ORBITAL DEBRIS: LEGAL REMEDIES AND INTERNATIONAL STATE LIABILITY

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I. Introduction

Operations in outer space are currently chasing commercial targets on a considerable scale, as evidenced by the ever increasing activities on the satellite launching pads[3]. The space race has resulted in an impressive number of launchers, especially when it comes to military reconnaissance and communication satellites[4]. We are now accustomed to many services provided from space in our daily life e.g. communications, remote sensing of the environment, navigation, weather forecast, television, etc. In addition to the main areas of space applications, such as space communications, remote sensing, space navigation, significant benefits result from secondary applications of space technology by spin-off' products and processes[5]. 'They contribute to advancements in the fields of health and medicine, transportation, public safety, environment and resource management, computer technology, industrial productivity, in general to the growth of national economies and increase of the quality of life'[6]. The outer space has been a subject and an object of mankind's fascination since time immemorial. The idea of developing space faring capabilities developed over a considerable period of time but at a dynamic pace nevertheless.

The objects which have since been released into the space are the result of launch activities, with the deployment of payloads, upper stages which injected them into orbit, and associated mission-related objects, such as launch adaptors, lens covers, clamp-bands, and yo-yo de-spin devices[7]. Over the years the maturing space infrastructure has provided support to the new and continuing efforts to combat energy security, disaster risk reduction, climate change, etc. Ironically, the spatial environment though,

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3 BIN CHENG, STUDIES IN INTERNATIONAL SPACE LAW 23 (2004)
4 I.H.PH. DIEDERIKS-VERSCHOOR & V . KOPAL, AN INTRODUCTION TO SPACE LAW 106 (2008).
5 Id. at 148.
6 FRANCIS LYALL & PAUL B. LARSEN, SPACE LAW: A TREATISE 10 (2009)
7 HEINER KLINKRAD, THE CURRENT SPACE DEBRIS ENVIRONMENT AND ITS SOURCES, in Space Debris: Model and Risk Analysis Springer-Verlag Berlin Heidelberg 2006 pp. 5

has been left to bear the brunt of mankind's increasing dependence on satellites.

Since the beginning of the space age, over 20,000 metric tons of materials have been taken into the orbit by rockets[8]. Today, nearly 4,500 tons of these materials remain as about 10, 000 'resident space objects', of which only 5 percent are functioning spacecraft[9]. These objects, however, are the ones that can and have been tracked by telescopes and military radars. The object of concern here is the millions of small, untraceable scraps which are scattered into the orbits throughout the space near the Earth, from a mere few hundred kilometres to over 40,000 kilometres above the planet's surface[10]. Over 500,000 pieces of junk or space debris are tracked as they orbit the planet, while travelling at speeds reaching up to 17, 500 mph, which is fast enough for a considerably smaller piece of orbital debris to cause serious damages to a spacecraft or a satellite[11]. The increasing number of space junk increases potential threat to all vehicles in space, space shuttles, ISS and also further spacecraft with humans aboard.

II. Space Debris and Orbital Debris: The Concept

Space debris consist of both natural and artificial particles. The natural debris are meteoroids which are in orbit around the sun whereas artificial debris on the other hand are man–made debris in orbit around the Earth and thus are more commonly referred to as Orbital Debris. The man-made orbital debris's population is growing rapidly, dominating the meteoroid environment due to factors like non–functional satellites; failed satellites and spacecraft; launched rocket stages of a satellites into space; nose cones, payload covers, etc; solid propellant slag; space activity cast-aways (accidental or deliberate), e.g. wrenches, human waste; deterioration fragments, e.g. peeling paint; fragments from exploding batteries, fuel tanks (not totally empty), etc[12]; fragments from both accidental and deliberate collisions.

With more than 20,000 pieces of debris which are larger than the size of a softball orbiting the Earth, at speeds up to 17,500 mph, even a relatively small piece of such junk ispotent enough to damage a spacecraft or

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[8] Nicholas L. Johnson, *Monitoring And Controlling Debris In Space*, SCIENTIFIC AMERICAN (1998).

[9] Id.

[10] Id.

[11] Space Debris and Human Spacecraft | NASA, Available at: http://www.nasa.gov/mission_pages/station/news/orbital_debris.html (last visited Oct 21, 2016).

[12] *Fast Facts on Space Debris*, (October 24, 2016), http://www.spaceacademy.net.au/watch/debris/sdfacts.htm.

a satellite[13]. More and more number of debris are formed because of the collision of existing orbital debris with satellites. In 1978, Cosmos 954, a nuclear-powered Soviet spy satellite, crashed into the Canadian wilderness and scattered radioactive debris. In 1979, the orbit of the US Skylab space station unexpectedly decayed because of 'atmospheric bulges produced by solar storms. The station re-entered the atmosphere and crashed into the Indian Ocean and across Australia'[14]. In 1983, a tiny flake of paint hit the space shuttle Challenger and pitted its windshield'.In the year 1996, a French satellite was damaged after being hit by debris from a French rocket which had exploded a decade earlier. Replacement of a number of windows of space shuttles has been made due to severe damage resulted from materials, which when investigated, were analysed as paint flecks.

The anti–satellite mission carried out by China in the year 2007[15] led to the increase of orbital debris by 3,000+ piecesas a ballistic nuclear missile was fired from the Chinese coast to abolish and destroy an old weather satellite. In February 2009, 'a defunct Russian satellite collided with a functioning U.S Iridium commercial'[16] satellite and destroyed it, further resulting in the creation of more debris. The growing number of debris in the orbit of the Earth poses risk to the users of the orbital environment. Further, it increases the risk that humans and manmade structures could be impacted when the objects re–enter the atmosphere of the Earth.

'Many objects have been jettisoned into space: lens covers, separation bolts used to lock fixtures in place, auxiliary motors, launch vehicle fairings, various shrouds, and objects merely dropped or discarded during manned missions (such as the glove that a U.S. astronaut dropped during a spacewalk from Gemini 4 in 1965)[17]. If we analyse the incidents we may notice the accidents aren't the sole cause of orbital debris. The operators of the space consciously abandon rocket bodies, payloads etc which results into fragmentation debris. This has causedvarious accidents, malfunctions, intentional self-destruction, etc.

It may be noted that sometimes unintentionally elements, articles or pieces were released in space, such as 'screwdrivers or protective gloves

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[13] Id.

[14] J. D. Scheraga, *Pollution in Space: An Economic Perspective*, 15 AMBIO, 358 (1986).

[15] Id.

[16] Himanshu Goenka, *Space Debris Shown Orbiting Earth In New Video Renews Focus On Tackling Space Junk*, I. B. Times, (Dec.29, 2015, 2:14 AM), http://www.ibtimes.com/space-debris-shown-orbiting-earth-new-video-renews-focus-tackling-space-junk-2242130.

[17] Richard Crowther, *Space Junk- Protecting Space for Future Generations*, 296 SCIENCE 1241 (2002).

during extra-vehicular activities of astronauts, slag particles produced during solid rocket motor burns, cooling liquids released from Russian reconnaissance satellites, or degradation products resulting from crack formations and small particle impacts on the coatings of the satellites and upper stage surfaces'[18]. The most important single source of space objects, however, is on-orbit explosions of spacecraft and rocket stages, sometimes more than 20 years after their launch[19]. 'The NASA[20] on numerous occasion has conveyed their concerns with regard to any kind of damage that a space shuttle or the International Space Station may sustain due to orbital debris. Grave damage may be cause to the shuttle or the ISS and human life may be at risk even for a nano-size piece of the orbital debris.

III. International Level Framework - Evolution

The Soviet Union's launch of Sputnik 1, in October 1957 came as a watershed moment in the history of space exploration programmes. With Sputnik 1 being the first artificial satellite to be launched into the outer space, it is important to understand that what were the laws regarding the outer space prior to its release, and the legal implications that arose post launch. Before the release of Sputnik, there was no clear legal status of the outer space. It was so interpreted as per the conventional sense of law that the rules which governed the airspace were to be extended further up to the orbit of the Earth when the human race attained space faring capabilities. The law as it was then stated that a country could exercise its sovereign control to the airspace over its own territory[21]. Now, if the conventional sense of the law were to be followed in terms of the outer space then the Soviet Union had already violated the law by launching Sputnik 1, which passed over a number of nations which also included the United States of America. Back in the day, U.S President Dwight Eisenhower accepted the right of the Soviet Union to control and operate an orbital satellite which was over the U.S territory. Therefore, it was established and settled that the laws that governed aircrafts and airspace would not be carried forward to govern spacecrafts and the outer space.

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[18] See Nicholas L. Johnson, National Research on Space Debris and Impact Hazards, presentation to the 39th Session of the Scientific and Technical Subcommittee (STSC), United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) (Feb. 2003). Also cited in Steven A. Mirmina, *The American Journal of International Law*, Vol. 99, No. 3 (Jul., 2005), pp. 650.

[19] Heiner Klinkrad, *The Current Space Debris Environment and Its Sources*, in SPACE DEBRIS: MODEL AND RISK ANALYSIS 5 (2006).

[20] NASA stands forUnited States National Aeronautics and Space Administration.

[21] Matthew J. Kleiman, *Space Law 101: An Introduction To Space Law*, (October 24, 2016), https://www.americanbar.org/groups/young_lawyers/publications/the_101_201_practice_series/space_law_101_an_introduction_to_space_law.html.

The founding instrument of the legal regime pertaining to outer space dates back to 1967, known as the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (the "Outer Space Treaty"). This treaty established a list of principles which were later detailed elaborately and were made to form a number of international treaties as well as domestic laws for the nations. These principles [22] are as follows:

- Outer space and celestial bodies can be explored and used by all the States.
- National appropriation cannot be done on outer space and celestial bodies.
- Weapons of mass destruction are not permitted in the outer space.
- The use of the moon as well as the other celestial bodies shall be for peaceful purposes only.
- States shall be held responsible for their activities in the outer space, by both governmental and non – governmental entities.
- A non – governmental entity shall require the authorization as well as constant supervision from the concerning State to carry out outer space activities.
- The jurisdiction shall be retained by the States over the space objects that they launch, and any person thereon.
- States shall be held liable for any damage which is caused by their space objects.
- States should to avoid the harmful contamination of the outer space.

Following are the legal instruments which followed the Outer Space Treaty[23].

i. The 1968 Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space (Rescue Agreement 1968).

ii. The 1972 Convention on International Liability for Damage caused by Space Objects (Liability Convention).

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[22] Id.

[23] MA Xinmin, *The Development Of Space Law: Framework, Objectives And Orientations*, speech at United Nations/ China/APSCO Workshop on Space Law, (Oct. 24, 2016), http://www.unoosa.org/documents/pdf/spacelaw/activities/2014/splaw2014-keynote.pdf.

iii. The 1975 Convention on Registration of Objects Launched into Outer Space (Registration Convention).

iv. The 1979 Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (Moon Convention).

Presently, the international space law regime consists of five international treaties which form its crux. These are complemented by the various relevant UN General Assembly resolutions, bilateral or regional treaties and customary international law. Further legislations, State practices, intergovernmental organisations form the subsidiary sources for the determination of the rules that govern the outer space. So, in general two layers of laws form the law of the outer space. The first layer of this is the international law that governs the rights and duties of the States as well as the intergovernmental organisations. These include the five aforementioned treaties, the five principles which govern the outer space (declaration of legal principles of 1963, principles governing television broadcasting of 1982, remote sensing of 1986, nuclear power sources of 1992, and international cooperation in outer space of 1996). The second layer of space law is in the form of the national laws. These involve the laws which are enacted specifically for the purpose of implementing the State's obligations under the international treaties, and the laws which are for regulating those activities which have not been stipulated in the international treaties[24].

The current legal framework irrespective of its immaculate and specific nature fails to address the problem pertaining to the space debris. Liability for the damages caused by the space debris is not clear as well. This lack of a commonly accepted standard for operating space objects launched by States calls for a greater degree of concern and places a demand for a more uniform and binding legal structure in this regard.

IV. Debris Mitigation

Lamentable as it may be, but human intervention in any domain comes with far reaching repercussions. The same happened with the outer space ever since the human race decided that it is going to explore and exploit the outer space with its inventions. After Sputnik set the bar for launching artificial satellites, numerous satellites and space objects were launched into the outer space by various countries of the world. This also led to the generation of space junk. Unprecedented amounts of waste in the space have become a cause of increasing concern because of the potential damage that they might cause.

[24] Id.

The growing concern regarding the menance caused by space junk has implored the international committee to bring about a sense of accountability among the States for their actions carried out in the outer space. Even before the launch of Sputnik I, the commentators of law w.r.t the discipline of space law which was at its nascent stage then, were involved in a scholarly discourse regarding the legal principles that are to govern mankind's future ventures into the outer space. The early lawyers were able to identify the potential damages and dangers to the outer space arising out of the use of space vehicles and the destructive implications of space activities. They were then further debating into the merits of the principle of strict liability as applied to damages resulting from space activities.[25]

Not much imagination is required to understand the consequences of a large missile, carrying many tons of propulsive fuel, landing in a habitable area. The possibility that a harm could result out of space activities was intensified after a huge twenty-pound object fell on a street in Manitowoc, Wisconsin. This object was later identified as a fragment of Sputnik IV. More fragments from the same satellite fell into the nearby Lake Michigan. Although no damage was caused, but the possibility of grave harm could in no way be ruled out. This was also not the only time when space objects had made their way through to and crashed onto the Earth's surface. In the September of 1960, a section what seemed to be a fragment of Pioneer VI, an unsuccessful United States moon probe, landed on a South African farm[26]. The International Space Station has been made to carry out a number of collision avoidance manoeuvres in a mere timespan of the last decade[27]. Not so long back, in January 2007, an anti – satellite missile test was carried out by China[28]. The FY - 1C polar orbit satellite which was a weather satellite of China, of the Fengyun series orbiting at an altitude of 865 kilometres, with a mass of 750 kilograms, was destroyed by a type of Kinetic Kill Vehicle which was traveling at a speed of8 kilometres/ second. This was a head-on engagement since the vehicle was travelling at the opposite direction of the satellite. The foreign ministry of China confirmed this news on January 23, 2007 exactly 12 days after it carried out the programme on January 11. This event has been known to cause a drastic

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[25] Stanley Mazaroff, *Exonerations From Damage Caused By Space Activities*, 54 Cornell L. Rev. 71 (1968) (last visited Oct. 24, 2016), http://scholarship.law.cornell.edu/clr/vol54/iss1/5.

[26] Id.

[27] Chris Bergin, *ISS dodges Minotaur debris via PDAM*, (June 8, 2015), https://www.nasaspaceflight.com/2015/06/iss-dodges-minotaur-debris-pdam/.

[28] Brendan Nicholson, *World fury at satellite destruction*, (January 20, 2007), http://www.theage.com.au/news/national/fury-at-space-destruction/2007/01/19/1169095981210.html.

increase in the amount of space junk that has been orbiting the Earth. China was globally condemned for its action. However, it claimed that it had informed the Japanese and the US authorities of its plans prior to the commencement of the tests. In February 2008, the United States launched its own programme to destroy a non – functioning US satellite. The US cited this action as a necessary one in order to remove the constant threat that was posed by the decaying satellite with a tank full of hydrazine fuel [29].

V. International State Liability

The rising threat of orbital congestion has been recognised by the international space community since the 1980s. However, it was only in the year 1993 when concerted international actions to address the problem were started. This is when the Inter-Agency Space Debris Coordination Committee (IADC) was established by the different national as well as regional space agencies. A set of guidelines were adopted by the IADC for mitigation measures of space debris in the year 2002[30]. The United Nations Committee on the Peaceful Uses of Outer Space (UN COPOUS), in collaboration with IADC was formed to update and revise the IADC guidelines on debris mitigation. The guidelines which were agreed upon, were adopted and consequently endorsed by COPOUS in the year 2007, as the Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space[31]. Currently, the international space law regime consists of five treaties of the United Nations and five Declarations. However, all these documents fail to provide a specific definition of the term 'space debris'. The term used in these documents is 'space object' and an oblique definition has been provided to this term.

International liability has been accredited to a State for damages caused by objects or their components, launched into the outer space under Article VII of the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including Moon and other Celestial Bodies (Outer Space Treaty). It states that:

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[29] Tim Ross, Holly Watt and Christopher Hope, *America threatened China over 'star wars'* The Sydney Morning Herald (2011), (Feb. 4, 2011), http://www.smh.com.au/world/america-threatened-china-over-star-wars-20110203-1affj.html.

[30] Inter-Agency Space Debris Coordination Committee, *Terms of Reference*, (Oct. 27, 2016), http://www.iadc-online.org/Documents/IADC%20_TOR%20rev%2011.4%20(public%20version).pdf.

[31] *Report of the Committee on the Peaceful Uses of Outer Space*, UNGAOR, 62nd Sess, Supp No 20, UN Doc A/62/20, (Oct. 27, 2016), http://www.unoosa.org/pdf/gadocs/A_62_20E.pdf.

> *"Each State Party to the Treaty that launches or procures the launching of an object into outer space, including the Moon and other celestial bodies, and each State Party from whose territory or facility an object is launched, is internationally liable for damage to another State Party to the Treaty or to its natural or juridical persons by such object or its component parts on the Earth, in air space or in outer space, including the Moon and other celestial bodies."*

Based on the essentials of Section 7 of the Outer Space Treaty, the Liability Convention (Convention on International Liability for Damage Caused by Space Objects), was brought into consideration and then negotiated upon, by the Legal subcommittee between 1963 to 1972. The Agreement was arrived upon at the General Assembly in 1971[32], and the Convention came into force in September 1972. The Liability Convention states that, a launching State shall be absolutely liable to pay compensation for any damage caused by its space objects on Earth's surface or to an aircraft[33], and liable for the damages due to its errors in the space[34]. The Convention further provides for procedures for the settlement of claims for damages. Article IX of the Convention states that:

> *"A claim for compensation for damage shall be presented to a launching State through diplomatic channels. If a State does not maintain diplomatic relations with the launching State concerned, it may request another State to present its claim to that launching State or otherwise represent its interests under this Convention. It may also present its claim through the Secretary-General of the United Nations, provided the claimant State and the launching State are both Members of the United Nations."*

State responsibility has been regarded as *"a legal construct that allocates risk for the consequences of acts deemed wrongful by international*

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[32] United Nations Office for Outer Space Affairs, *Liability Convention*, (Oct 29, 2016) http://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/introliability-convention.html.

[33] Article 2, Convention on International Liability for Damage Caused by Space Objects, United Nations Office for Outer Space Affairs, (Oct 29, 2016) Liability Convention, http://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/introliability-convention.html.

[34] Id. at Article 3.

law to the artificial entity of the State"[35]. In international space law, while responsibility applies to a *"State's obligation to regulate and control space activity both in the present, and in the future, to assure compliance with not only the letter but the spirit of the Outer Space Treaty principles"*, liability on the other hand refers to an *"obligation of a State to compensate for damages"*[36].

Under the current legal regimen, ownership of space objects is not coterminous with the jurisdiction and control over the said objects. Article VIII of the Outer Space Treaty states that:

> *"Ownership of objects launched into outer space, including objects landed or constructed on a celestial body, and of their component parts, is not affected by their presence in outer space or on a celestial body or by their return to the Earth."*

While *'jurisdiction and control'* is clearly geo-spatial in nature as it can be retained "*in outer space or on a celestial body,"* 'ownership' is in perpetuity as it "*is not affected by the presence of an object in outer space or on a celestial body or by its return to the Earth.*" The law is also mute about the temporal factor of 'jurisdiction and control' as to when can a State relinquish *de jure* jurisdiction and control over its space objects. This is particularly important in cases when a State of registry has lost *de facto* control over a space object due to a technical anomaly which has rendered the space object non-functional and consequently, a potential target for correction.

VI. Conclusion

The development of the public international law jurisprudence over the years, can be looked into for answering the unanswered questions arising from the remediation of space debris. Public international law principles can also be relied upon in order to address the lacunae in the current international space law regime. It is imperative that greater accountability be enforced upon the space faring nations with respect to the outer space activities undertaken by them.

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[35] Christine Chinkin, *A Critique of the Public/Private Dimension* (1999) 10 EJIL 387 at 477, See also: Joyeeta Chatterjee, *Legal Issues Relating To Unauthorised Space Debris Remediation*, 65th International Astronautical Congress, McGill University, Institute of Air and Space Law.

[36] W. B. Wirin, *Practical Implications of Launching State – Appropriate State Definitions*, (1994) 37 Proc. of Colloq.on the Law of Outer Sp., See also: Id.

In February 2017, the Indian Space Research Organisation created a record for launching 104 nanosatellites into the orbit through a single rocket[37]. While, this is a notable achievement on the part of the country, it also adds to the responsibilities that the country has towards ensuring the protection of the outer space environment. This is to be applied to all the countries that send objects to the outer space. The outer space cannot be treated as a dump yard for wasteful materials. In the absence of absolute liability, the unflinching exploitation of the space environment could prove to be extremely dangerous.

Another important aspect of debris remediation is the need for the space faring nations to stand on at an equal footing in terms of ownership and liability. US and China missions have led to the generation of huge amounts of space junk, and an immense amount of international backlash. Since 2013, a Swiss spaceflight company, Swiss Space Systems (S3), is formulating its plans in association with Canada for a potential launch of a private space plane for the purpose of cleaning up the space junk by the year 2018. With the launch of this new Clean Space One satellite which uses European Suborbital Reusable Shuttle, known as the Clean Space One, the company aims to de – orbit defunct satellites and other objects forming space junk. It will first demonstrate the de – orbiting of Switzerland's Swisscube Nanosatellite only, so as to avoid any potential legal issues[38].

This Swiss mission could be the opening towards the next step to be taken by the international community. It is the responsibility of the established space faring nations, to engage in greater discourse for developing State practice and legal and policy guidelines on space debris remediation. Greater investment in research and development of technology which could be used for cleaning out the space junk would be one such important move taken by the space faring nations. Unilateral actions which encourage responsible and judicious space behaviour among licensed private entities could bring about a pleasant change in the current face of the debris remediation programmes. An international understanding and cooperation is a must for a successful space cleaning rendezvous. A great and tacit understanding of the law is another important requirement in this regard. Certain clarifications in terms of the existing legal framework addressing the ambiguities would also render great help. There are numerous ways to

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[37] *India Launches Record-Breaking 104 Satellites From Single Rocket*, The Guardian, (Feb. 28, 2017), https://www.theguardian.com/science/2017/feb/15/india-launches-record-breaking-104-satellites-from-single-rocket.

[38] Rob Coppinger, *Space Junk Cleanup Satellite Launching on Swiss Space Plane in 2018*, Space.com, (Oct. 27, 2016) https://www.space.com/23049-space-junk-satellite-swiss-space-plane.html.

handle the challenges that are faced by the space law regime, but through concerted efforts and cooperation these can be overcome.

Finally, to conclude it may be said that current debris population in the LEO region had reached the point where the environment is unstable and collisions will become the most dominant debris-generating mechanism in the future[39]. Hence:

- The laws on outer space need to transform into a more binding nature from the existing directive nature.
- It is imperative that these laws are molded to include non-state actors and private enterprises, in terms of damages and liability.
- The state parties which have not ratified the conventions must also be brought into consideration since, damage can be caused to and by anyone.
- Non-space faring states must also be brought under the ambit of damages and liability.

The existing debris in the outer space poses a threat to the outer space activities as well as the Earth's atmosphere. Therefore, the laws need to recognize these dangers and formulate binding provisions for the States to abide by.

[39] J. -C. Liou and N. L. Johnson, *Risks in Space from Orbiting Debris*, *311* SCIENCE 340 (2006).