

Research report

Forum: United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS)

Issue: Combating the issue of pollution in space

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Introduction

In the span of 60 years of space travel, the general human population has regarded the problem of space pollution as a relatively dismissive issue that hasn't taken the primary role in the international agenda. Recent National Aeronautics and Space Administration (NASA) studies however pose the issue of space population as a lot more pressing than suspected. NASA states that they're currently 128 million debris pieces in earth's orbit which include over 2900 non-functional or non-operational satellites. In recent years the rise of privatisation in space together with the rapid growth in technology for space travel cutting the costs led to a large increase in space exploration. This perceptibly leads to even more space pollution possibly endangering current satellite systems and in the future conceivably jeopardising human space explorations as a whole.

This issue is however not effortlessly fixed: the removal of space debris is extremely complex due to debris size and location. International space organisations such as the European Space Agency (ESA) have made efforts to tackle this issue. Most notable was the ClearSpace1 which is set to launch in 2025 and aims to eliminate the larger orbital space debris. The technology to resolve this issue is just starting to properly develop whilst the technology that is causing space pollution is only developing more rapidly. The UNCOPUOS is a suitable place to start the negotiations on artificial waste, international responsibility and property rights or a new legal framework as a whole. Accordingly, at present, the international community is left with the task of paving the way toward a safe and clean space.



Fig 1. The ClearSpace 1 by ESA, ESA

Definitions of key terms

United Nations Committee on the Peaceful Usage of Outer Space (UNCOPUOS)

In 1959 the General Assembly established the United Nations Committee on the Peaceful Usage of Outer Space (UNCOPUOS) with the means of creating a governing body advocating peace, security and development in global space exploration. Now the UNCOPUOS mainly encourages international collaboration in outer space, supports and initiates global research projects, studies space activities whilst reporting back to the General Assembly and lastly oversees possible legal problems that may arise during the exploration of outer space.



Fig 2. UNOOSA and UNCOPUOS headquarters, UN press

Space pollution

A phenomenon taking place in space where man-made wreckage and nonfunctional objects together with micrometeoroids orbit the earth. When talking about the ‘pollution of space’ you however only talk about the negative aspects that take part in space endangering natural areas. In legal and political discussions ‘space pollution’ is often only seen as man-made pollution.

Space debris

Non-operational human-made objects orbiting the earth, re-entering the earth’s atmosphere or in a non-orbital track in outer space. Space debris is often made up of small fragments and remains of satellites and rockets.

Satellites

A satellite is strictly known as a planet, moon or object orbiting a celestial body. For example, the moon is a satellite of the earth and the earth is a satellite of the sun. Nonetheless, when talking about space we commonly use the term “satellite” when referring to a man-made mechanism with the purpose of acting as an information transmitter in many forms all while being in earth’s orbit. A satellite can also be used outside of the earth’s orbit for example for celestial body research missions.

Ablation cascade

This phenomenon is described as the possible tipping point of collisions, where if orbital collisions keep happening, space might even become unusable at some point. This theory was first introduced in 1978 by chief NASA researcher Donald J. Kessler who stated that the rise of

space exploration leading to space junk and space debris could harm humanity in the future. When these uncontrollable pieces of space debris would fill space abysmal things could happen: entire economic systems would collapse, military services would blackout and entire communication networks would be destroyed. This doomsday scenario would eventually seal humanity off from ever endeavouring to exploit space again. We now know the ablation cascade by terms like “the Kessler Syndrome ” or “the butterfly effect”.

International Space Station (ISS)

The International Space Station (ISS) is an international space station orbiting the earth in low orbit. The ISS is a multinational collaboration project led by five international parties: NASA (owned by the U.S.), Roscosmos (owned by the Russian Federation), JAXA (owned by Japanese authorities), ESA (a collective organisation under the European Union) and the CSA (owned by Canada). This 109 metres wide modular space station was first launched on the 20th of November 1998. The ISS is now used for astrobiology, physics, meteorology and astronomy research.



Fig 3. Donald J. Kessler, Press



Low Earth Orbit (LEO)

The Low Earth Orbit (LEO) is defined as an orbit around the earth at a height of 2,000 km (1,200 mi) from sea level. A LEO needs to consist of 11.25 orbits in one day and an eccentricity of fewer than 0.25. Around 70% of all artificial mechanisms in space are currently in the LEO region.

Anti-Satellite Tests (ASATs)

An Anti-Satellite Test (ASAT) is a ground-to-space defence mechanism that targets orbiting objects such as satellites. This military strategy can destroy entire banking systems and leave foreign armies with no communication structures completely dismantling them. This technique is also widely known for the many debris pieces it creates. There are currently four governments that have effectively tested an ASAT: The United States of America (VP Harris announced that the U.S. would not perform ASATs anymore on the 18th April 2022), the People’s Republic of China, India and the Russian Federation.

Here is a short list of abbreviations that are often used throughout this report and will be handy for deliberations on space pollution:

ASAT	Anti-Satellite Test
ASI	Italian Space Agency

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BNSC	British National Space Centre
CNES	Center National d'Etudes Spatiales
CNSA	China National Space Administration
CSA	Canadian Space Agency
DLR	Deutsches Zentrum für Luft-und Raumfahrt e.V.
DoD	Department of Defence (U.S.)
ESA	European Space Agency
ISRO	Indian Space Research Organisation
JAXA	Japan Aerospace Exploration Agency
LEO	Low-Earth Orbiting
NASA	National Aeronautics and Space Administration
NSAU	National Space Agency of Ukraine
Rosaviakosmos	Russian Aviation also, Space Agency
SSN	Space Surveillance Network
UNOOSA	United Nations Office of Outer Space Affairs

General overview

Problem and possible consequences

Throughout civilization humanity has always felt a need to evolve, it's what makes us human. The same goes in space development. Space pollution is to summarise it caused by the intervention of humanity and the research actions we have made. Throughout time we have seen that we put newer and more advanced systems into orbit (look at the Timeline of Key Events). These systems are vulnerable due to their usage of new cutting edge technology and specific materials. When these satellites are labelled outdated due to the rapidly evolving space technology they are deemed 'retired' and become non-functional. Over time these satellites will disintegrate and turn into orbiting space debris. The orbit is full of these 'retired' satellites and they form the focal part of space pollution.

Over the years more than 5,000 space exploration missions have been made using rocket launch systems. When a satellite is launched into orbit certain pollutant gases like Sulphur dioxide and carbon dioxide are released. Because of the density and the lack of gravity in outer space these gases tend to flow to the top surpassing the Ozone layer. In space, a free cloud of nebulae is then left. This cloud interferes with satellite systems and other ground-based tech.

At the moment space pollution, fortunately, does not form a risk for new space explorations and their launch, it however will be in the future states Donald J. Kessler with his theory of the ablation cascade.

The biggest problem facing us at this time is the danger space debris poses for already orbiting satellites

and space stations. These artificial objects will have to manoeuvre

around space debris in order to stay unharmed. For example, the ISS had to first perform manoeuvres back in 1999 to avoid a sequence of Pegasus HAPS remains. Nowadays manoeuvring around space debris is more and more common for these mega-constellations.



Fig 4. Art depiction of the ablation cascade, ESA

Space debris in statistics

Since the beginning of the space race in 1957, there have been 6,620 rocket launches, with a total of 13,320 satellites being placed into orbit in total. At the moment there are 8,580 satellites still in orbit with only 6,000 actively working. It is hard to say how much space debris is actually out there because space debris ranges from large old rocket engines to trivial paint flakes. However, Space Surveillance Networks (SSNs) are currently monitoring 31,550 space debris items. With all the space pollution out there we have experienced over 630 collisions, explosions or break-ups resulting in space debris. A prime example is the Kosmos 2251 and Iridium-33 collision in 2009. Due to the lack of technological advancement, we can't track every piece of debris in space, nonetheless, NASA algorithms predict that there are 36,500 space debris objects greater than 10 cm, 1,000,000+ space debris objects ranging from 1 cm up to 10 cm and 130 million space debris objects ranging from 1 mm up to 1 cm.

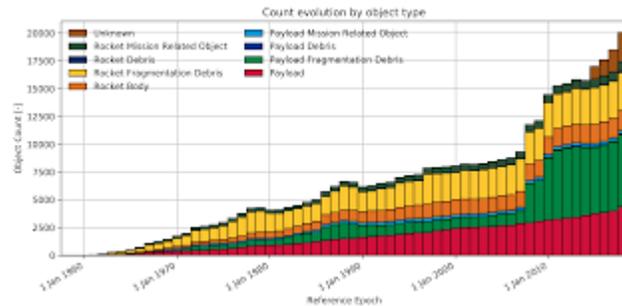


Fig 5. The rise in orbital objects, ESA

Major parties involved

The United States of America

The United States of America is by far the largest player in space with over 2,800 satellites currently in orbit, this is more than 50% of all satellites currently in orbit. This is due to the United States Government rapidly developing new governmental bodies in order to create enough technology to keep up with its 'competitors'. Most memorable would be the sixth military branch created by President Trump back in 2019, the United States Space Force. This new military branch has the main aims of space security, space combat, information mobility and space domain awareness. At the moment the U.S. Space Command, a subdivision within the Department of Defence (DoD) created in 1985, is tracking 35,000 pieces of space debris.

The U.S. also stations the National Aeronautics and Space Administration (NASA), the most advanced non-governmental space association in the entire world. In collaboration with the DoD, they have established a large set of longstanding rules regarding close byes, evaluating the danger of space debris, debris manoeuvre and evacuation procedures.

In recent years the U.S. has been widely criticised for not putting in enough effort to prevent collisions: the U.S. mainly focuses on traffic management which is making sure that operational satellites don't collide with non-operational satellites. However, experts state that the real danger is in debris management, foreseeing if debris doesn't collide with other debris, which the U.S. barely focuses on. The U.S. also sets a stage for non-governmental organisations like Blue Origin, SpaceX or Virgin Galactic to exploit space and subsequently drive down the cost of space travel. Programs like SpaceX Starlink follow very strict guidelines and already suffer from space pollution in the LEO.

Space Exploration Technologies Corp. (SpaceX)

When discussing space pollution we cannot ignore the arising privatised sector currently at play in space. The most notable NGO in space would be SpaceX, with a net worth of 125 billion dollars and a reputation for creating the newest tech the space exploration sector has seen. SpaceX is known for its many cutting-edge projects like the partially reusable Falcon Heavy (known as the most powerful rocket ever) and the Starlink project aiming to create a global internet connection through the use of 30,000 SpaceX satellites, Starlink is the biggest satellite system in the world. Another key project of SpaceX is the still developing Starship, a completely reusable rocket with the ability to fly to Mars. Since its start in 2002 SpaceX has been a major player in space tech development namely by creating all their rockets in the U.S. and with that creating the lowest launch cost there is.

When asked if SpaceX does anything to counter space pollution, SpaceX CEO Elon Musk commented on Twitter: “Yes, we can fly Starship around space & chomp up debris with the moving fairing door.” To ensure such big NGOs are included in the conversation this year LmunA UNCOPUOS will have a delegate representing SpaceX.

The People’s Republic of China

At the moment the PRC is most noted when discussing space pollution. As of 2021, the PRC is the largest flotsam polluter of space with over 40% of all flotsam and jetsam fragments finding their origin in the PRC, Roscosmos stated in a press release. The U.S. closely follows and the Russian Federation is also a keep contributor: together these large nations produce 93% of all space pollution. Attention in the global community first rose in 2007 when the PRC successfully shot down an unresponsive weather satellite causing 3,000 pieces of space debris to land in orbit. Since then the PRC has continued its ASATs and now has multiple state-of-the-art ground-based ASAT infrastructures. However, the PRC is also playing its part in finding new innovative solutions: in 2018 the Chinese government announced a development schedule for a laser system of multiple optical masers in space to take down space junk in the LEO.

The Russian Federation

It goes without saying that Russia, with around 100 military or dual-use satellites, is a key partner in space and if a new legally binding framework countering pollution is going to be established the Russian Federation must therefore be involved. At the moment the Russian Federation is a key polluter due to the relatively old satellite techniques that were used causing a lot of debris fragments to form. Some sources say that the Russian Federation might own the biggest collection of debris still in orbit. At the moment 6,125 debris pieces are in orbit carrying a Russian flag, followed by the U.S. with 4,627 debris pieces, and lastly the PRC with 3,672 fragments.

European Space Association (ESA)

The European Space Association (ESA) is a large collective for European nations in order to partake in space exploration. With the combined knowledge and funds from the 22 members, the ESA is able to achieve striking results far beyond what any European nation could perform standing alone. The ESA mainly focuses on researching celestial bodies and astronomical phenomena as well as the development of satellites and other outer space technology systems. In these proceedings, the ESA works closely with other international space organisations such as JAXA, NASA and Roscosmos. The following European states are members of the ESA: Austria, Denmark, Estonia, France, Germany, Hungary, Ireland, Italy, Luxembourg, Belgium, the Netherlands, Norway, Finland, Poland, Switzerland, Portugal, Romania, Spain, Sweden, Greece, the United Kingdom and lastly the Czech Republic.

Inter-Agency Space Debris Coordination Committee (IADC)

The Inter-Agency Space Debris Coordination Committee (IADC) is a collective established in order to work amid national legislative space agencies to combat the rise of space debris with the main focus being on debris management. The IADC functions as a platform for space agencies to trade data concerning orbital debris flows, encourage cooperation in the creation of debris exercises and lastly strongly encourage the international collaborative development of new debris moderation systems. At the moment IADC has 11 active members from different nations: The Russian Federation (Roscosmos), Ukraine (NSAU), Japan (JAXA), India (ISRO), Italy (ASI), France (CNES), Europe (ESA), the United States of America (NASA), Germany (DLR), the PRC (CNSA) and lastly the United Kingdom (BNSC).

Timeline of Key Events

<i>Date</i>	<i>Historical event</i>
<i>October 4th, 1957</i>	The first artificial satellite named “Sputnik” was launched into orbit by the USSR. This marks the beginning of the space-race between the USSR and the U.S.
<i>June 1st, 1961</i>	A total of 50 orbital space debris pieces were counted.
<i>1961</i>	The U.S. Able-star launch vehicle deployed its load.
<i>1966</i>	The first satellite to orbit the moon was launched, ‘ <i>luna 10</i> ’
<i>1971</i>	The first space station was launched, ‘ <i>Saylut 1</i> ’
<i>1978</i>	The Ablation cascade was first introduced by NASA scientist Donald J. Kessler.
<i>1991</i>	USSR’s navigation satellite Cosmos 1934 was hit by space debris fragments breaking off two chunks of Cosmos 1934
<i>1996</i>	STEP 2 Rocket Body accidentally exploded into 754 space debris pieces.
<i>1998</i>	NASA started using Goldstone radar data to enlarge the space debris tracking system.
<i>1999</i>	The ISS performed its first-ever collision avoidance manoeuvring. Dodging a Pegasus HAPS that was used to put Orbcomm in orbit.
<i>October, 2001</i>	The CNSA agreed to comply with the Space Debris Mitigation Guidelines.
<i>November, 2001</i>	Kosmos 2367 broke up resulting in a 300 pieces space debris cloud, this space debris became an issue in the upcoming space shuttle launch in the direction of ISS.
<i>December, 2001</i>	Indian PSLV also broke up into 300 pieces of space debris.
<i>January, 2004</i>	The second Orbital Debris Quarterly (ODQ) was held.
<i>January 11th, 2007</i>	The PRC launched an ASAT to take down an old weather satellite, Fengyun-1C, resulting in 3,428 pieces of space debris. 1,600 pieces of debris were tracked by NASA in the following months. This is the largest space polluting incident of all time and the total amount of space debris rose by 75% after this occasion.

2009	The United States Space Surveillance Network is tracking 19,000 pieces of debris larger than 5 cm.
2009	The Kosmos 2251 accidentally smashed with the satellite Iridium-33 resulting in 1,740 pieces of space debris being identified in a year, only 4% fell out of orbit in the span of one year. The debris cloud threatened the Space Shuttle mission STS-125.
July, 2016	NASA reports that 18,000 artificial objects are orbiting the earth, counting 1,419 operational satellites.
2018	American startup Seer Tracking being the first to develop cutting-edge AI systems that could be used to track small debris fragments.
November 15 th , 2021	Russia performed an ASAT on an old electronic signals intelligence (ELINT) satellite, Kosmos 1408, resulting in approximately 1,500 debris pieces.

Previous attempts to solve the issue

- ‘Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space’, guidelines made by the UNCOPUOS and the Committee and its Scientific and Technical Subcommittee, 2010, (ST/SPACE/49)
- ‘National research on space debris, safety of space objects with nuclear power sources on board and problems relating to their collision with space debris’, research proposed by Germany and the U.S. in the UNCOPUOS, 2003, (A/AC.105/789/Add.1)
- The UN made the United Nations Office on Outer Space Affairs (UNOOSA) located in Vienna
- 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”), in 1967. This could be seen as the basic framework for international space law, it mainly bans the positioning of nuclear weapons or other weapons of mass destruction in outer space and the placing of such weapons on celestial bodies. It also promotes the peaceful usage of outer space.
- The UN created the Committee on the Peaceful Usage of Outer Space (UNCOPUOS) in 1959 by resolution 1472 (XIV).
- International cooperation in the peaceful uses of outer space, a resolution adopted by the General Assembly, 2008, (A/RES/62/217)

Possible solutions

The area of outer space framework working is relatively new to the international policymakers scene. Therefore the global community has many different directions it can go in and delegates can be creative with making new legal structures, technological systems or other creative measures into solving this issue. At the moment the field of technology is in its development starting with space debris management and collecting. Many intriguing startups like Orbitguardians, Clearspace or Astroscale work on new ways of solving the issue by for example looking at certain scenarios and how to work towards a solution from there on. These small startups also look at adapting the problem on a bigger scale. For example, the Japanese Astroscale startup works with newer End of Life (EOL) and Active Debris Removal (ADR) services and is currently providing other technological developments. However, when searching for a solution to the growing space junk problem it's important to remember that no nation nor startup can solve this problem alone. When working towards a solution a global collective must be set up consisting of non-governmental organisations, space agencies and research stations encouraging researching, data transferring and cooperation. With cooperation ensured as a core value, new much-needed technology can be developed.

When looking at the problem from a bigger picture it must first be solved from the principal on. This includes putting legally binding restrictions on debris causing ASATs, the debris forming space explorations and space militarization acts that resolve in debris. Such a big legislative initiative is a major international project that should be built up on the grounds of former resolutions and treaties. Lastly, more legislative actions must be made towards the property and responsibility 'laws' of debris pieces working toward a more inclusive and international debris database

As Donald J. Kessler described in his papers, we're at a turning point in space pollution and should move carefully in the future looking more conscious at what and how we put artificial objects into orbit. We should seek to find efficient ways to communicate, monitor and discuss national space explorations and together we can come to a point where every nation is partaking in putting less debris in orbit and getting more debris out of orbit.

Make sure to fully prepare for debate (policy paper, opening statements, key objectives, draft resolution), look sharp and dignified (suit with tie and formal wear) and lastly enjoy being part a MUN!

Further reading

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