Abstract

This article provides a summary on the origins of the concept of the Long-Term Sustainability of Outer Space Activities (LTSOSA) by reviewing previous discussions related to the definition of this concept with the conclusion that the LTSOSA is in fact derived from the concept of sustainable development, and comprises five legal elements, including the principles of intergenerational equity, sustainable use, intragenerational equity, integration and peaceful purposes. In this regard, the LTSOSA to some extent has been already reflected in international environmental law and international space law. This article therefore argues that to enhance the LTSOSA, the Asia-Pacific Space Cooperation Organization (APSCO), which is a regional intergovernmental cooperative organization, has to embrace an LTSOSA regime because of its own interests, the need to fulfil its international obligations that have been imposed by international environmental law and international space law, and the need for regional efforts, which can complement both national and international efforts. Finally, it is concluded that APSCO should establish internal legal regulations that address issues related to the LTSOSA, at least those that take into consideration space debris mitigation, space weather, space traffic management, capacity building (especially the transfer of space-oriented environmentally sound technology) and radio frequency interference.

Keywords: LTSOSA; Definition; International legal framework; APSCO; Internal regulation; Space legal issues

1. Introduction

There have been significant improvements in how the universe is viewed in the past 60 years due to space science and space technology, which have greatly enhanced daily life with the help of meteorological forecasting, climate modelling, environmental monitoring, natural resources management, satellite navigation, communication, and early warning systems[1]. These have all contributed to mitigating disasters and supporting disaster management[2]. Simply put, space science and space technology have so much importance that it is anticipated that the exploration and use of outer space will continue over the long term.

However, behind the advancements in space science and technology is a dramatic increase

[1] A/AC.105/2017/CRP.26, 7-16 June 2017, at 11, available on the UNOOSA website: http://www.unoosa.org/oosa/oosadoc/data/documents/2017/aac.1052017crp/aac.1052017crp.26_0.html. (accessed 10 August 2017).
[2] *Id.*

in space debris and space traffic. In 1989, it was estimated that there were approximately 7000 pieces of space debris larger than 10 cm in size[3], which increased to 9428 in 2006[4]. However, several anti-satellite tests[5], combined with collisions between different space objects increased the number to 21,000 in 2011[6], and around 29,000 in 2013[7]. So much space debris is now left in orbit that it poses a significant threat to persons and assets in outer space and even on Earth[8]. In addition, an increasing number of space objects are launched into orbit[9], which not only creates challenges in space traffic management but also increases potential collisions between them. In parallel, similar concerns have been expressed over space weather, frequency interference and military uses of outer space, all of which also pose risks to the safety of space operations. Suffice to say, if each space actor only considers its own short-term interests, the future of space exploration and use will be seriously jeopardized[10]. Therefore, the LTSOSA

[3] William B. Wirin, SPACE DEBRIS (notes), American Institute of Aeronautics and Astronautics (1989) 185.
[4] M.Y.S. Prasad, Rajeev Lochan, Common but differentiated responsibility-a principle to maintain space environment with respect to space debris, American Institute of Aeronautics and Astronautics (2007) 288.
[5] On January 11, 2007, China launched an SC-19 ASAT missile and destroyed its defunct weather satellite, FY-1C. Brian Weeden, Anti-Satellite Tests in Space-The case of China, Secure World Foundation. 16 August 2013. https://swfound.org/media/115643/china_asat_testing_fact_sheet_aug_2013.pdf. Laura Grego, A History of Anti-Satellite Programs, Union of Concerned Scientists, released online on January 2012, at 13. https://www.ucsusa.org/sites/default/files/legacy/assets/documents/nwgs/a-history-of-ASAT-programs_lo-res.pdf. (accessed 4 May 2018). On 14 February 2008, America also fired a missile to destroy its Reconnaissance satellite, USA-193. Laura Grego, ibid, at 12. Also see David Wright, The Current Space Debris Situation, 2010 Beijing Orbit Debris Mitigation Workshop. https://swfound.org/media/99971/wright-space-debris_situation.pdf. (accessed 10 June 2017).
[6] National Research Council. Limiting future collision risk to spacecraft: an assessment of NASA's meteoroid and orbital debris program. National Academies Press; 2011. p. 6, as quoted by Ray A. Williamson, Assuring the sustainability of space activities, Space Policy 28 (2012) 154. See also David Wright, *ibid.*
[7] "How many space debris objects are currently in orbit?", ESA, July 2013. http://www.esa.int/Our_Activities/Space_Engineering_Technology/Clean_Space/How_many_space_debris_objects_are_currently_in_orbit . (accessed 10 July 2017).
[8] Cerise, a French military reconnaissance satellite, was hit by a space debris generated by an Ariane rocket in 1996. Alby, F., Lansard, E., & Michal, T., Collision of Cerise with Space Debris, Second European Conference on Space Debris (1997) 589. http://adsabs.harvard.edu/full/1997ESASP.393..589A. Five Japanese were injured by space debris on a ship in 1969, and a similar thing happened to an American woman in 1997. U.S. Congress, Office of Technology Assessment, Orbiting Debris: A Space Environmental Problem-Background Paper, OTA-BP-ISC-72 (Washington, DC: U.S. Government Printing Office, September 1990), at 3. https://web.archive.org/web/20160304000243/http://www.fas.org/ota/reports/9033.pdf. In 2007, a big piece of space debris from a Russian spy satellite flew very close to a LAN Airlines Airbus A340 carrying 270 passengers. Matteo Emanuelli, Tobias Lips, Risk to Aircraft from Space Vehicles Debris, International Association for the Advancement of Space Safety, presented at the 2015 Fifty-second session of UN COPOUOS Scientific and Technical Subcommittee, 6 February 2015, at 5. http://www.unoosa.org/pdf/pres/stsc2015/tech-29E.pdf.
[9] There have been 7900 space objects launched into outer space since 1957 and 3384 of them currently in orbit. Recently, the number of space objects launched per year increased faster than ever before. Specifically speaking, between 1964 and 2012, it was controlled range from 72 to 168 per year. However, after 2012, more than 200 space objects were sent to the orbit each year. (210 in 2013, 242 in 2014, 223 in 2015, 222 in 2016 and 305 in 2017). http://www.unoosa.org/oosa/osoindex/searchng.jspx?lf_id=#?c=%7B%22filters%22:%5B%5D,%22sortings%22:%5B%7B%22fieldName%22:%22object.launch.dateOfLaunch_s1%22,%22dir%22:%22desc%22%7D%5D%7D. (accessed 8 November 2017).
[10] David A. Broniatowski, Annalisa L. Weigel, The political sustainability of space exploration, Space Policy 24 (2008) 152.

has been the subject of much discussion and debate within the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS) since 2010.

However, comparatively few, if any, legal studies have examined the interplay between issues that concern the LTSOSA and the internal regulations of regional intergovernmental space organizations such as the Asia-Pacific Space Cooperation Organization (APSCO), which is already an important space actor. Therefore, this study will address the research gap by examining whether it is necessary to incorporate an LTSOSA regime into the APSCO legal mechanism and some legal issues that APSCO faces in doing so. After an introduction of the origins of the LTSOSA, a discussion will follow on the definition of LTSOSA in Section 2 with a doctrinal method and a comparative approach, and then its legal sources in Section 3. In the fourth section, the need for APSCO to establish a regulatory framework in relation to the LTSOSA will be discussed. The final section will focus on various selected legal issues in respect of an LTSOSA regime with a doctrinal method.

2. Concept of LTSOSA

2.1. Origins of LTSOSA

Space environmental concerns were addressed by the Committee on Space Research (COSPAR) which was established by the International Council of Scientific Union as early as 1958[11]. More importantly, the principle of environmental protection was added in Para. 6 of the Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space in 1962 (Outer Space Principle Declaration of 1962) and established as a fundamental principle in Article IX of the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (Outer Space Treaty of 1967).

A stable, safe and conflict-free space environment is an indispensable prerequisite for our long-term exploration and use of outer space[12]. However, militarization and weaponization of

[11] 'News of Science: Development of International Effects to Avoid Contamination of Extraterrestrial Bodies' (1958) 128 Science 887, as quoted by Stephan Hobe, Bernhard Schmidt-Tedd, Kai-Uwe Schrogl (ed.), Goh (assist. Ed.), Cologne Commentary on Space Law (Vol. 1): Outer Space Treaty, Carl Heymanns Verlag (2009) 171.

[12] Prerequisites for promoting the consideration of ways and means of maintaining outer space for peaceful purposes in the context of the issue of the long-term sustainability of outer space activities, a working paper submitted by the Russian Federation, Committee on the Peaceful Uses of Outer Space Scientific and Technical Subcommittee, Fifty-first session Vienna, 10-21 February 2014, A/AC.105/C.1/L.338, at 4. http://www.unoosa.org/pdf/limited/c1/AC105_C1_L338E.pdf.

outer space, though might be regarded as essential means to enhance national security by some countries in the space age[13], have become essential reasons for giving rise to instability, unsafety and possible conflict in outer space[14] and thus interfering with our further exploration and use of outer space. First, the alternate placement and installation of weapons between the United States and the Soviet Union in space, which were primarily triggered by combination of great importance of satellites in military uses[15] and fierce arm race between the two superpowers in outer space in the early years of the cold war[16], had brought about ongoing tensions between them during the cold war. Second, the test of anti-satellite (ASAT) weapons have become one of essential reasons for the proliferation of space debris since the cold war[17] and thus posed a great threat to the space environment and the safety of space operation[18]. Unfortunately, from the very beginning of the space age, proposals of achieving a complete demilitarization of outer space had been clearly rejected by the two superpowers[19]. Moreover, the existing legal regime applicable to outer space is not sufficient to prevent the placement and test of conventional weapons in outer space [20]. First, Article IV of the Outer Space Treaty of 1967 only prohibits the deployment of weapon of mass destruction rather than conventional

[13] National security was one of the most important considerations for the United States to develop its military capacity in outer space after the Soviet Union successfully launched the first human-made satellite Sputnik I and declared its superiority in the exploration of outer space. "Draft Preliminary Statement of U.S. Policy on Outer Space," U.S. National Security Council Planning Board, 20 June 1958，at 1. http://marshall.wpengine.com/wp-content/uploads/2013/09/NSC-5814-Preliminary-U.S.-Policy-on-Outer-Space-18-Aug-1958.pdf.

[14] Anton Vasiliev, The Treaty of the Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force Against Outer Space Objects, Published in: Celebrating the Space Age: 50 Years of Space Technology, 40 Years of the Outer Space Treaty— Conference Report 2–3 April 2007, Geneva, UNIDIR, 2007, at 114-115. https://www.peacepalacelibrary.nl/ebooks/files/UNIDIR_pdf-art2670.pdf.

[15] A large number of satellites at the beginning of the space era were deployed mainly for the military purposes, such as for reconnaissance, early warning of ballistic missile launches, battle assessment, arm control verification. Laura Grego, supra note 5, at 1.

[16] Negating military satellite threats was one of essential reasons for the two superpowers' heavy investment in ASAT technologies to against each other. Hence, it appears to be fair to say that the arm race in outer space was partly characterized by the development and test of different kinds of ASAT systems between the two superpowers in the cold war. See Laura Grego, supra note 5, at 2-6.

[17] The American test of the Air-Launch Miniature Vehicle in 1985 against its aging Solwind satellite generated more than 250 pieces of space debris, which was big enough to be tracked at the time, and 800 to 900 smaller pieces. Laura Grego, *supra note* 5, at 5. The Chinese ASAT test generated 2841 pieces of catalogued debris. David Wright, supra note 5.

[18] The French satellite Cerise collided with space debris in 1996. Alby, F., Lansard, E., & Michal, T., *supra* note 8.

[19] B Cheng, 'Military Use of Outer Space: Article IV of the 1967 Space Treaty Revised' in C-J Cheng and D H Kim (eds), The Utilization of the World's Air Space and Free Outer Space in the 21st Century (Kluwer, The Huge 2000) 308. Stephan Hobe, Bernhard Schmidt-Tedd, Kai-Uwe Schrogl (ed.), Goh (assist. Ed.), *supra* note 11, at 71.

[20] Report of the Committee on the Peaceful Uses of Outer Space, Fifty-eighth session (10-19 June 2015), General Assembly, Official Records Seventieth Session Supplement No. 20, at 10. http://www.unoosa.org/res/oosadoc/data/documents/2015/a/a7020_0_html/A_70_20E.pdf.

weapon in earth orbit[21]. Second, the ASAT test in outer space is not clearly forbidden in the provisions related to the peaceful purposes in the outer space treaty[22].

Legal issues in respect of environmental protection in outer space, however, were not discussed until an international trend came about which stressed on balancing economic development and protecting the international environment[23], and some detrimental changes in the space environment in the late 1980s and early 1990s. However, discussions on the balance between economic development and international environmental protection, which started as early as the 1970s, did not draw global attention until 1987[24], when sustainable development was explicitly brought up in the well-known Brundtland Report, which indicated that development must meet the needs of the present with due regard to the needs of future generations[25]. Following that, sustainable development emerged in various international documents[26], international case decisions[27] and the academic literature[28] from different perspectives, and was even recognized as a general principle in the 1990s[29]. The global pervasiveness of sustainable development, combined with adverse changes in the space environment in the 1990s[30], inevitably turned the attention of academics and practitioners in

[21] Laura Grego, *supra note 5, at 3.* See also Article IV, UNGA Res. 2222 (XXI) (December 19, 1966), "Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies". Stephan Hobe, Bernhard Schmidt-Tedd, Kai-Uwe Schrogl (ed.), Goh (assist. Ed.), *supra* note 11, at 71. He Qizhi, Outer Space Law, Law Press China (1992) 66-67.

[22] Laura Grego, *id.* Stephan Hobe, Bernhard Schmidt-Tedd, Kai-Uwe Schrogl (ed.), Goh (assist. Ed.), *supra* note 11, at 78, 80.

[23] See Motoko Uchitomi, Sustainable Development in Outer Space-Applicability of the Concept of Sustaianble Development of Space Debris Problems, American Institute of Aeronautics and Astronautics (2000) 71-72.

[24] David Hunter, James Salzman, Durwood Zaelke, International Law Environmental Law and Policy, New York: Foundation Press (1998) 100.

[25] Report of the World Commission on Environment and Development (The Brundtland Report), Our Common Future (1987), 43.

[26] For instance, Agreements on Co-operation for the Sustainable Development of the Mekong River Basin, 34 ILM 864 (1995); Declaration on Establishment of the Artic Council, 35 ILM 1382 (1996); Partnership for Prosperity and Security in the Caribbean, 36 ILM 792 (1997); Yaoundé Declaration on the Conservation and Sustainable Management of Forest, 38 ILM 783 (1999); South East Europe Compact for Reform, Investment, Integrity and Growth, 39 ILM (2000); Revised Protocol on Shared Watercourses in the Southern African Development Community, 40 ILM 321 (2001)", as quoted from Philippe Sands, Jacqueline Peel, Adriana Fabra, Ruth MacKenzie, Principles of International Environmental Law (3nd edition), Cambridge: Cambridge University Press (2012) 207.

[27] In the Gabčíkovo–Nagymaros case, the ICJ invoked the concept, indicating the term had a legally procedural and substantive function. In the Shrimp/Turtle case, the WTO Appellate Body invoked the concept in examining whether American measures had been carried out in a discriminatory manner. Philippe Sands, Jacqueline Peel, Adriana Fabra, Ruth MacKenzie, *supra* note 26, at 208-9.

[28] Philippe Sands, Jacqueline Peel, Adriana Fabra, Ruth MacKenzie, *supra* note 26.

[29] The "principle of sustainable development" seemingly had been mentioned first "in the preamble to the Agreement on the European Economic Area Agreement of 1992. *Id.*

[30] The estimated number of space debris (more than 1mm) had exceeded 35 million by 1995, the number of those more than 10 cm amounted to 8000 pieces. But most of it could not be identified as they were too small (smaller than 1 cm). The National Science and Technology Council, Committee on Transportation Research and Development (USA), Interagency Report on Orbital Debris 1995, at 6, as quoted by Motoko Uchitomi, *supra* note

the space community to the environmental protection of outer space. First, to ensure the stability of space activities, the first Group of Governmental Experts on Transparency and Confidence Building Measures in Outer Space Activities was established under the auspice of the United Nations in 1990, and released its report in 1993[31]. Second, in wake of an obvious increase in space debris that posed more risks to space operations, the issue of space debris was placed on the agenda of the Scientific and Technical Subcommittee of UNCOPUOS in 1994[32]. This fueled more discussion in the academia on the relevance of sustainable development to the space debris issue and protection of the space environment[33].

The first legislation effort made to address orbiting space debris at the international level was by the International Law Association, which spent 8 years examining the legal issues related to space debris and adopted the ILA Draft International Instrument on the Protection of the Environment from Damage Caused by Space Debris[34] in 1994. Following that, the Inter-Agency Debris Coordination Committee (IADC) published the IADC Debris Mitigation Guidelines in 2002[35], which created the basis for the new Space Debris Mitigation Guidelines which were adopted by the UNCOPUOS in 2007[36], and subsequently have been widely accepted by the international community. Meanwhile, the number of human-made spacecrafts, especially satellites, increased rapidly, causing more crowding of the earth orbit and resulting in the need to manage space traffic with the implementation of rules[37]. In response, the International Academy of Astronautics published a cosmic study report on their position on space traffic management in 2005 which was presented to the UNCOPUOS in June 2006[38].

Apart from the military uses of outer space, space debris and space traffic congestion,

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23, at 72. Such environmental change increased the possibility of damaging or even destroying operative satellites in case of crash. Motoko Uchitomi, *id.*

[31] Sergio Marchisio, The Legal Dimension of the Sustainability of Outer Space Activities: The Draft International Code of Conduct on Outer Space, Proceedings of the International Institute of Space Law (2012) 6-8. See also https://www.un.org/disarmament/topics/outerspace/. (accessed 15 August 2017).

[32] Karl-Heinz Bockstiegel, ILA Draft Convention on Space Debris, German Journal of Air and Space Law 43 (4) (1994) 395. Report of the Scientific and Technical Subcommittee on the Work of its Thirty-First Session, 1994, A/AC.105/571, at 2.

[33] Most legal studies about space debris started surfacing in 1989. Lucinda R. Roberts, Orbital Debris: Another Pollution Problem for the International Legal Community, Florida Journal of International Law 11 (1997) 616. See Gunnar Leinberg, Orbital Space Debris, 4 J.L. & Tech. (1989) 93-116. Howard A. Baker, Space Debris: Legal and Policy Implications (1989). Stephan Hobe, Space Debris: A Proposal for its International Legal Regulation, 34 Proc. on L. Outer Space (1991) 194-200. Delbert D Smith, The Technical, Legal and Business Risks of Orbital Debris, New York University Environmental Law Journal, 6 (1997) 50-71. Motoko Uchitomi, *supra* note 23, at 71-80. Mark Williamson, Space ethics and protection of the space environment, Space Policy 19 (2003) 47–52.

[34] Karl-Heinz Bockstiegel, *supra* note 32, at 396.

[35] Gérard Brachet, The origins of the "Long-term Sustainability of Outer Space Activities" initiative at UN COPUOS, Space Policy 28 (2012) 162.

[36] *Id.*

[37] *Id.*

[38] *Ibid*, at 163.

however, the long-term exploration and use of outer space were also threatened by space weather, nuclear contamination and radio frequency interference. More importantly, these six issues were more or less correlated with each other, and addressing them respectively was not an optimal choice. It was thus necessary to come up with a more inclusive concept that covered and addressed all the aforementioned issues. Under such circumstance, some proposed that the concept of sustainable development should be extended to the space domain[39]. This concept, however, was not entirely fitting to reflect the unique character of outer space, in that space related activities should be conducted only for peaceful purposes. The more acceptable concept was the LTSOSA instead, which was broached by Karl Doetsch in his speech to the UNCOPUOS in 2004[40]. Unfortunately, it was not regarded as a serious concern until some serious incidents took place in outer space after 2006, including two anti-satellite tests and a collision between the Iridium 33 and Cosmos 2251 satellites[41]. A tremendous amount of space debris was generated after these events[42], which created an international awareness that the ability to sustain the long-term exploration and use of outer space was no longer guaranteed[43]. This increasingly enhanced awareness among the delegates of the UNCOPUOS members states, combined with the increasing research on the issues related to the LTSOSA, promoted discussions on this concept within the UNCOPUOS after 2007. Consequently, it was confirmed as an agenda item of the UNCOPUOS from 2010 onwards[44]. Fortunately, under the Working Group on the LTSOSA of the UNCOPUOS, a set of comprehensive guidelines in respect to the LTSOSA have been drafted since 2010[45], thus marking a laudable step towards addressing the LTSOSA issues.

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[39] A/AC.105/L.277, 8 June 2010, at 3, available on the UNOOSA website: http://www.unoosa.org/oosa/oosadoc/data/documents/2010/aac.105l/aac.105l.277_0.html. (accessed 10 July 2017).

[40] See Laura Delgado, Christopher D. Johnson, Victoria Samson, Michael Simpson, Brian Weeden, The Importance of the United Nations Guidelines for the Long-Term Sustainability of Space Activities and Other International Initiatives to Promote Space Sustainability, OASIS - Observatorio De Análisis De Los Sistemas Internacionales 20 (2014) 42. Also https://swfound.org/media/189048/swf_un_copuos_lts_guidelines_fact_sheet_december_2014.pdf. (accessed 10 August, 2017).

[41] *Supra* note 5.

[42] The intentional collision of Fengyun-1C generated 2841 pieces of debris in 2007, the collision between Cosmos 2251 and Iridium 33 in 2009 created 1788 pieces, but there is not data on the number of debris generated by the US's test. David Wright, *supra* note 5.

[43] Gérard Brachet, *supra* note 35, at 161-2.

[44] Gérard Brachet, *supra* note 35, at 164.

[45] Through nearly 7-year discussion, by 14 June 2017, UNCOPUOS had agreed to a first set of Guidelines for LTSOSA, including Guidelines 1, 2, 3, 4, 12, 13,16, 17, 25, 26, 27, 28. But the preamble and Guidelines 6, 7, 8, 9, 10, 11, 14, 15, 18, 19, 20, 21, 22, 23, 24, 30, 31 and 32 are in need of further discussion afterwards. See *supra* note 1.

2.2 Defining LTSOSA

2.2.1. Previous discussions

The LTSOSA is often discussed and defined as an analogy with sustainable development[46]. This definition, however, is not a holistic view of the LTSOSA, as the peaceful purposes have been recognized as basic requirements for outer space activities[47]. Hence, there are definitions that have incorporated these requirements in defining the LTSOSA. For instance, it is the "use of outer space in a peaceful, safe, equal and efficient way"[48], or "ensuring that all humanity can continue to use outer space for peaceful purposes and socioeconomic benefit now and in the long term"[49]. While helpful for reflecting on the nature of the LTSOSA, they neglect the relationship between the concept of LTSOSA and that of sustainable development, which had been clearly emphasized in the working paper of the fifth UNCOPUOS session of 2010[50]. Specifically speaking, the former definition does not include the principle of sustainable use which has been regarded as a basic component of sustainable development, while the latter is oversimplifying, without taking into consideration the principle of intragenerational equity. In this sense, Marchisio provides a comparatively more comprehensive definition, which not only includes the concept of sustainable development but also gives weight to "peaceful purposes"[51].

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[46] See Ray A. Williamson, *supra* note 6, at 155; Sylvie Durrieu, Ross F. Nelson, Earth Observation from Space--The Issue of Environmental Sustainability, Space Policy 29 (2013) 239; Yin Yuhai, Yan Yongliang, Challenges Related to Long-term Sustainability of Outer Space Activities and Their Solutions, Journal of Beijing University of Aeronautics and Astronautics (Social sciences edition) 3 (2016) 21. Zhao Yun, New Perspective and Emerging Approach on Sustainable Development in Outer Space from China s Practice in Space Cooperation, Chinese Review of International Law 3 (2017) 62-4.

[47] Para 2 of the preamble of Outer Space treaty of 1967 in particular recognizes "the exploration and use of outer space for peaceful purposes". While the Treaty only possesses 13 operative articles, Article 3, 4, 9 and 11 of it refer to the "maintain international peace" or "peaceful exploration and use of outer space". In other words, the peaceful purpose has become a fundamental characteristic of outer space activities under the Outer Space Treaty of 1967.

[48] Bin Li, Weeden and Chow: Commentary from a Legal Perspective, Space Policy 28(2012)178; Wang Guoyu, The Issue of Long-term Sustainability of Outer Space Activities and China's solutions, Aerospace China, 2(2016)32.

[49] https://swfound.org/our-focus/space-sustainability/. (accessed 10 July 2017). See also Ajey Lele, Space Sustainability: Consent to Security Insurance, Strategic Analysis, 36 (5) (2012) 708-9. Timiebi U. Aganaba, Towards Space Sustainability: Lessons from Environmental Liability Regimes, Thesis (LL.M.), McGill University, 2012, at 15-6. http://pqdd.sinica.edu.tw.eproxy2.lib.hku.hk/cgibin2/Libo.cgi?request=LA_RESOURCE.GET&template=&user=aaemakecfbodnbfplanofmkpkiieecdlledenmcjchiegjpkplpefjdkjlifgpoi&client_type=search&lang=ddc.eng&urlID=1485088640730&app=13&type=path&field=image&doi=54538195&file=MR84120.pdf&. (accessed 10 April 2017).

[50] It states that "Sustainable space utilization supporting sustainable development on Earth: (i) The contribution of space science and technology to sustainable development on Earth; (ii) The concept of sustainable development extended to the domain of outer space". *Supra* note 39.

[51] He argues that "sustainability means the use of outer space in a way that maintains its potential to meet the needs and aspirations of present and future generations, and that ensures all humanity continue to use it for

Attention must also be drawn to an explanation that "sustainability" should include not only technical feasibility but also political will[52]. In other words, space sustainability not only means the technical feasibility that leads to the sustainable exploration and use of outer space in the long term, but also the political willingness to do so. This view, to some extent, contributes to the understanding of the LTSOSA.

2.2.2. Definition of LTSOSA in UNCOPUOS draft guidelines

Apart from the discussions in the academia, the conceptualization of the LTSOSA is also found within the UNCOPUOS. There are three alternatives for consideration by the delegates in the latest draft guidelines for the LTSOSA, under which the LTSOSA is defined as "the conduct of space activities in a manner that balances the objectives of access to the exploration and use of outer space by all States and governmental and non-governmental entities only for peaceful purposes with the need to preserve the outer space environment in such a manner that takes into account the needs of current and future generations" (Alternative 1) or "the conduct of space activities in a manner that balances equitable access to the exploration and use of outer space [solely] for peaceful purposes with the need to preserve the outer space environment for current and future generations" (Alternative 2), or "the conduct of space activities in a manner that enables equitable access to the exploration and use of outer space [solely] for peaceful purposes and preserves the outer space environment for current and future generations" (Alternative 3)[53]. From these three alternative definitions, it is obvious that the LTSOSA, in effect, largely reflects the concept of "sustainable development" as provided in the Brundtland Report of 1987. The difference between them, however, is that the LTSOSA under the draft guidelines gives weight to "peaceful purposes".

It is also worth noting that the draft guidelines for the LTSOSA emphasize an oft-stated aim with a broader perspective, in which the aim is not limited to maintaining a balance between conducting space activities and protecting the space environment, but also includes supporting sustainable development goals on Earth[54]. This makes sense, since those space activities which cannot give us real or potential socioeconomic benefits in the long term will not be carried out with sustainable interest further.

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peaceful purposes, scientific and technological advancements and socioeconomic benefits." Sergio Marchisio, *supra* note 31, at 3.

[52] Scott Pace, Challenges to US Space Sustainability, Space Policy 25 (2009) 156. David A. Broniatowski, Annalisa L. Weigel, *supra* note 10, at 148.

[53] *Supra* note 1, at 12-3.

[54] *Ibid*, at 4.

2.2.3 Five legal elements of LTSOSA

The origins of the LTSOSA indicates that it shall be defined as a derivative of "sustainable development" and "sustainability" in the space domain. That is, the LTSOSA has implications of sustainable development. In this regard, the LTSOSA appears to be a concept that comprises five recurring elements, which take into consideration four legal elements of sustainable development offered by Sands[55]: the principles of intragenerational equity, sustainable use, intergenerational equity, integration, and peaceful purposes, all of which are closely related and usually used in overlapping ways[56].

First, the principle of intragenerational equity is established to ensure equitable access to the exploration and use of outer space by all space actors[57]. In particular, a space actor should use space resources in a manner that takes into account of the needs of other contemporary actors[58], *inter alia*, the developing countries. Second, the principle of sustainable use aims to ensure that the exploitation and use of space resources are conducted in a 'sustainable', 'prudent', 'rational', 'wise' or 'appropriate' fashion[59]. Third, the principle of intergenerational equity is established to preserve the space environment and space resources in a manner that considers the needs and interests of future generations[60]. Four, the principle of integration establishes that space activities should be conducted in a manner that maintains a balance between "the objectives of access to the exploration and use of outer space" and "the need to protect the space environment"[61]. Finally, the principle of peaceful purposes means that the exploration and use of outer space are carried out for only peaceful purposes[62], which has been

[55] Professor Philippe Sands provides a persuasively theoretical explanation of the concept of "sustainable development", which, he thinks, consists of four legal elements: "the principle of intergenerational equity", "the principle of sustainable use", "the principle of intragenerational equity" and "the principle of integration". Philippe Sands, Jacqueline Peel, Adriana Fabra, Ruth MacKenzie, *supra* note 26.
[56] *Id.*
[57] *Supra* note 1, at 12.
[58] Philippe Sands, Jacqueline Peel, Adriana Fabra, Ruth MacKenzie, *supra* note 26.
[59] *Id.*
[60] *Id.*
[61] *Id.*; *Supra* note 57.
[62] *Supra* note 1, at 45. However, three different opinions are expressed over the meaning of "peaceful": non-military, non-aggressive, and non-weaponed. The first one is a complete demilitarization and a perfect goal of maintaining the LTSOSA if possible. Unfortunately, it was rejected by both of superpowers at the beginning of space age. The second one upheld by USA respects the right of self-defense, but more or less will threat the LTSOSA. The last one has the similar implication as the first one. less weapons were placed in outer space, less threat to the space environment will occur. Thus, if we connect the concept of "peaceful" with the meaning of LTSOSA, "non-military" is the best explanation for the "peaceful", though it is denied by the reality, it should at least be the goal we strive for. Otherwise, our future generations will not enjoy the same benefit we have now. Stephan Hobe, Bernhard Schmidt-Tedd, Kai-Uwe Schrogl (ed.), Goh (assist. Ed.), *supra* note 11, at 22.

a basic characteristic of space activities under the Outer Space Treaty of 1967[63] and one of its fundamental principles. In short, the concept of LTSOSA is not only reflected through the overlapping relationship between the LTSOSA and sustainable development, but also the unique character of outer space activities.

3. International legal framework for LTSOSA

In this section, international law related to the LTSOSA is addressed, including hard and soft laws. First, international environmental law will be discussed, including international instruments and customary international law. This is followed by an analysis of the international space law, including the Outer Space Treaty of 1967 and the Moon Agreement of 1979. Finally, there is a discussion on the UNCOPUOS guidelines for the LTSOSA.

3.1. International Environmental Law

Outer space has a similar legal status as the high seas[64] since it "is not subject to national appropriation by claim of sovereignty"[65]. This indicates that outer space is part of the international environment[66]. Moreover, Article III of the Outer Space Treaty of 1967 has confirmed the applicability of international law to space activities[67]. Hence, outer space should be subject to the rules of international environmental law[68]. First, Principle 21 of the Declaration of the United Nations Conference on the Human Environment establishes that states are responsible for avoiding damage to areas beyond their national jurisdiction when conducting activities[69]. Principle 25 of this declaration further requires all international

[63] See *supra* note 47.
[64] J.C. Cooper, Fundamental questions of outer space law, in I.A. VLASIC (ed.), Explorations in aerospace law: selected essays by John Cobb Cooper, Montreal: McGill University (1968) 48, as quoted by Philip De Man, Exclusive Use in an Inclusive Environment: The Meaning of the Mon-Appropriation Principle for Space Resource Exploitation, Springer (2016) 14.
[65] UNGA Res. 2222 (XXI) (December 19, 1966), *supra* note 21, Article II.
[66] Malcolm N. Shaw in his book, International Law (Fourth edition), discusses outer space in the 15th Chapter, titled "International environmental law", indicuating that he agrees to subject protection of the space environment to the international environmental law. see Malcolm N. Shaw, International Law (Sixth edition), Cambridge: Cambridge University Press (2008) 881-3. Philippe Sands also thinks that the treaties and principles "regulating environmental aspects of outer space" are important part of International Environmental Law. See Philippe Sands, Jacqueline Peel, Adriana Fabra, Ruth MacKenzie, *supra* note 26, at 299-302.
[67] Article III, *supra* note 65.
[68] Viikari, The Environmental Element in Space Law - Assessing the Present and Charting the Future, Studies in Space Law (2008) 120, as quoted by Anal Ferreira-Snyma, The Environmental Responsibility of States for Space Debris and the Implications for Developing Countries in Africa, XLVI CILSA (2013) 35.
[69] Principle 21, Declaration of the United Nations Conference on the Human Environment, Report of the United Nations Conference on the Human Environment, United Nations, Stockholm, 5-16 June 1972,

organizations to "play a coordinated, efficient and dynamic role" in protecting and improving the environment[70]. In addition, the responsibility of the states to avoid damage as established in Principle 21 is reiterated in Principle 2 of the Rio Declaration on Environment and Development[71]. More importantly, this no-harm rule has been recognized as part of the corpus of international law by the International Court of Justice (ICJ) in its 1996 advisory opinion on the *Legality of the Threat or Use of Nuclear Weapons*[72]. In its 1997 case that concerns the *Gabč íkovo–Nagymaros Dams* project, the ICJ proceeds further to recognize the duty of control and preventive action for the purpose of protecting the environment as a well-consolidated principle of general international law, and that the norms that aim to balance economic development and protection of the environment have been validated by many international instruments[73]. Thus, it can be concluded that the responsibility of states and international organizations to protect the environment beyond their jurisdiction from damage incurred by activities within their jurisdiction or control, and reconcile economic development and protection of the relevant environment, has been established as a rule of customary international law.

Furthermore, the Treaty Banning Nuclear Weapon Tests in Atmosphere, in Outer Space and Under Water prohibits any nuclear explosions in outer space[74] to prevent the nuclear pollution of outer space[75]. This is a commendable rule to protect the space environment, as the uncontrollable effects of intentional nuclear explosions perpetuate for a long period of time and may cause substantial injury to astronauts or space station crew members as well as damage property in space[76]. As noted earlier, protection of the space environment is a very essential part of the LTSOSA, and all space activities must be conducted with due regard to protect the

A/CONF.48/14/Rev.1, at 5. See also Stephan Hobe, Bernhard Schmidt-Tedd, Kai-Uwe Schrogl (ed.), Goh (assist. Ed.), *supra* note 11, at 5.

[70] *Ibid*, Principle 25.

[71] Stephan Hobe, Bernhard Schmidt-Tedd, Kai-Uwe Schrogl (ed.), Goh (assist. Ed.), *supra* note 11, at 177. See also Principle 2 of the 1992 Rio Declaration on Environment and Development, United Nations, 12 August 1992, A/CONF.151/26 (Vol. I).

[72] Stephan Hobe, Bernhard Schmidt-Tedd, Kai-Uwe Schrogl (ed.), Goh (assist. Ed.), *supra* note 11, at 177. See also Legality of the Threat or Use of Nuclear Weapons, Advisory Opinion, ICJ Reports 1996, para. 29, p. 241-242. http://www.icj-cij.org/files/case-related/95/095-19960708-ADV-01-00-EN.pdf. (accessed 10 July 2017).

[73] Case concerning the Gabčíkovo–Nagymaros Project (Hungary v Slovakia) (Judgement) (1997) ICJ Rep 7; J Brunnee and E Hey (eds), 'Symposium: The Case Concerning the Gabčíkovo–Nagymaros Project' (1997) 8 Yearbook of International Environmental Law 3, as quoted by Stephan Hobe, Bernhard Schmidt-Tedd, Kai-Uwe Schrogl (ed.), Goh (assist. Ed.), *supra* note 11, at 177-8.

[74] Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water, U.S.-U.K.-U.S.S.R., art. I, Aug. 5, 1963, 14 U.S.T. 1313, as quoted by J. H. Huebert, Walter Block, Space Environmentalism, Property Rights, and the Law, The University of Memphis Law Review 37 (2007) 304.

[75] J. H. Huebert, Walter Block, *ibid.*

[76] See also Volker von Prittwitz, Space as Environment: On the Way to Sustainable Space Policy?, ESPI Perspectives No. 50, 2011, at 3. https://www.files.ethz.ch/isn/131812/ESPI_Perspectives_50.pdf. (accessed 10 July 2017).

space environment. Hence, the abovementioned rules can be the legal grounds for enhancing the LTSOSA.

3.2. International Space Law

Even without reference to the LTSOSA, some treaties in the space domain have already more or less incorporated this concept. The first treaty to do so is the Outer Space Treaty of 1967, of which Para 1 of Article I provides that "(t)he exploration and use of outer space ..... shall be the province of all mankind"[77]. This appears to insinuate the principles of intragenerational and intergenerational equities, because "all mankind" *per se* includes current and future generations, which means that the current and future generations shall share the same right to equitably access, explore and use outer space. Moreover, this explanation is in line with Para 1 and 2 of the preamble of the Outer Space Treaty of 1967, which recognizes "the great prospects opening up before mankind as a result of man's entry into outer space" and "the common interest of all mankind in the progress of the exploration and use of outer space"[78]. The terms "prospects" and "progress" pinpoint that the benefits from the exploration and use of outer space should be enjoyed by not only the current generation but also the future generations. In addition, the principle of intragenerational equity is reflected in Para 2 of Article I, which states that the exploration and use of outer space shall be freely accessible to all countries without discrimination, on an equitable basis[79]. This principle is also later highlighted in Para 1 of Article IX of the Outer Space Treaty of 1967[80]. Following that, Para 2 of Article IX directly highlights that the exploration of outer space shall be conducted in a manner that avoids the harmful contamination of outer space and also adverse changes in the earth environment[81], which points to the principle of integration[82]. More importantly, the principle of peaceful purposes has been stipulated in Articles III and IV, which emphasize that outer space shall be used exclusively for peaceful purposes. In short, the concept of the LTSOSA, although an unwritten basic principle, has been largely reflected in the Outer Space Treaty of 1967.

The LTSOSA is also highlighted in the Moon Agreement of 1979. First, the principle of

[77] Para 1, Article I, *supra* note 65.
[78] *Ibid*, Para 1&2, preamble.
[79] *Ibid*, Para 2, Article I.
[80] George T. Hacket, Space Debris and the Corpus luris Spatials (1994) 99-103, as quoted by Motoko Uchitomi, *supra* note 23, at 78.
[81] Para 2, Article IX, *supra* note 65.
[82] Motoko Uchitomi, *supra* note 80.

peaceful purposes is reflected in Article 3 of the agreement, which emphasizes that the Moon and other celestial bodies shall be explored and used exclusively for peaceful purposes[83]. Second, Para 1 of Article 4 indicates that the Moon and other celestial bodies "shall be the province of all mankind" and "the interests of present and future generations" shall be taken into account[84], which obviously reflects the principle of intergenerational equity which is also emphasized in Para 3 of Article 7. Third, Para 1 of Article 4 also provides that "the exploration and use of the Moon" "shall be carried out for the benefits and in the interests of all countries"[85], which undoubtedly illustrates the principle of intragenerational equity that has been legitimized in Para 4 and Para 7 of Article 11. Fourth, Para 1 of Article 4 and Para 1 of Article 7 both provide the implications of the principle of integration, in that consideration shall be given to the improvement of living standards and economics as well as social development[86], and all state parties shall avoid the harmful contamination of the Moon and other celestial bodies when exploring and using them[87]. Fifth, the principle of sustainable use appears to be reflected in Para 7 of Article 11, which provides that the state parties are to develop and manage space resources in a rational, safe and orderly manner[88]. In other words, while the Moon Agreement of 1979 does not incorporate the LTSOSA as a basic principle, it actually has all of its implications, thus constituting a basic legal instrument that supports the LTSOSA.

3.3. UNCOPUOS Guidelines for LTSOSA

The LTSOSA is a general principle that needs to be legitimized with more specific regulations. Therefore, the draft LTSOSA guidelines discussed within the UNCOPUOS are taken into consideration, which consist of five important aspects: "policy and regulatory framework for space activities", "safety of space operations", "international cooperation, capacity-building and awareness", "scientific and technical research and development" and "implementation mechanisms"[89] for addressing issues related to the LTSOSA[90].

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[83] Article 3, UNGA Res. 34/68 (December 5, 1979), "Agreement Governing the Activities of States on the Moon and Other Celestial Bodies".
[84] *Ibid*, Article 4.
[85] *Id.*
[86] *Id.*
[87] *Ibid*, Para 1, Article 7.
[88] *Ibid*, Para 7, Article 11.
[89] *Supra* note 1.
[90] Christopher D. Johnson and Victoria Samson, A Summer Update on the COPUOS Long-Term Sustainability Guidelines, released on the Space Review on July 24, 2017. http://www.thespacereview.com/article/3291/1 (accessed 25 July 2017).

These guidelines are actually voluntary norms rather than binding laws[91]. Establishing such guidelines, however, in some ways, may be a more ideal way of addressing the complexities of LTSOSA related issues, because currently no international agreement has been concluded to respond to these challenges[92] and adopting a widely acceptable treaty often requires lengthy discussions among the stakeholders on the specificities[93]. In this regard, developing an LTSOSA regime from the bottom-up may help to create stability for the new situation in the space domain[94].

Furthermore, the LTSOSA regime is not part of the treaty-based rules of the International Space Law yet, and no compelling evidence indicates that it has entered the corpus of customary international law either. While some countries, such as France and Britain[95], report their state practices with regard to their implementation of the first set of guidelines on the LTSOSA in 2017, there is not enough evidence to support that state practices and *opinio juris* in support of an LTSOSA regime are incorporated in the rules of customary international law. However, there is reason to believe that the endorsement of the guidelines for the LTSOSA by the UN General Assembly[96] and their implementation by more countries in the future will pave the way to the conclusion of a new international convention or the emergence of customary international law in the foreseeable future[97].

4. Need for regulatory framework related to LTSOSA to guide APSCO

[91] *Id.* and Sergio Marchisio, *supra* note 31, at 20. This doesn't mean that the subscribing countries are not completely bounded by these guidelines. They de facto carry the weights of a joint political commitment of the majority of the UN Member States once endorsed by the UN General Assembly, representing their expectation of good practice and reflecting the values and aspirations of them. Such commitment, expectation, values and aspirations will inevitably impose diplomatic pressures on those that do not abide by the guidelines. Sergio Marchisio, *supra* note 31, at 20. See also Anal Ferreira-Snyma, *supra* note 68, at 30. Welly, Enlightened state-interest - a legal framework for protecting the "common interest of all mankind" from Hardinian tragedy, Journal of Space Law (2010) 307, 312-13.

[92] No international convention was concluded as to dealing with the exploration and use of space after the 1979 Moon Agreement, though several principles and declarations in a form of UN resolution in this field were endorsed by the UN General Assembly. This fact, combined with the International Telecommunication Union's experience, indicates that formulating any treaty-based policy in respect to space affairs is very difficult now and also in the near future. Mark Williamson, *supra* note 33, at 51. See also Timiebi U. Aganaba, *supra* note 49, at 19.

[93] *Id.*

[94] *Id.*

[95] See A/AC.105/C.1/2017/CRP.21 and A/AC.105/C.1/2017/CRP.26.

[96] GA resolutions can be an important source of evidence for proving the existence of the emergence of an opinio juris required for establishing a new rule. ICJ Advisory Opinion, *supra* note 72, para 70, at 254-5.

[97] Tronchetti, 'Soft law' in Brünner & Soucek (eds), Outer space in society politics and law (2011) 621. Welly, *supra* note 91, at 311-12. Gable, Rules regarding space debris: Preventing a tragedy of the commons, 2007 Proceedings of the International Institute of Space Law - 50t Colloquium on the Law of Outer Space 259-262. Anal Ferreira-Snyma, *supra* note 68, at 30-1.

The LTSOSA is in fact of great interest and importance for the APSCO member states, because they have been benefiting tremendously from their space programs since 2006. However, this cannot be regarded as adequate consideration for creating internal regulations in respect of the LTSOSA to guide APSCO. Other factors must be taken into account, including international obligations and regional cooperation, which are examined respectively in the following sections.

4.1. Fulfilling international obligations

As mentioned earlier, the principles of intergenerational equity, intragenerational equity, peaceful purposes and integration have been established in the Outer Space Treaty of 1967 and become the underlying principles that guide the space activities of all state parties. However, the problem is whether these principles are directly applicable to the activities of APSCO, which is neither a party to the Outer Space Treaty of 1967, nor have they publicly accepted the rights and obligations within the treaty. This ambiguity arises out of the '*pacta tertiis nec nocent nec prosunt*': third parties do not benefit from a treaty and are not obliged by a treaty to which they are not parties[98]. However, an exception to this rule is that if the majority of the state members of an international organization are contracting parties to a treaty, then this treaty applies to the entire international organization[99]. Coincidentally, APSCO has eight member states, of which seven are state parties to the Outer Space Treaty of 1967, including Bangladesh, China, Mongolia, Pakistan, Peru, Thailand, and Turkey. Moreover, Article XIII of the Outer Space Treaty of 1967 establishes that the treaty applies to the activities of its state parties, including those that are conducted within the framework of international intergovernmental organizations[100]. Hence, APSCO should be bound by the principles that concern the LTSOSA in the Outer Space Treaty of 1967, and should bear the responsibility to carry out its space activities for peaceful purposes, with due regard to intergenerational and intragenerational equities as well as protection of the space environment. However, these are just general principles, which need to be legitimized with more specific regulations. Furthermore, while their cooperation for peaceful purposes is highlighted[101] and some issues related to capacity-

[98] Stephan Hobe, Bernhard Schmidt-Tedd, Kai-Uwe Schrogl (ed.), Goh (assist. Ed.), *supra* note 11, at 220. See also Article 34 of the 1969 Vienna Convention on the Law of Treaties.
[99] *Id.*
[100] Para.1, Article XIII, *supra* note 65.
[101] Para 2 of the Preamble and para 1 of Article 4, Convention of the Asia-Pacific Space Cooperation Organization. http://www.apsco.int/apscon/apSCO-AD/imapic/20126131512594754 2.pdf. (accessed 15 August 2017).

building are addressed in the APSCO Convention[102], they lack a systematic regime that addresses the emerging issues that concern the LTSOSA, including space debris, space traffic congestion, space weather and frequency interference[103], and, in fact, are not in the position to address the challenges of the LTSOSA from a legislative point of view. In this regard, APSCO should establish an internal regulatory framework aimed at carrying out its international obligations related to the LTSOSA under the Outer Space Treaty of 1967.

4.2. Need for regional cooperation

The emerging issues related to the LTSOSA are very complicated and challenging. Therefore, addressing the LTSOSA requires national, regional and global efforts[104]. That is, efforts made by regional intergovernmental cooperation organizations, such as APSCO, can be one of the three essential ways to reinforce the LTSOSA which is at the regional level, thus complementing the national and global efforts. In addition, cooperation at the regional level in practice appears to be more efficient than that at the global level[105] because there are often fewer conflicts of interest, such as those that are geopolitical or cultural or economic. Apart from that, the global organizations are often faced with the difficulty in organizing large numbers of member states in collective action and the issues related to the proliferation of free rider problem[106]. APSCO, however, has only eight member states which are all developing countries and thus comparatively speaking, is more efficient when it comes to implementing space programs and making decisions as opposed to global bodies, such as the UNCOPUOS, which has 83 member states from the North and the South.

[102] APSCO has established its capacity-building mechanism in its Convention, including education and training activities concerning space science and technology and their applications (Article 7), exchange of personnel (Article 20) and exchange of information (Article 21) among member states.
[103] Ray A. Williamson, *supra* note 6, at 154-5; Yin Yuhai, Yan Yongliang, *supra* note 46, at 23-4.
[104] A/AC.105/C.2/2017/CRP.32, the Legal Subcommittee of Committee on the Peaceful Uses of Outer Space, Draft declaration on the fiftieth anniversary of the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, 7 April 2017. http://www.unoosa.org/res/oosadoc/data/documents/2017/aac_105c_22017crp/aac_105c_22017crp_32_0_html/AC105_C2_2017_CRP32E.pdf. (accessed 10 July 2017).
[105] Previous research indicates that a global environmental agreement will achieve little and regional cooperation might be a good alternative to global cooperation in dealing with the environmental issues related to climate change. Geir B. Asheim, Camilla Bretteville Froyn, Jon Hovi, and Fredric C. Menz, Regional versus Global Cooperation for Climate Control, Journal of Environmental Economics and Management 51 (2006) 93–109. See also Dai, & Snidal, Xinyuan, Duncan. (2010). International Cooperation Theory, published in The International Studies Encyclopedia in 2017. http://www.oxfordreference.com.eproxy1.lib.hku.hk/view/10.1093/acref/9780191842665.001.0001/acref-9780191842665-e-0215. (accessed 10 December 2017).
[106] Dai, & Snidal, Xinyuan, Duncan, *id.*

Furthermore, the unique nature of the space environment means that the space activities of a space actor readily affect those of others without discrimination[107]. For instance, space debris, regardless of the country of its origins, constitutes a significant threat to the safe operation of every human-made space object in the Earth orbital areas. And cooperation and coordination among all space actors thus are necessary for the successful implementation of the LTSOSA. Moreover, these Earth orbital areas are public property which is accessible to everyone and therefore require the coordination of rules to address the potential collisions due to the increasing number of satellites. In this sense, APSCO has to enact regulations to coordinate the space activities of its member states, and interactions between its member states, non-member states and other international organizations.

5. Selected legal issues

Due to publication limitations, a select few of legal issues related to the LTSOSA regulations of APSCO are discussed in this section. One of the more important legal issues concerns the rewards reaped by the exploration and use of outer space, which are made possible only with safely carried out space operations. However, increasing volume of space debris, ambiguous space weather and space traffic congestion are real threats[108] to space operations of APSCO and its member states. Therefore, the legal issues that pertain to these three issues are discussed respectively in this section. In addition, enhancing the capacity-building of the APSCO member states, most of which are developing countries with emerging space capability, is a good way to achieve intragenerational equity, and thus the legal issues related to capacity-building are subsequently examined. Moreover, APSCO is a regional cooperation organization rather than a global one. In this regard, the legal issues related to the military use of outer space and the use of space resources will not be addressed by this article, as there has been not generally accepted international agreement on how to address these two issues. Instead, the last part of the following section discusses the radio frequency interference, because it is a real threat to the space activities of APSCO and its member states.

5.1 Space debris mitigation regulation

[107] Christopher D. Johnson and Victoria Samson, *supra* note 90.
[108] Ray A. Williamson, *supra* note 103. Yin Yuhai, Yan Yongliang, *supra* note 103. Gérard Brachet, *supra* note 35, at 161.

The most immediate concern around the LTSOSA is space debris, and the related risks were acknowledged by the United Nations as early as 1999[109]. There are two proposed means to address space debris: active removal and passive mitigation. It should be noted that the focus of this section is not on discussing the former but on addressing the latter. Because currently no international treaty is adopted to allocate the relevant responsibilities to actively remove space debris among those spacefaring countries[110]. Another problem is that active space debris removal requires high levels of technical capacity and a substantial budget, and thus would hardly be the priority of APSCO in the near future in which the member states, with the exception of China, are almost all developing countries that lack the financial and technical capacities to do so. However, an undisputable point is that the common responsibility to prevent harm to the space environment should be taken by all space actors[111], because as discussed earlier, this has already been received by the corpus of customary international law[112]. In other words, the responsibility to prevent the generation of space debris should be borne by every space actor, including APSCO and its member states. Thus, the space debris regulation of APSCO should address the passive space debris mitigation.

The first issue the regulation needs to address is the definition of space debris, on which previous researchers' opinions diverge. While some think that it should cover human-made

[109] Jan Helge Mey, Space Debris Remediation: Some Aspects of International Law Relating to the Removal of Space Junk from Earth Orbit, German Journal of Air and Space Law, 61 (2) (2012) 251.

[110] The principle of common but differentiated responsibility has been proposed to allocate responsibility among different countries, based on financial and technological capabilities as well as previous contributions to space environmental degradation and developed spacefaring nations would bear more responsibilities than developing countries. M.Y.S. Prasad, Rajeev Lochan, *supra* note 4, at 290. Li shouping, Zhao Yun, Introduction to the Law of Outer Space, Guangming Daily Press (2009) 115. Jan Helge Mey, *ibid*, at 262-3. Anal Ferreira-Snyma, *supra* note 68, 48-9. See also Peter Stubbe, Common but Differentiated Responsibilities for Space Debris – New Impetus for a Legal Appraisal of Outer Space Pollution, ESPI Perspectives No. 31, 2010, at 8-9. www.espi.or.at. (accessed 10 July 2017). However, this principle is considered to be quite controversial and vague by many academics. David Hunter, James Salzmen, Durwood Zaelke, *supra* note 24, at 359. Marcus Schladebach, Space Debris as a Legal Challenge, Max Planck Yearbook of United Nations Law 17 (2013) 74, 84. The United States government even goes as far as to reject any interpretations of this concept that would permit the shirking of the international responsibilities of the developing countries in Principle 7 of the Rio Declaration on Environment and Development in 1992. See 51. U.S. interpretive statement on World Summit on Sustainable Development declaration. https://www.state.gov/s/l/38717.htm. (accessed 10 July 2017).

[111] Motoko Uchitomi, *supra* note 23, at 77.

[112] Hall, Noah D., Transboundary Pollution: Harmonizing International and Domestic Law, University of Michigan Journal of Law Reform (40, 4) (2007) 696. Birnie, Patricia W./Boyle, Alan E., International Law and the Environment, New York: Oxford University Press (2002) 5. Epiney, Astrid, Das, Verbot erheblicher grenzüberschreitender Umweltbeeinträchtigungen, Relikt oder konkretisierungsfähige Grundnorm?, Archiv des Völkerrechts 33 (1995) 317. See also *supra* note 72 and 74.

and natural debris[113], the others contend that it should only refers to the human-made one[114]. Regardless of the above arguments, the space debris in the space debris mitigation regulation should only be limited to the human-made one, which refers to "all man-made objects, including fragments and elements thereof, in Earth orbit or re-entering the atmosphere, that are non-functional"[115]. Because, technically speaking, APSCO and its member states are only capable of preventing the generation of the human-made one rather than naturally occurring one. Moreover, the natural debris only exists in the near-Earth environment[116], decays through natural mechanisms in a short period of time[117] and thus poses little threat to space operation.

The generation of human-made space debris often takes place during launching and in-orbit operations[118]. To avoid doing so, APSCO thus should take the necessary regulatory measures during the mission planning, design, manufacture and operational (launch, mission and disposal) phases of spacecraft[119]. First, the space debris regulation shall encourage APSCO and its member states to develop and use advanced space technology, that can allow them to improve their space system to the extent that no space debris will be released during normal operations[120]. If no such technology can be developed, an effort should be made to minimize the adverse impact of any release of space debris on the space environment[121]. Second, during operational phases, APSCO and its member states should "minimize the potential for break-ups", "limit the probability of accidental collision in orbit", "avoid intentional destruction and other harm activities" and "minimize potential for post-mission break-ups resulting from stored energy"[122]. Third, after the end of their mission, APSCO and its member states should return their spacecraft to Earth or move them to graveyard orbits, thus minimizing the potential for

[113] Li shouping, Zhao Yun, supra note 110, at 102. Sreemeena Sethu; Mandavi Singh, Stuck in Space: The Growing Problem of Space Debris Pollution, 2 UK L. Student Rev. (2014). http://www.uklsa.co.uk/wp-content/uploads/2014/06/UKLSR-Volume-2-Issue-1-Article-6.pdf. Zhang Yulin and Wang Zhaokui, Space Traffic Safety Management and Control, IEEE TRANSACTIONS ON INTELLIGENT TRANSPORTATION SYSTEMS 17 (2016) 1190.

[114] Viikari, supra note 68, at 71. Frans von der Dunk and Fabio Tronchetti (eds.), Handbook of Space Law (Edward Elgar Publishing, 2015) 719. Agatha Akers, To Infinity and Beyond: Orbital Space Debris and How to Clean It Up, University of La Verne Law Review 33 (2012) 287-288; I. H. Ph. Diederiks-Verschor, V. Kopal, An Introduction to Space Law (Third edition), Kluwer Law International (2008) 128.

[115] Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space, United Nations' Resolution 62/217 of 22 December 2007. http://www.unoosa.org/pdf/publications/st_space_49E.pdf. (accessed 15 March 2018).

[116] Stephen Gorove, Space Debris in International Legal Perspective", (1990) 3 2nd Proc. Colloq. L, OuterSpace, 97. Sreemeena Sethu; Mandavi Singh, supra note 113.

[117] Sreemeena Sethu; Mandavi Singh, *id*.

[118] Ray A. Williamson, *supra* note 6, at 156.

[119] *Supra* note 115.

[120] *Id.*

[121] *Id.*

[122] *Id.*

further creation of space debris and freeing space for the operation of new satellites with an aim of making the use of earth orbits sustainable also. This will be absolutely a laudable practice to implement the principle of sustainable use.

5.2 Space weather regulation

One of the recent concerns about the LTSOSA revolves around space weather which has different impacts, including radiation storms, solar wind and flares as well as coronal mass ejections[123], all of which pose significant risks to spacecrafts, terrestrial telecommunications and power networks as well as crew or astronauts in space station[124]. Moreover, the impact of space weather on various economic activities has been increasingly acknowledged[125]. For instance, the directional drilling technique to tap oil and gas reservoirs relies on accurate GPS positioning, but the drill-head may drill in the wrong place if its GPS reception is disturbed by some solar activities, such as radiation storms and solar wind[126]. Solar energetic particles at the magnetic poles can interfere with international airline flights, forcing the re-routing of the flights and leading to flight delays as well as an increase in fuel consumption.[127] Fortunately, the importance of understanding and forecasting space weather has been recognized by the space community, thus space weather has been added as an agenda item by the UNCOPUOS in 2013[128].

Two factors should be considered in terms of how to respond to space weather. First, APSCO should establish a mechanism that enables space weather to be continuously studied and monitored, develop a better understanding of space weather, and share the knowledge with its member states or even the entire international community[129]. Understanding the effects of space weather is also very essential when designing space objects[130], including spacesuits. Any design flaw may be detrimental to space objects and even persons in space. Therefore, APSCO can source funds to support research work to develop new technologies and designs that would minimize the detrimental effects of space weather on space objects, encourage its member states to develop these new technologies and designs, and share their research findings as well

[123] Hans J. Haubold, The UN Braces for Stormy Space Weather, German Journal of Air and Space Law 62 (2013) 201.
[124] Scott Pace, *supra* note 52, at 159.
[125] Hans J. Haubold, *supra* note 123, at 202.
[126] *Id.*
[127] *Id.*
[128] Hans J. Haubold, *supra* note 123.
[129] *Supra* note 1, at 6-8.
[130] Williamson, *supra* note 5, at 155.

as established practices with other member states or even the entire international community in effective and mutually acceptable ways[131]. Moreover, a mechanism that facilitates cooperation with other international organizations, such as the World Meteorological Organization (WMO) and the International Space Environment Service (ISES), and non-member states, is important to further develop the ability of APSCO member states to understand space weather and share their knowledge and best state practices with each other[132].

Second, the Moon Agreement of 1979 has established the international obligation to inform others of adverse phenomena that may endanger health or life[133] in outer space. While APSCO is not subject to this agreement, the obligation to conduct space activities for the benefit of all countries and in the interest of maintaining international security has been stipulated in Articles I and III of the Outer Space Treaty of 1967, which is binding for APSCO. Hence, upon receiving information on adverse phenomena, APSCO should have in place an informative mechanism that promptly disseminates this information on space weather[134] to minimize damages, thus allowing all member states as well as the international community to adequately prepare for any catastrophic events.

5.3 Space traffic management regulation

Similar to traffic on earth, orbital areas can be congested if satellites or space stations are drastically increased in number without regulation, which may lead to collisions between these space objects eventually. Unfortunately, the number of defunct space debris and operational space objects has significantly increased in the past 10 years, and thus regulations at the international level for managing space traffic have become inevitable. Currently, every member state of the ASPCO operate their space objects in earth orbits[135]. To preserve their space assets and maintain the safe operation of their space objects in earth orbits, it is needed for APSCO and its member states to establish a space traffic management regime with an aim of coordinating their space objects, their space objects with that of other non-member countries and international organizations for avoiding unnecessary collisions. More importantly, the

[131] *Supra* note 1, at 8.
[132] *Ibid*, at 7.
[133] Para. 3, Article 5, *supra* note 83.
[134] *Supra* note 1, at 7.
[135] The third generation BeiDou navigation satellite system has been established since 2015, which will consist of 35 satellites in the near future. China also possesses a certain number of satellites used for communication, remoting sensing and weather broadcasting as well as military purposes. Thailand, Pakistan, Iran, Bangladesh, Mongolia, Peru and Turkey all have and operate their own satellites in earth orbits.

regulation of how to detect space debris and avoid collisions between their space objects and space debris should be also addressed by the coordination regime, as the risks created by space debris to the operation of their space objects are more challenged and tougher because of the instable and uncontrollable movement of space debris in earth orbits.

Generally speaking, the core of space traffic management is monitoring space objects, and ensuring the accuracy of their orbital data. Hence, consideration should be given to, first, the development and use of scientific techniques and methods of monitoring space objects, including defunct space debris and operational space objects, in earth orbits, to improve the accuracy of their orbital data[136]. In the capacity building regulation, thus, it should be encouraged to transfer or share such techniques and methods among the APSCO member states[137]. Second, Article XI of the Outer Space Treaty of 1967 has established an obligation to disseminate information on the nature, conduct, location and results of space activities[138]. Moreover, Article IV of the Convention on Registration of Objects Launched into Outer Space (hereinafter referred to as the Registration Convention) goes into greater detail, and requires each state of registry to provide their basic orbital parameters, including the nodal period, orbital inclination, apogee and perigee from time to time, and notifications on their changes[139]. However, these four parameters are not adequate to clearly identify the orbital path of a spacecraft[140]. The eccentricity[141], semi-major axis[142] and mean anomaly at epoch[143], that are very essential parameters to define an orbit[144], should be registered and shared with other space actors. Unfortunately, they are missing in the Registration Convention. To prevent possible collisions, APSCO is responsible to establish a rule as to how to share and disseminate these five parameters of space objects among its member states from time to time in its space traffic management regulation[145]. Apart from that, APSCO should enhance its cooperation with other non-member countries and international organizations, in an attempt to collect as much more comprehensive orbital information on the relevant space objects and space debris as possible. Only by having more comprehensive and updated orbital parameters related to those space

[136] *Supra* note 1, at 5.
[137] See *supra* note 1, at 6.
[138] Article XI, *supra* note 65.
[139] Article IV, UNGA Resolution 3235 (XXIX)) (15 September 1976), "Convention on Registration of Objects Launched into Outer Space".
[140] Christian Brünner, Alexander Soucek, Outer Space in Society, Politics and Law, Springer Science & Business Media (2012) 352.
[141] The eccentricity refers to "how far the elliptical orbit differs from a perfect circle". *Id.*
[142] The semi-major axis refers to "half of the major axis of the elliptical orbit". *Id.*
[143] The mean anomaly at epoch refers to "the exact time of the satellite's passage at one given point". *Id.*
[144] *Id.*
[145] *Supra* note 1, at 5-6.

objects that are close to their space objects, can APSCO and its member states have enough time to make the satellite maneuver and prevent potential collisions.

5.4. Capacity-building regulation

Capacity-building activities are conducted in many forms, such as "education, training and sharing of appropriate experience, information, data, tools and management methodologies and techniques, as well as the transfer of technology"[146]. However, the main concern for capacity-building is the transfer of technology, *inter alia*, environmentally sound technology (EST)[147]. The desire of the developing countries to obtain EST through technology transfer is because they believe that the sharing will promote their economic growth[148], prevent excessive consumption and over-exploitation of natural resources[149] and allow the "decentralization and localization of technology"[150]. Many developed industrial countries, however, have concerns about technology transfer, as it may infringe on intellectual property rights, patents and biotechnologies[151]. Irrespective of these arguments, the unique character of outer space renders it necessary to conduct transfer of space-oriented EST, since outer space, especially the orbital areas, are public areas, which all countries can freely access and conduct activities[152]. Nevertheless, this unique character means that space activities readily affect others without discrimination, regardless who conducts them, and also incurs tremendous damage to people and property on Earth which occurs without intentional control[153]. That is very different from the traditionally environmental issues on Earth where they are often restricted to the territory of individual nations except for transboundary effects. In this sense, the protection of intellectual property rights should not be the only consideration of the developed spacefaring countries in the transfer of space technology. Other factors, such as the mitigation of the

[146] *Supra* note 1, at 9.
[147] Under Agenda 21, Environmentally sound technologies are regarded as "process and product technologies" that conserve the environment, utilize all resources in a sustainable fashion and create "low or no waste, for the prevention of pollution"; they also include "end of the pipe" technologies that address pollution after it takes place, such as recycling "their wastes and products". Agenda 21, United Nations Conference on Environment & Development Rio de Janerio, Brazil, 3 to 14 June 1992, Para 1 and 2, Chapter 34. https://sustainabledevelopment.un.org/content/documents/Agenda21.pdf (accessed 4 August 2017).
[148] M. Blakeney, Legal Aspects of the Transfer of Technology to Developing Countries 60-66 and 73 (Oxford: ESC, 1989), as quoted by Klaus Bosselmann, Poverty Alleviation and Environmental Sustainability through Improved Regimes of Technology Transfer, 2/1 Law, Environment and Development Journal (2006) 22.
[149] Klaus Bosselmann, *ibid.*
[150] *Id.*
[151] Philippe Sands, Jacqueline Peel, Adriana Fabra, Ruth MacKenzie, *supra* note 26, 688.
[152] Article I, *supra* note 65.
[153] Frans von der Dunk and Fabio Tronchetti (eds.), supra note 114, at 717. See also *supra* note 8.

adverse impacts of space activities of the developing spacefaring nations with low space capacity should be also considered. Hence, transferring space-oriented EST to developing spacefaring countries to improve their capacity to protect the shared space environment appears to favor them. Otherwise, the long-term implementation of their space activities cannot be ensured if the space environment is damaged by countries without space-oriented EST, and that will also be an unfair burden to them if merely several developed spacefaring nations are capable of addressing those issues without the participation of other countries.

Notably, APSCO has addressed the capacity-building issue in various ways. First, it is required to assist its member states in the areas of "space technological research and development, applications and training", and "share achievements among the Member States in space technology and its applications as well as in space science research"[154]. Second, it is obliged to exchange scientific and technical information with respect to the areas of space science and space technology and their applications[155]. A good example is the sharing of the remote sensing data from small multi-mission satellites (SMMS) among its member states[156]. Unfortunately, to date, no relevant regulation that addresses the transfer of space technology has been established within APSCO.

In the context of dealing with issues that pertain to the LTSOSA, however, APSCO needs to take into account the transfer of space-oriented EST that address space environmental issues, such as developing reusable launch vehicles[157], developing and sharing technology that can actively remove space debris or instilling higher standards for satellite design so that less space debris is generated after the satellites are defunct[158]. In this regard, more specific regulations are necessary to assist with the transfer of space-oriented EST with the aim to address the relevant barriers, including the high costs of space technology[159], the dire situations related to

[154] Article 4, *supra* note 101.
[155] *Ibid*, Article 21.
[156] China and Thailand, based on the 1998 MOU on the Cooperation in SMMS project jointly signed by China, Iran, Republic of Korea, Mongolia, Pakistan and Thailand in Bangkok, jointly invested and manufactured the Asia-Pacific Small Multi-Mission Satellite (SMMS), which is an Earth remote sensing satellite. The SMMS data can be available to the APSCO Members States, by means of downloading, without charge. Data Policy and Data Sharing Regulation of APSCO. http://www.apsco.int/AboutApscosS.asp?LinkNameW1=Policies,_Rules_and_Regulations&LinkNameW2=Rules_and_Regulations&LinkCodeN3=1722&LinkCodeN=13. (accessed 15 August 2017).
[157] Howard A. Baker, Space Debris: Law and Policy in the United States, U. Colo. L. Rev. 60 (1989) 88.
[158] Guideline 1 & 2, *supra* note 115.
[159] Matthew Townsend, The International Transfer of Technology, Environmental Policy and Law, 23/2 (1993) 66.

the protection of intellectual property in the user countries [160] and national security [161]. Therefore, transferring EST at a reasonable market price is a good start to balance the benefits of the transferee and transferor. Second, a mechanism that monitors the protection of intellectual property rights should be in place, which would require a commitment from the transferee, or the transferor is entitled to temporarily halt the use and claim for damages. Third, the use of the transferred technology must be in line with the principle of peaceful purposes. Thus, a monitoring mechanism should be established that requires users to commit to the peaceful use of the technology, and direct APSCO and its relevant member states to adopt measures that monitor the use afterwards[162]. Otherwise, APSCO and its relevant member states are entitled to and also responsible for suspending or even terminating the transfer.

5.5 Radio frequency interference regulation

The radio frequency spectrum refers to "the range of frequencies of electromagnetic waves which can be generated for the purpose of providing communication between points without artificial guide"[163]. The Constitution of the International Telecommunication Union (CITU) has declared it as a limited natural resource, because the entire range of radio spectrum can be utilized under current technological capability, and the interference trouble can incapacitate the simultaneous use of radio frequency by more than one receiver[164]. Hence, they

[160] *Ibid*, at 66-7. Research has indicated that developing countries are less interested in protecting intellectual property right than developed countries because of some complicated economic, cultural and political factors behind this. Alan S. Gutterman, The North-South Debate Regarding the Protection of Intellectual Property rights, Wake Forest Law Review, 28 (1993) 118-124. Hence, some developed states refuse to transfer their important technology on the pretext of their obligations to protect intellectual property right under national and international laws. Philippe Sands, Jacqueline Peel, Adriana Fabra, Ruth MacKenzie, *supra* note 26, at 687.

[161] The dual-use nature of the space technology often leads to the establishment of a strict export control regime in many countries, which impedes the transfer of the space technology. Yun Zhao, National Space Law in China-An Overview of the Current Situation and Outlook for the Future. 155, Brill Nijhoff, Leiden | Boston, 2015, as quoted by Long Jie, China's space station project and international cooperation: Potential models of jurisdiction and selected legal issues, Space Policy 36 (2016) 34.

[162] This idea comes from the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from Their Utilization of 2010 (2010 Nagoya Protocol), Article 17 of which requires parties to adopt measures to monitor how the genetic resource is used in the user countries. In addition, Article 15 and 16 refer to the benefit sharing mechanism in detail. Most importantly, Article 22 and 23 provide for the arrangement regarding capacity building, inter alia, transfer of technology. Similar technology transfer arrangement is referred to in the 1992 Climate Change Convention and the 1997 Kyoto Protocol. See Philippe Sands, Jacqueline Peel, Adriana Fabra, Ruth MacKenzie, *supra* note 26, at 685.

[163] Transport and Communications Indicators, Management of the radio frequency spectrunm (1990) December Quarter 31 Bulletin 1, as quoted by Farhad Talaie, Legal Issues concerning the Radio Frequency Spectrum and the Geostationary Satellite Orbit, 1998 Australian International Law Journal (1998) 29.

[164] Farhad Talaie, *id*.

should be used in a rational, efficient and economic manner so as to ensure that every user, *inter alia*, the developing countries, also have equitable access to them[165].

More importantly, consideration must be given to addressing harmful radio frequency interference (RFI)[166]. Radio frequency can be interfered by not only natural but also human-made factors. Space weather is one important reason why radio frequency can be interfered. More specifically, strong enough solar flares can give rise to a radio blackout without communication of high frequency radio waves, which range from 3 to 30 MHz band[167]. Even sometimes cloud and rain can be sources of interference with communication of radio frequency[168]. The human-made frequency interference, however, is more complicated than the natural one. First, when the radio receiver of a satellite cannot meet the international standards for filtering out interference, the RFI could happen. Second, when two or more satellites which broadcast on similar frequency are too close to each other, the communication of signals from the satellites to the earth receivers can easily be interfered[169]. Third, if some signal transmitters are controlled intentionally to transmit the same or similar radio frequency as that of others' transmitters regardless of uplink or downlink, the RFI could also happen[170].

The risks posed by RFI in outer space are obvious. First, the RFI can pose a detrimental impact on the operation of the global navigation satellite system (GNSS). The presence of very strong RFI can lead a GNSS receiver to be blind and even stop working due to the intentional jamming[171]. Even if in normal case, the presence of RFI can generally be severe enough to adversely affect the performance of receiver on the front end at the acquisition and tracking stage[172]. Apart from that, the services with regard to satellite broadcast and remote sensing, which rely on the transmitting and retransmitting of radio waves by satellites, can be adversely affected also.

Currently, China has successfully started operating its BeiDou Navigation Satellite

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[165] Para 131, Article 33 of the ITC. And Article 44 of the CITU.
[166] *Supra* note 1, at 5.
[167] https://swfound.org/space-sustainability-101/radio-frequency-interference/. (Accessed 20 November 2017).
[168] *Id.*
[169] For instance, in 2010, Galaxy 15 satellite of America got malfunctioning for the unknown reason and passed close to AMC-11 satellite without control, leading to the interference with the broadcast of AMC-11 due to their broadcasting on similar radio frequency. Ray A. Williamson, *supra* note 6.
[170] For example, five major international broadcasters, including Voice of America, British Broadcasting Corp., Deutsche Welle, Audiovisuel Extérieur de la France and Radio Netherlands Worldwide, in 2012 complained that Iran was responsible for deliberately jamming their broadcasts, since Iran uplinked radio waves on the same channel as theirs and interfered with the reception of their satellites. Ray A. Williamson, *id*. http://www.radioworld.com/business-and-law/0009/broadcasters-complain-about-irans-signal-jamming/325826. (Accessed 25 November 2017).
[171] Fabio Dovis, Expert Advice: The Impact of RFI on GNSS Receivers, April 1. 2015, available at http://gpsworld.com/expert-advice-the-impact-of-rfi-on-gnss-receivers/. (Accessed 27 November 2017).
[172] *Id.*

System, other member states of APSCO all operate their own satellites in earth orbits and many space cooperation programs within APSCO also depend on the benign operation of satellites. In this regard, to mitigate the harmful interference with operation of satellites and communication of radio signals, it is needed for APSCO to establish a mechanism addressing the radio frequency interference. It should be also noted that some rules related to how to address the radio frequency interference have been established by the ITU, of which all APSCO member states are also members. The specific rules thus can be designed based on the CITU, the ITU Radio Regulations and the ITU Radiocommunication Sector Recommendations[173]. First, every member state of APSCO shall carry out its space activities in a fashion that cannot give rise to harmful interference with the reception and transmission of radio signals in relation to the space activities of other member states and APSCO[174]. Second, APSCO shall establish an international cooperation and coordination mechanism to prevent the space activities of non-member actors from causing harmful interference with the reception and transmission of radio signals with respect to the space activities of APSCO and its member states. Third, a coordinating organ shall be established to respond to the settlement of the harmful interference, and specific rules related to the coordination can be designed based on the coordination rules established in article 15 of the ITU Radio Regulations[175].

6. Conclusion

The LTSOSA is derived from the concept of sustainable development on Earth. However, the primary difference is that the former gives weight to the principle of peaceful purposes. More specifically, the LTSOSA incorporates five legal elements, including the principles of intergenerational equity, sustainable use, intragenerational equity, integration and peaceful purposes. In this sense, the concept of LTSOSA has been in fact reflected more or less in international environmental law and international space law.

Frankly speaking, the issues around the LTSOSA will not be addressed in the near future. Efforts must be made by every space actor in collaboration with each other for every step of the way. If more space actors, be they nations or international intergovernmental organizations, respectively regulated themselves with internal regulations or domestic laws, the goal of

[173] *Id.*
[174] *Supra* note 1, at 5.
[175] The Radio Regulations of the International Telecommunication Union, edition of 2016, at 237-239. http://search.itu.int/history/HistoryDigitalCollectionDocLibrary/1.43.48.en.101.pdf. (Accessed 3 March 2018).

enhancing the LTSOSA could be more readily realized. In this sense, it is now timely for APSCO to incorporate an LTSOSA regime or components of an LTSOSA regime into its legal mechanism. This is not only an international responsibility in accordance with international law, but also APSCO, in return, can benefit from space sustainability in the long run. Moreover, the successful resolution of issues related to the LTSOSA relies on international cooperation at all levels, including regional intergovernmental cooperation organizations such as APSCO, which can complement global and national efforts to enhance the LTSOSA.

In terms of the internal regulations related to an LTSOSA regime, five major legal concerns that are related to space debris, weather and traffic, capacity building and radio frequency interference are discussed in this article. Aside from these issues, other issues, including environmental protection regimes related to the use of nuclear power sources, situation awareness regulation, international cooperation regulation and regulation with regard to scientific and technical research and development are also worth discussing in future research. While it is not necessary for APSCO to embrace all aspects of an LTSOSA regime, it is certain that the incorporated mechanisms should reflect the five legal elements.

One may think that APSCO may only have eight member states, so that the implementation of an LTSOSA regime within APSCO has a comparatively limited role in enhancing the LTSOSA. However, the LTSOSA is in the interest of all space actors, including spacefaring countries and international inter-governmental organizations, which means that all of them should work together towards achieving the goal of maintaining the LTSOSA, and incorporating an LTSOSA regime as a component of the APSCO platform is just part of this goal. Hopefully, the benefits from the sustainable and peaceful exploration and use of outer space will be available over the long term, as long as the space actors are all willing to embrace an LTSOSA regime.