IMPACT OF OUTER SPACE ACTIVITIES ON THE GLOBAL ENVIRONMENT : ISSUES AND REMEDIES UNDER INTERNATIONAL SPACE LAW

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I. Introduction

The origin of space law can be traced back to the time when Satellite Sputnik -1 was launched on Oct 4, 1957. From then the world started a new way of thinking. Though the Space Law is still in its nascent form, it is an evolving branch of the International Law. It has been developing under the aegis of the United Nations of General Assembly. The exploration and its importance were long recognised. The silent race between the USA and the Soviet Union was much in evidence. The USSR took the first tiny step with the launch of the Sputnik satellite on October 4, 1957. Compared to the current utilisation, exploitation and future plans for space, it was indeed a 'baby' step. The Sputnik satellite was a polished metal sphere of a mere 58 cm diameter with four external radio antennae, and it was launched into a low earth orbit. The signals from the satellite lasted only till October 26, 1957, for only 22 days, as the batteries got discharged. Hence the technological claim to fame of the Sputnik satellite was that it was the first satellite launched into space and not really for any other reason.

II. Concept of Air Space and Outer Space

2.a) Outer Space: The concept of outer space has no single accepted and technical definition. There are some proposed definitions of outer space, like; "any of space beyond limits determined with reference to the boundaries of a celestial body or system, especially the region of space immediately beyond Earth's atmosphere and Inter-planetary space"[3]. There are different opinions and definitions of Outer Space and upper Atmosphere as given in relation to legal language. There are interchangeable terms having different legal and scientific meaning like Space, Outer Space, Air Space, Extra-Territorial Space, Cosmic Space, Extra-Atmospheric Space, World Space, Contiguous Space, Territorial Space etc. So there is urgent need to have a single universally accepted definition of Outer Space, to

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3 Outer space, available at http://www.thefreedictionary.com/outer+space (last visited on January 28,2016)

distinguish it from other terms and also as due to rapid development of space and aviation technology that gives aircrafts, the capacity to reach certain parts of outer space. The universally accepted definition will reduce the conflict in the interpretation of the law. In addition a clear definition of Outer Space can help us having the definition of "Space Object". The specification of air and space boundaries by U.N will help in broadening the scope of peaceful activities in outer space. All that said, it is logical to differentiate air-space and outer space. The cogency of that logic has increased significantly during the years of space exploration. In particular the provisions of 'Arms Limitation Agreements' and treaties distinguishes between weapon systems accordingly as they are or not space located. Such agreements do not themselves define space for their purpose but appear to rely on the common understanding of what or where space 'begins'. The needs of arms limitation agreements may therefore compel towards some resolution of the matter. However, it would be entirely proper for a boundary between air-space and outer space to be determined for the purpose of arms limitation without that determination necessarily being read through to rule on questions of civil interest[4]

II.I. The Essential Characteristics of Outer Space

The unique characteristics of outer space and its uses include the following :

i) Outer Space is the void that exists between the celestial bodies, including the earth.

ii) An outer space is not completely empty but consists of hard vacuum containing a low density of particles, predominately a plasma of hydrogen and helium as well as electromagnetic radiation, magnetic fields, neutrinos, dust and cosmic rays.

iii) The area of outer space lies beyond the uppermost which reaches of the atmosphere of Earth and between all other objects in the universe.

iv) The temperature in the outer space, as set by the background radiation from the big bang, is 2.7 kelvins (k).

v) The outer is also consists of local concentrations of various stars and galaxies.

vi) In most galaxies it was observed that, where 90% of the mass is in an unknown form called as the dark matter which interacts with the other matter through gravitational forces but not electromagnetic forces.

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[4] Francis Lyall and Paul B. Larsen, *Space law: A Treatise*, P.162, Ashgate publishing Limited, England, 2009

vii) There is no firm boundary from where the outer space begins.

viii) The Karman line at an altitude of 100 km (62 mi) above the sea level, is conventionally used as the start of outer space.

II.II. The Airspace

Air law, is the body of public and private law, both national and international that regulates aeronautical activities and other uses of airspace. It would not be out of place to discuss here the legal regime of the airspace in the light of views as expressed by certain eminent jurists. It was felt that before the flights above the earth surface became a reality, the air space was thought to be free for the peaceful uses by all. The Chicago convention and the earlier conventions were silent on the definition of the term "Airspace". However, there are certain theories that may enlighten the determination of the upper limit of airspace. The Theories of Airspace are as follows[5] :-

1. Usque and Coelum Theory
2. Gravitational Theory
3. Airspace Theory
   (a) Atmospheric Theory
   (b) Aerodynamic Theory
   (c) Biological Theory
4. Theory of Satellite Orbit
5. Theory of the Karman Line
6. Theory of Effective Control
7. Interest Theory
8. Theory of Security
9. Intermediate or zone Theories
10. Functional Approach
11. Spatial Approach

III. COPOUS (International laws and Treaties)

The United Nations General Assembly established a committee on the peaceful uses of outer space (COPUOS), to regulate the outer space activities in universe. The development of many regulations and overall framework of law was taken up in 1958 through an ad-hoc Committee on Peaceful Uses of Outer Space, under the aegis of United Nations. Later, the ad-hoc committee was subsequently replaced by a permanent body called the United Nations Committee on Peaceful Uses of Outer Space

[5] Dr. Harnam Bhayana, International law in the regime of outer space, p.9, (R. Cambray & Co. Pvt. Ltd, Calcutta, 2001)

(UNCOPOUS). The entire international law on space is contained in the following treaties and principles adopted by the UN from time to time. The worldwide interest and concern of all nations with the emerging space activities manifested itself in the United Nations at an early stage. Shortly after the launch of first artificial satellite in 1957, on the basis of a proposal by the United States and 19 other states, the United Nations general assembly established a committee on the peaceful uses of outer space (COPUOS), consisting initially of 24 and now of 53 members.[6]The committee created two standing subcommittees of the whole, the scientific and technical subcommittees and the legal subcommittees, for the drafting of legal regulations. Guided by the principle of consensus in its decisions, the committee has succeeded in drafting five international agreements, all of which are currently in force, although their significance and the number of states adhering to each agreement differ markedly. The greatest support has been given to the 1967 outer space treaty[7], and the least adherence to the 1979 Moon Agreement,[8] which lacks, in particular, the support of the space faring nations. The other treaties elaborated by the United Nations include the 1968 Rescue Agreement,[9] the 1972 liability convention,[10] and the 1975 Registration Convention.[11]

The 1967 Outer Space Treaty is the Magna Carta of International Space Law which was built on several principles already included in the Declaration of Legal Principles, 1963, governing activities of states in the exploration and use of outer space. The Treaty gives the opportunity to encompass the freedom of scientific investigation and free access to all the areas of celestial bodies.

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6 U.N.G.A. Res. 1472 (XIV), 1959

7 Treaty on principles governing the activities of states in the exploration and use of outer space, including the moon and other celestial bodies, done Jan. 27, 1967, entered into force oct 10, 1967, 18 U.S.T. 2410, T.I.A.S. No. 6347; 610 U.N.T.S. 205 (herein outer space treaty)

8 Agreement Governing the Activities of States on the moon and other celestial bodies, adopted by the united nations general Dec. 5, 1979, opened for signature Dec. 18, 1979, Entered into Force July 11, 1984, U.N.G.A Res. 34/68 (1979)

9 Agreement on the rescue of astronauts, return of astronauts, and the return of objects launched into outer space, done Apr. 22, 1968, entered into force Dec. 3,1968, 19 U.S.T. 7570, T.I.A.S. No. 6599, 672 U.N.T.S. 119 (hereinafter Rescue Agreement)

10 Convention on international liability for damage caused by space objects , done Mar. 29, 1972, entered into force Sept. 1, 1972,24 U.S.T. 2389, T.I.A.S. No. 7762, 961 U.N.T.S. 187 (hereinafter liability convention)

11 Convention on the registration of objects launched into outer space, opened for signature jan.14,1975, entered into force sept.15,1979, 28 U.S.T. 695, T.I.A.S. No. 8480, 1023 U.N.T.S. 15 (hereinafter Registration Convention).

The 1968 Agreement on The Rescue of Astronauts, Return of Astronauts and The Return of Objects launched into outer space was adopted by the UN General Assembly on 19 December 1957. The imminent increase in the activities of astronauts, the uncertainty of space technology, the potential need for their rescue has led to the adoption of this agreement by the UN Nation.

The third major International treaty, The Liability Convention 1972, provides for rules governing international liability for damage caused by space objects and for the presentation and settlement of claims.

The fourth major treaty, The Registration Convention 1975, requires launching states to register their launched objects in an appropriate national register and also requires them to furnish certain data on such launchings to the united nations Secretary-General, who is to maintain a central register of such objects and related information on a mandatory basis.

The Moon Agreement, 1979 repeats the essentials of the OST as to moon and celestial bodies, but also enlarges its scope. The treaty repeats the applicability of International law that its exploration and use are to be available for all and for the benefit of all. The main area of controversy concerns the provision on common heritage of mankind

IV. Space Debris: A major Environmental Issue

IV.I. Concept of Space Debris

Towards the end of the third decade of the space age, it became apparent that another population of debris was having an impact on artificial satellites but, unlike the naturally occurring meteoroids, it was man-made in origin and are called the artificial space debris. This orbital debris population was growing rapidly, dominating the meteoroid environment in the size range of micrometres. This new particulate environment, posing a significantly increased collision hazard to the artificial satellites, was found to be the direct consequence of launching and operating similar systems during the preceding 30 years. As we become more dependent upon space-based systems for remote sensing, communications and navigation, it is important that we understand the nature of threat that orbital debris pose to operational satellites and take appropriate steps to ensure the sustainable development of near-Earth space. Orbital debris are considered to be those man-made objects that are present in the orbit and revolving around the Earth but serve no useful purpose. In its 1999 report on Space Debris (UN 1999), the United Nations Committee for the Peaceful Uses of Outer Space (UNCOPUOS) proposed that 'Space Debris are all man-made objects, including their fragments and parts, whether their owners can be identified or not, in Earth orbit or re-entering the dense layers of the atmosphere that are non-functional with no reasonable expectation of their being able to

assume or resume their intended functions or any other functions of which they are or can be authorised.

There are no two views regarding the various advantages of artificial satellites to the mankind. At the same time, however, these man-made objects launched in the space is increasingly posing hazardous threats to the environment. This is due to the irresponsible and adamant principles of some countries, which are responsible for the Space Debris in outer space, which is posing threat to entire future space exploration and launching programs. With the increasing number of space activities, the claims for the damage control have also grown. The size of Space Debris and the amount of threat pose by them are contrary. Even at present it is unfortunately, impossible to track and to keep record of all the data of Space Debris due to its size. Since the space age began six decades ago, rockets have lifted more than 20,000 metric tons of material into orbit. Today 4,500 tons remain in the form of nearly 10,000 "resident space objects", only 5 percent of which are functioning spacecraft. These objects are just the large ones that military radars and telescopes can track. Of increasing interest to spacecraft operators are the millions of smaller, untraceable scraps scattered into orbits throughout near-Earth space, from only a few hundred kilometres to more than 40,000 kilometres (25,000 miles) above the surface of the planet. If Earth's tiny attendants moved like the hordes of miniature moons around Jupiter or Saturn, they would be a thing of beauty. The rings of the giant planets have been finely orchestrated; their constituent rocks and chunks of ice orbit in well-behaved patterns, and collisions between them occur at gentle velocity. However, Earth's artificial satellites resemble angry bees around a beehive, seeming to move randomly in all directions. The population density of satellites is fairly low; the region around Earth is still a vacuum by any terrestrial standard. However, the haphazard motions of the swarm lead to huge relative velocities when objects accidentally collide. A collision with a one-centimetre pebble can destroy a spacecraft. Even a single one-millimetre grain could wreck a mission. The extraterrestrial refuse comes in many forms: dead spacecraft, discarded rocket bodies, launch- and mission-related castoffs, and remnants of satellite breakups, solid-rocket exhaust, frayed surface materials, and even droplets from leaking nuclear reactors. Although more than 4,800 spacecraft have been placed into orbit, only about 2,400 remain there; the rest have re-entered Earth's atmosphere. [12]

IV.II. Kinds of Debris Found in the Outer Space

Currently there is about six metric tons of space debris in earth orbit and about 45 % of that is in low-earth orbit and polar orbits where the threat

[12] Nicholas L. Johnson, "Monitoring and Controlling Debris in Space" (1998)

of collisions continues to increase. This process can lead to an escalating cascade of more and more debris. Space was free of man-made pollution until 1957, when the Russians launched Sputnik. Since that time 15,000 large objects have been discarded in orbit, including rocket boosters and fuel tanks, dead satellites, tools and garbage jettisoned from manned spacecraft[13]. Forty thousand smaller objects (approximately 2.5 cm in size) and billions of tiny flakes of paint also float in space. Space debris in near-earth orbit is particularly hazardous because it travels at approximately 17,500 miles (29,575 km) per hour[14]. At these velocities, even a tiny flake of paint 1/50 of an inch (0.51 mm) across could puncture an astronaut's spacesuit. A paint fleck that is 1/10 of an inch (2.54 mm) in diameter can damage a space-craft.17Today we are very much at risk of such a cascading build-up that is known as the "Kessler Syndrome"[15]. The Earth encounters a flux of natural debris as it sweeps through interplanetary space. This sporadic flux of meteoroids totals more than 200 kg of dust within 2000 km of the Earth's surface, travelling in excess of 20 km s-1 and is relatively evenly distributed in position and velocity (NSTC 1995). This population is periodically augmented by stream meteoroids when the Earth passes through the remnants of comets such as Temple-Tuttle, to produce short-lived us significantly enhanced and directional fluxes such as the Leonards (Beech et al. 1997). Historically, this was the background particulate environment against which artificial satellites were designed. The *res communes* nature of outer space, without discrimination, the freedom of exploration and use of it, to every state, and apparently an inherent right to dump debris of space systems by the space faring nations, unmindful of long term consequences. Since the launch of first space object in 1957 more than 4800 [16] space launches have placed about 7,150 spacecraft in orbit along with the associated rocket bodies. Dominant contributors are US and then USSR and Russia. Presently there are about 1,071 operational spacecraft orbiting around the Earth. More than 100 countries own a spacecraft.

Two events in recent years have particularly contributed to orbital space debris build-up. One event was the collision of the defunct Russian Cosmos 2251 weather satellite with the Iridium 33 in the low earth orbit

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[13] D. Dudeny, "The High Frontier in Perspective", Worldwatch Paper 50, Worldwatch Institute, Washington DC, 1982

[14] NASA, Space Mathematics (US Government Printing Office, Washington, DC 1972.

[15] Joseph. N. Pelton. "Springer Briefs in Space Development ", p.2. International Space University Switzerland, 2015

[16] Data for the period: 1957-2011.
Total number of launches: 5,196 (4769 ½ success)
Total number of payloads carried: 7,120

mobile communications satellite[17]. On 10 February 2009, areal space nightmare came true. A satellite belonging to Iridium Communications relaying data to and from mobile phone users was passing over Siberia's Taymyr Peninsula. At 16:56 GMT Iridium 33 was there, at 16:57 it was not. It had collided with a dead Russian military communications satellite. Weighing one tonne and travelling at a relative speed of 12 kilometres per second, the Cosmos 2251 satellite hit the Iridium 33 with three times the kinetic energy of an Airbus A380. Both spacecraft disintegrated, scattering wreckage far and wide. The loss of one of its 66 satellites was a blow to Iridium but what caused sleepless nights for satellite operators and space agencies everywhere was the floating debris. The US Space Surveillance Network catalogued more than 2,000 fragments bigger than a grapefruit from the collision and a much greater number of smaller ones. At the speeds required for low-Earth orbit, an object the size of a marble can cripple a satellite or punch a hole in a space station. By the incident of Iridium-Cosmos crash, the world of space agencies suddenly woke up to the threat posed by the thousands of tonnes of objects- operational and dead cruising in low orbit.

The second was the shooting down of an old and defunct Chinese Fen Yun weather satellite by the Chinese military. The Chinaon Jan, 2011 demolished an aging weather satellite, the Feng Yun-lC, orbiting Earth at an altitude of approximately 850 kilometres. The satellite disintegrated when struck by a projectile carried into space by a ballistic missile launched from the Xichang space launch facility in south-western China[18]. China for the first time used a weapon to destroy one of its satellites. Beijing says its feat was not hostile, but it polluted space with a huge amount of potentially harmful debris and sparked debate over China's professed desire to prevent a space arms race.

Each of these events led to the creation of nearly 3,000 new tracked debris elements. Currently, there are 22,000 of these space debris elements are being actively tracked by U.S. surveillance networks. Each of these debris elements are capable of creating major new debris, especially if they collided with another satellite or upper stage rocket. In short, without further remedial action to remove space debris from Earth orbit, the problem will continue to get worse[19]. [NASA Office of Orbital Debris].

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[17] Cosmos, Space junk: catastrophe on the horizon, available at http://cosmosmagazine.com/space/spacejunk-catastrophe-horizon (last visited on April 30, 2016)

[18] Wade Boese, "Chinese Satellites Destruction stirs Debate" ,vol.37, no.2, *Arms Control Today*, p.27 (2007)

[19] Joseph. N. Pelton. "Springer Briefs in Space Development", p.2. International Space University, Switzerland, 2015

IV.III. Removal of Space Debris through Legal Mechanism

"Space Debris" is one of the biggest problems that are going to affect both extra-terrestrial and terrestrial environment. The major treaties, which are dealing with space law along with the provisions of environment safety, are Outer Space treaty, 1967 and Moon Treaty, 1979. Further, there are more treaties, which more or less deals with such issue: The Environment Modification Convention 1977, Space Liability Convention 1972, The Rescue Agreement 1968, and The Space Registration Convention 1975.[20] There are basically two main ways to remove the space debris:

- Mitigation
- Active Removal

(i) Mitigation

Mitigation means reducing the further creation of space debris while Removal may be by a human made scheme. In Resolution 62/217, "International cooperation in the peaceful uses of outer space", the General Assembly endorses the Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space and agrees that the voluntary guidelines for the mitigation of space debris reflect the existing practices as developed by a number of national and international organizations, and invites Member States to implement those guidelines through relevant national mechanisms.

(ii) Active Removal of Space Debris

The idea of Active Debris Removal was articulated thirty years ago[21]. Nevertheless, the technical challenges and prohibitive high costs towards technology developments and demonstrations might have thwarted serious attempts. Nevertheless, as it has become quite imperative, the concept of Active Debris Removal (hereafter referred to as ADR) is gaining momentum among global space community. Besides technical challenges certain non-technical barriers relating to legal, policy and economic aspects are also to be overcome to effectively implement ADR systems. As per the report of the International Inter Disciplinary Congress on Space Debris Remediation and On-Orbit Servicing[22]

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[20] Kunwar Malhotra, "Outer Space law and the problem of space debris (2015), available at www.lawoctopus.com/academike/Outer_Space_law_problem_space debris (last visited on April 3,2016)"

[21] J.C. Liou, "orbital debris conference" vol-15, issue 3, NASA Conference Publication, (July, 2011)

[22] U.N. Document A/Ac.105/C.i/2012/CRP.16 dt. January 27 2012- A report of the the International Inter Disciplinary Congress on Space Debris Remediation and On-Orbit Servicing.

Under this method the space debris are planned to be removed by the human made machines (spacecrafts). Many private companies even have entered into the contract with various space agencies to help in removing Space Debris. Only Mitigation Guidelines are not enough as there is an urgent need to protect the outer space environment form space debris for further research and to ensure sustainability of these activities in future also. The following are some of the essential prerequisites for the conduct of active debris removal and on-orbit satellite servicing [23]:

- A "cost effective" technique;
- A proper legal and policy framework to protect the parties involved and to deal with "alternative use" concerns ;
- Available and willing target for removal or customer for servicing;
- Someone to pay (cost);
- Accurate tracking and necessary assistance during operations.
- Technical Capability to locate, approach, connect diorite/servicing device, control orientation and to move the target object to desired destination; and
- Safety of the public on ground, at sea and travelling by air.

There are some other ways to get rid of Space Junk like:

- Auto Detector Debris Satellites, which can auto-detect the space junk and destroys either it or take it back on Earth.
- Supersonic Laser, which can be use by placing it on Earth only, but it, will burn the space trash. These lasers have been put up in Australia.
- Artificial Robots, which can go to space and there only work will be to destroy orbital debris.
- Space Magnet, which can attract small pieces of debris and throw it out from Earth's orbit.
- Space Bombs, which can burn the space junk, without harming any other satellites.
- Self-De-Orbiting Mechanism, which can allow satellite to automatically go out of Earth's orbit, after it is of no use.

[23] Corinne M. Jorgenson (ed.) , Space Debris remediation- Common but Different Responsibility, "Proceedings of the international law institute 2013"p.380, Eleven International Publishing, Netherlands, (2014)

Article VIII of the Outer Space Treaty, states that non-functional satellites still belongs to its launching States, which further means without the consent of that State, no other country can interfere with it. And it is equally possibility of accidents during the cleanup of space debris,

Article VI of Outer Space Treaty states that the country under whose jurisdiction the satellite falls retains the responsibility of the activity and any accidents during their activities.

(iii) UN-Space Debris Mitigation Guidelines[24]

- Limit debris release during nominal operations
- Minimize break-up potential during operations
- Limit accidental in-orbit collision probability
- Avoid intentional destruction & harmful activities
- Limit the probability of post-mission break-up
- Limit the long-term presence of spacecraft and launcher orbital stages in the LEO protected region re-entry objects resulting from this recommendation must not pose an undue risk to the ground population
- Limit the long-term interference of spacecraft and launcher orbital stages with the GEO protected region.

V. Conclusion

The desire of man to peep into the mysteries of nature led him to discover new areas of invention. This relationship of man and nature is going on from centuries and shall continue to go till the existence of life on the planet. In this sequence, 20th century is a remarkable century because the latter half of this century, the world saw a present event of space exploration, when a satellite was launched in outer space by soviet union named sputnik 1. The activities in outer spaces, with advanced technology, have shown more remarkable achievements such as space-walks, space-link-ups, spaceships, space laboratories and space shuttles. The prudence of man even led him to conquest mars, Venus, Saturn and other planets in the solar system. Certainly he would like to go beyond it.[25] Far above the Earth, orbiting satellites play a crucial role in our everyday lives powering

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[24] Sergio Marchisio, "Space Debris Mitigation And Space Law", Session 10: Space Technology and Space Law, Mombasa, Kenya, p. 8 (2011). Also, UNGA Res. 62/217 of 21 December, 2007.

[25] Harnam Bhayana, *International in the Regime of Outer Space*, p.1, R. Cambray & co. Pvt. Ltd, Calcutta, 2001

countless services ranging from cell phones to banking, weather reports, and navigation. Taken largely for granted, these modern conveniences are actually in constant peril, due to potential collisions with the accumulating outer space debris left by those defunct satellites. The treaties do not actually address the problem of space debris. The mitigation guidelines, though they are brought up by various agencies of United Nations, in some cases they are being misused and not followed by the big powers. The guidelines are just made for show up in world of laws. In principle every human activity in every field needs a law, not to curb freedom but to regulate its operation and to make it compatible with similar rights of others.