space to consider astronomical concerns and also created an emerging norm in the industry to cooperate with astronomers.²⁷³

8.3 The IAU’s Centre for the Protection of the Sky

In April 2022, the International Astronomical Union established a Centre for the Protection of the Dark and Quiet Sky from Satellite Constellation Interference (IAU CPS), which is hosted by the US National Science Foundation’s National Optical-Infrared Astronomy Research Laboratory (NOIRLab) and by the Square Kilometer Array Observatory (SKAO), headquartered in the UK.²⁷⁴ The IAU CPS includes an ‘industry and technology hub’ with the purpose to coordinate interaction of astronomers with the industry in the future, encourage implementation of best practices and mitigations by satellite constellation operators to reduce their impact on astronomy, develop tools that enable the satellite industry’s voluntary adoption of recommended mitigations, and promote ongoing innovation of solutions.

The hub is currently chaired jointly by a representative of the Industry Working Group (Amazon Kuiper) and a representative of the astronomy community, and it features

²⁷¹ <https://spacenews.com/u-k-government-announces-new-space-sustainability-measures/>.

²⁷² <https://spacesustainabilityrating.org/>.

²⁷³ https://www.unoosa.org/documents/pdf/spacelaw/workshops/SLC2022/presentations/L._Williams_-_2022_May_11_UN_Chile_Conference_ESO.pdf.

²⁷⁴ <https://cps.iau.org/>.

participation at varying levels from several of the major constellation companies. The hub is starting efforts to increase the number of involved companies. The company AST SpaceMobile, which recently launched its first demonstration satellite called *Bluewalker 3*, plans a 100+ satellite constellation to bypass ground infrastructure and connect to cell phones directly from space. The satellites have very large 64 square metre antennas and threaten to be the brightest objects in the night sky after the Moon in the absence of substantial mitigations.²⁷⁵ At the time of writing, the company had engaged in initial discussions with IAU CPS representatives and have stated that they plan mitigations.

8.4 Self-regulation: A Satisfactory Answer?

In the years to come, the channel of information-sharing and cooperation that has been opened between the industry and the astronomers could help facilitate the creation of best practices and standards to ensure the long-term sustainability of both activities: ground-based astronomy, and LEO satellite constellations. Advanced self-regulatory measures such as codes of conduct approved by all the industry players would be particularly useful and could even have an indirect legal relevance by exposing non-compliers.²⁷⁶

According to Starlink's website:

While it will not be possible to create satellites that are invisible to the most advanced optical equipment on Earth, by reducing the brightness of the satellites, we can make the existing strategies... dramatically more effective. SpaceX is committed to making future satellite designs as dark as possible. (...) As launch costs continue to drop, more constellations will emerge and they too will need to ensure that the optical properties of their satellites do not create problems for observers on the ground... [W]e are working to make this problem easier for everyone to solve in the future.²⁷⁷

For the moment, States may prefer to leave this issue unregulated and in the hands of the stakeholders. In this sense, we find the statement made by the delegation of the United States of America during the 59th Session of the Scientific and Technical Subcommittee of COPUOS. The US delegation endorsed the set of non-binding best practices produced so far by the Industry Working Group and their voluntary inclusion into satellite design and development.

²⁷⁵ <https://skyandtelescope.org/astronomy-news/as-bluewalker-satellites-join-a-brightening-sky-heres-how-you-can-help/>.

²⁷⁶ Young, Monica, "The New Space Race", *Sky & Telescope*, March 2020, p. 17.

²⁷⁷ <https://www.spacex.com/updates/starlink-update-04-28-2020/index.html>.

It also endorsed the recommendations on the many steps astronomers can take to mitigate the impact of satellite constellations.²⁷⁸

This approach is consistent with the present era, which favors de-regulation and evaluation by market forces. Governments would allow at first the space industry to regulate itself, while maintaining some watching over the effectiveness of the approach. External pressures such as governmental enforcement of best practices, or the adoption of new legal rules, would be introduced only if necessary.²⁷⁹

Other measures that could be reached jointly by the industry, the astronomical community, and the governments could be the development of industry technical standards (possibly ISO standards as well); the development and implementation of additional mechanisms for coordination of the stakeholders; introducing financial support for mitigation measures in national science policies; and creating further incentives for corporate social responsibility.²⁸⁰

However, there are practical limitations in every self-regulation model. Self-regulating attempts may fail, given the inherent conflict of interest in asking any organization to police itself.²⁸¹

In our present case, there is a perception that mitigation measures adopted so far have not been sufficient to solve the problem. Even if they had been, the continuity of such measures is dependent on the goodwill of the companies. This implies that astronomers face the risk of a change of mind by SpaceX and the other operators. SpaceX already unilaterally discontinued the use of the Darksat and the Visorsat for technical reasons.²⁸² And as more private and governmental entities enter this market, it is not known whether they will all be motivated and resourced to make similar efforts, and whether they will voluntarily meet best practice

²⁷⁸ United States Mission to International Organizations in Vienna, U.S. Statement on Dark and Quiet Skies, COPUOS STSC, February 2022: <https://vienna.usmission.gov/2022-copuos-stsc-dark-and-quiet-skies/>. A similar statement was issued by the US delegation at the COPUOS STSC session in February 2023: https://www.unoosa.org/documents/pdf/copuos/stsc/2023/Statements/10_AM/17_USA_10_Feb_AM.pdf.

²⁷⁹ Gunningham, Neil and Rees, Joseph, “Industry Self-Regulation: An Institutional Perspective”, *Law & Policy*, Vol. 19, No. 4, October 1997, pp. 363-414. <https://onlinelibrary.wiley.com/doi/abs/10.1111/1467-9930.t01-1-00033>.

²⁸⁰ Williams, Andrew, “Future Directions for Policy and Regulatory Measures”, presentation made during the STSC Symposium on Dark Skies, COPUOS STSC, February 15, 2022. <https://www.unoosa.org/documents/pdf/copuos/stsc/2022/Part1.pdf>.

²⁸¹ Gunningham and Rees, “Industry Self-Regulation: An Institutional Perspective”, at pp. 388-9, 406. On the particular problem of light pollution caused by satellites, see also Sokol, J. “The fault in our stars”, *Science*, 374 (6564), 2021, October 8, pp. 142–147. <https://doi.org/10.1126/science.acx9260>.

²⁸² <https://skyandtelescope.org/astronomy-news/newest-starlink-satellites-have-gotten-brighter-again/>.

standards in the absence of binding regulation compelling them to do so. One unethical or incompetent actor could have disastrous consequences.²⁸³

Also, the interference is not limited anymore to ground-based observatories: Space-based telescopes in LEO are also increasingly affected by satellite trails, and in those cases, mitigations are more challenging to implement.²⁸⁴

Furthermore, technical mitigations rely on detailed knowledge of the spacecraft system, typically resulting in companies asking astronomy groups or individual observatories to enter into non-disclosure agreements. While such bilateral collaborations are important to establish good practices, they could become unsustainable as the number of satellite constellation projects grows.

We also suffer from the lack of more clear and objective rules. For instance, one vital goal is to reduce the brightness of satellites, but how much brightness is adequate, and who determines that? In the SATCON workshops, the astronomers proposed a first standard: brightness should in no case exceed the seventh magnitude.²⁸⁵ So far, this brightness limit has been acknowledged by some, but not all of the operators.²⁸⁶ It would be much more reassuring to have such standards adopted as legal norms and have them uniformly applied to all operators.

An international regulation would usually be negotiated and agreed at the United Nations, as this is the only international organization with competences over space activities in general. More specifically, this would be done via the UN Committee on the Peaceful Uses of Outer Space (COPUOS).

A number of member States have already expressed in COPUOS their support for the elaboration of some legal rules regarding satellite constellations: in a conference room paper presented in February 2021 at the STSC, several States jointly with the IAU stated that “the

²⁸³ Young, Monica, “The New Space Race”, *Sky & Telescope*, March 2020, p. 21.

²⁸⁴ <https://www.iau.org/static/publications/uncopuos-stsc-crp-8jan2021.pdf> at para 18. For more information on Hubble, see e.g. <https://skyandtelescope.org/astronomy-news/satellite-trails-mar-hubble-images/>. On the impact on other space telescopes, such as e.g. India’s AstroSat, see statement from India at the STSC: https://www.unoosa.org/documents/pdf/copuos/stsc/2023/Statements/16_PM/17_India_16_Feb_PM_1.pdf.

²⁸⁵ The scale of magnitudes is a logarithmic scale used by astronomers whereby the brightest stars are first magnitude, and the faintest stars visible without optical aid are about sixth magnitude. Accordingly, the proposed standard means that the brightness of mega constellation satellites should always be below naked-eye levels.

²⁸⁶ For example, Space-X in January 2023 entered into an agreement with the US National Science Foundation to minimize the magnitude of their satellites to 7. Jeff Foust, “NSF and SpaceX reach an agreement to reduce Starlink effects on Astronomy”, SpaceNews (January 12, 2023): <https://spacenews.com/nsf-and-spacex-reach-agreement-to-reduce-starlink-effects-on-astronomy/>.

mitigation of the effects caused by satellite constellations calls for an internationally agreed regulation i.e., it falls within the core remit of the UN COPUOS²⁸⁷ and that “COPUOS is the primary international forum in which to address the need to create an international approach to equitably managing light and radio emissions from space and preventing undesired impacts.”²⁸⁸ The views of different States on this matter were also reflected in the final reports of the STSC 2021 and 2022 sessions.²⁸⁹

The 61st Session of the COPUOS LSC, held in March-April 2022, also witnessed a discussion on whether the Subcommittee should take up a new agenda item for future meetings, addressing from a regulatory point of view the impact that LEO satellite constellations is having on radio astronomy as well as optical and infrared astronomy. Consensus to do that was not achieved, however, as other delegations opined that the consideration of the item on dark and quiet skies for science and society should continue for the moment within the framework of the STSC, and that technical discussions needed to be completed before the item could be placed on the agenda of the LSC.²⁹⁰

Future regulatory requirements at the international and national level could assume the most important concrete recommendations already made to the industry. Rules could set limits on the brightness of satellites by introducing changes in their design and imposing a maximum orbital altitude for satcons, in order to minimize their visual impact on the night sky. Future rules could also compel operators to share accurate and timely orbital data related to the constellations, so that astronomers could plan their observations accordingly. Finally, environmental impact assessments and other strategies aiming to mitigate the visual impact of satellites on the night sky might also be required. All those strategies could be implemented in coordination with other space policy issues (space traffic management, environmental issues, space debris, spectrum management, etc.)

²⁸⁷ Chile, Ethiopia, Jordan, Slovakia, and Spain together with the IAU, “Recommendations to keep dark and quiet skies for science and society,” UN Doc. A/AC.105/C.1/2021/CRP.17 at paragraph 9. Available at: https://www.unoosa.org/res/oosadoc/data/documents/2021/aac_105c_12021crp/aac_105c_12021crp_17_0_html/AC105_C1_2021_CRP17E.pdf.

²⁸⁸ *Ibidem* at para 16.

²⁸⁹ COPUOS, “Report of the Scientific and Technical Subcommittee on its fifty-eighth session”, UN Doc. A/AC.105/1240, at paragraphs 224-233: <https://documents-dds-ny.un.org/doc/UNDOC/GEN/V21/038/14/PDF/V2103814.pdf?OpenElement>; COPUOS, “Report of the Scientific and Technical Subcommittee on its fifty-ninth session”, UN Doc. A/AC.105/1258 at para 262-276: <https://documents-dds-ny.un.org/doc/UNDOC/GEN/V22/011/67/PDF/V2201167.pdf?OpenElement>.

²⁹⁰ COPUOS, “Report of the Legal Subcommittee on its sixty-first session”, UN Doc. A/AC.105/1260, at paragraphs 237-239: <https://documents-dds-ny.un.org/doc/UNDOC/GEN/V22/022/49/PDF/V2202249.pdf?OpenElement>.

9. CONCLUSIONS

9.1 At the Spring Meeting of 2021, the Board of Directors of the International Institute of Space Law (IISL) approved the creation of a study group under the name “IISL Working Group on Light Pollution of the Night Sky from a Space Law Perspective”. The Working Group (WG) was officially formed and started operating in September 2021. The purposes for the creation of this WG were to collect information about the issue of the light pollution or optical interference caused by satellite constellations on the night sky, analyze the problem from a Space Law perspective, raise awareness on the topic among all IISL members, and provide the IISL Board of Directors with an up-to-date report describing the current state of the situation.

9.2 At present, several companies are building and already launching large constellations composed of hundreds or even thousands of satellites each. The main goal of these networks is to provide broadband internet access from space to virtually any place on the planet. Other companies and nations also have plans for setting up large satellite constellations in low Earth orbits (LEO) with the intention to provide global internet access as well, or to provide other communications or remote sensing services. As a result, a number of new projects in LEO are emerging, taking advantage of the decreasing launch and satellite costs.

9.3 The surge in the number of satellites that have been placed in LEO since the first satcons started launching in 2019 is creating a number of technical and regulatory challenges. A significant one is a steady growth in the light pollution of the night sky. Astronomers and other scientists are concerned with the negative impact of a night sky increasingly filled up with shiny artificial objects and polluted by diffuse skyglow. In terms of numbers of people affected, potential economic damage, and scientific repercussions, the disruption of astronomical observations is particularly worrisome. Also affected by this luminic contamination are Indigenous communities, which may suffer an alteration of their cultural traditions as a result of the changes produced in the dark night sky, and many wildlife species, which may see their daily life cycles altered as well.

9.4 This emerging problem has already been the object of several international conferences. It has prompted statements from the International Astronomical Union (IAU) and from other institutions, and it has attracted the attention of many people, inside and outside the space community.

9.5 These concerns have also reached the United Nations and its Committee on the Peaceful Uses of Outer Space (COPUOS), where a number of delegations have brought them to the attention of the Committee. A new item on dark and quiet skies for science and society was included in the agenda of the Scientific and Technical Subcommittee (STSC) of COPUOS. Accordingly, discussions were held during the latest sessions of the STSC, in 2022 and 2023. The preservation of dark and quiet skies was flagged in 2022 also at the Legal Subcommittee (LSC) of COPUOS by some Member States, but no decision has been made yet about including a related agenda item.

9.6 Indeed, the global governance of space encompasses not only international legislation such as the five United Nations Treaties, the Resolutions adopted by the General Assembly of the United Nations, or the Guidelines on the long-term sustainability of outer space activities and on space debris mitigation. Also institutions and mechanisms such as COPUOS are essential components of space global governance.

9.7 Satellite constellations providing global telecommunication services are a lawful activity. So is ground-based astronomical observation of the sky. It is desirable to achieve coordination in order that both activities can co-exist peacefully. International Space Law can play a role in achieving that purpose.

9.8 Some rules contained in the 1967 Outer Space Treaty (OST) that may apply to this problem have been identified by the WG and by other legal authors, most notably Article I (which establishes freedom of access to and utilization of outer space), Article III (which opens the way to the application of general International Law in outer space), Article VI (which brings the duty to authorize and supervise private operators of satellite constellations), and Article IX (with its ‘due regard’ ‘harmful interference’ and “duty of consultation” provisions).

9.9 Article III means that there are important principles of International Environmental Law that may be applicable and might serve as an inspiration for a solution to the problem at hand. These include the principle of preventing transboundary harm, the precautionary principle, the principles of equitable use and sustainable development, and the good neighborliness principle. Principle 2 of the Rio Declaration on Environment and Development seems to be particularly relevant here: States have the duty to avoid the contamination of areas located beyond their jurisdiction, such as outer space.

9.10 Article VI implies that, in relation to the light pollution problem, States are internationally responsible for guiding private actors to ensure responsible and sustainable use of outer space.

Also and foremost, they are responsible for their compliance with International Law and principles through the imposition of relevant requirements for the authorization and supervision of space activities.

9.11 Article IX OST seems particularly suitable to apply to our problem, provided that ground-based astronomy may be considered as an activity contained within its scope of application. Historical interpretation of Article IX OST seems to favor such view, as argued in this report. A closer analysis of the events which led to formation of Article IX OST, together with the text of Article IX itself, suggest that the intention of the Treaty-makers was to protect the interests and activities of States carried out on Earth as well as in outer space.

9.12 Article IX in fact constitutes a limitation on the freedom of exploration and use of outer space. From this provision, very largely patterned after Principle 6 of the Declaration of Legal Principles contained in UNGA Resolution 1962 (XVIII) of 13 December 1963, it seems that States Parties to the Outer Space Treaty must conduct all of their activities in outer space 1) with due regard to the corresponding interests of all other States Parties to the Treaty; 2) avoiding harmful interference with the activities of others; 3) avoiding the harmful contamination of outer space and celestial bodies, as well as adverse changes in the Earth's environment; and 4) engaging in international consultations whenever necessary.

9.13 When applying the "due regard" and other provisions contained in Article IX, however, we have the problem of the wide margin of interpretation of these terms allowed by the Treaty. We also suffer from the lack of previous State practice in applying those provisions and in initiating international consultations under Article IX. As a result, there is no guidance on whether and how such duties would actually apply to the issue of light pollution of the night sky caused by space objects.

9.14 Apart from these Articles from the OST, and the potential application of International Environmental Law to outer space via Art. III OST, at present there are no international rules that apply to optical pollution of the night sky caused by space objects. Given that current regulation is clearly insufficient, the potential elaboration of new legal rules addressing specifically this problem was also considered by the WG. The underpinning approach is to seek answers to the legal questions regarding the existing international legal framework applicable to the problems that might proliferate when satellite constellations become commonplace.

9.15 As a first step, the WG considered the adoption of a series of non-binding guidelines in COPUOS as a method of elaborating the first international rules aimed to limit light pollution

due to activities in LEO. Such rules could take as a model the space debris mitigation guidelines and the long-term sustainability guidelines adopted in COPUOS in 2007 and in 2019, respectively. The goal would be to issue some guidelines that will reflect a reasonable compromise between the satellite operators and the needs of astronomers. Those guidelines could then be picked up by national governments as licensing regulations.

9.16 The LTS Guidelines constitute a useful model for addressing the challenge of light interference in Astronomy for a number of reasons. These guidelines are adopted through a bottom-up approach, offering a platform for all stakeholders to express their views. They are voluntary norms that offer flexibility to each country. The Guidelines fill the gaps of the existing space treaties and can serve as a basis for further development and evolution into binding laws and treaties. And they can become binding Customary International Law in the future. Since the LTS Guidelines have been envisaged as an evolving instrument that should be updated as new challenges are identified, they can serve as a possible source or as a possible model for establishing a preliminary, non-binding regulation of satellite constellations with an aim to preserve dark skies.

9.17 The actual elaboration of guidelines addressing light pollution caused by space objects could take place either within the currently existing long-term sustainability working group or in the framework of a new, separate expert group, depending on how the Member States of COPUOS should decide to proceed. In the discussions held during the latest session of the STSC in February 2023, the vast majority of Member States seemed to favor the creation of a specific group for this purpose.

9.18 The WG also explored the possibility and the desirability of adopting some kind of natural and cultural heritage protection of the night sky at the international level. Attempts have already been made in that respect, resulting in soft law documents such as the Universal Declaration of Human Rights for Future Generations (1994) or the Starlight Declaration adopted in an international conference in La Palma (2007). These international initiatives are in the right direction leading to creation of awareness and recognition of the light pollution problem. Although any binding legislative attempt for night sky protection at the international level is yet to be seen, these initiatives suggest that such attempts are very likely in the near future. A suggestive option would be the adoption of an international agreement protecting the dark sky as a world heritage, perhaps in the framework of UNESCO's role in protecting natural and cultural heritage.

9.19 In addition, the possible creation of a new fundamental human right of a cultural nature that would protect stargazing and the enjoyment of a pristine night sky has also been discussed by the WG. Already some international texts such as the 1966 International Covenant on Economic, Social and Cultural Rights and the 2007 United Nations Declaration on the Rights of Indigenous Peoples contain provisions that could be interpreted as considering that astronomy (understood both as stargazing generally and as a scientific discipline) is a cultural right to be protected.

9.20 Solutions to the current situation could also come from National Space Law, by introducing new licensing rules and legal standards that would be imposed on operators of satellite constellations at the domestic level. In this context of national legislation, mention should be made of the Statement issued by the Board of Directors of IISL in July 2021, “Consideration of the Interests of the Public and other Stakeholders in the Authorization and Continuing Supervision of Commercial Space Activities,” which asks national regulators to give careful consideration to the interests of all stakeholders, including the scientific community and the general public, regarding the consequences of authorizing activities such as large constellations of satellites.

9.21 The WG searched for national space laws concerning the visual impact of space objects on the night sky. However, except for a 2001 US federal law prohibiting obtrusive space advertising, no national legislation was found on that matter.

9.22 On the other hand, there are multiple national laws and regulations around the world preserving dark skies at the local level. This report provides a brief overview of those laws and regulations that are already in force and protecting the quality of the night sky, albeit from ground-emitted light pollution only. These laws reflect an *opinio iuris* of many States in terms of acknowledging the immense value of dark skies, and they constitute a significant precedent for establishing a worldwide protection of the night sky. They also may provide some elements to be taken into account when brightness of space objects finally becomes regulated. It is essential to emphasize that, lacking such global protection, the increasing light pollution caused by space objects will be defeating the purpose of all those national laws, and rendering them useless in practice.

9.23 Finally, the WG analyzed what is actually being done at the moment in order to address the problem of the light pollution of the night sky caused by large satcons, in terms of the mitigating measures adopted by satcons. The ongoing collaboration between the satellite

industry and the astronomical community has led to a set of best practices, which include implementing some voluntary changes to satellite designs, providing positional data of the satellites, and modifying the orientation of satellites in orbit-raising and orbit-lowering procedures in order to minimize the reflected light produced by satellites. This channel of communication between astronomers and operators is essential and it must be preserved.

9.24 Nevertheless, the WG examined to what extent these voluntary measures are working, and the general perception is that the mitigation measures adopted so far have not been sufficient to solve the problem. Even if they had been, the continuity of such measures is dependent on the goodwill of the companies: This is basically a case of self-regulation. Self-regulation should not replace the international institutions and instruments governing problematic matters. In contrast, it can be conceived as a complementary tool in the joint efforts to preserve the darkness of the skies. For this and other reasons, it is concluded that a proper regulation of the brightness of space objects as seen from the ground will be eventually necessary to fully solve this problem.

9.25 The WG also considered the recent initiatives related to space sustainability rating. The rating of companies based on their respect for sustainability of the outer space environment might be applicable also to the problem of light pollution of the night sky caused by space objects.



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