

# Going the Extra Mile: Tragedy of Commons in the Outer Space

Mr. Arihant Jain<sup>1</sup>

<sup>1</sup>Research Scholar, B.Com (Hons.) Batch 2020-23, Hans Raj College, University of Delhi, [0525arihantjain@gmail.com](mailto:0525arihantjain@gmail.com)

## Abstract

Since there is no delimitation to the right of the nations to outer space, outer space has become a typical commons, implying that every nation possess the right of utilization of the outer space and no nation can seize this right or exclude any other nation from the outer space. The contemporary but long-standing debris problem has been escalating for decades over decades, exposing space operations to grave risks, and hence demands an all-round international solution. The purpose of this paper is to study and examine the problem of space debris as a tragedy of commons in the outer space and the proposed solutions of this burning issue.

**Keywords:** outer space, space debris, tragedy of commons, space operations.

Hardin authored a paper titled "The Tragedy of

## INTRODUCTION

The tragedy of the commons or the problem of open access to resources, occurs because each user receives a direct benefit from using the resource but only bears a fraction of the cost of exploitation.

Economist William Forster Llyod first explained this theory in 1832 through the example of overgrazing, which occurs when cattle herders overuse common land for their purposes, ultimately depleting the land. Later, based on the theory stated by Llyod, Garret

the Commons" (1968)<sup>[1]</sup> and expressed concerns regarding overpopulation leading to the earth's resource depletion. According to him, whenever individuals act in their own self-interest, resources are eventually exhausted or depleted. This is because an individual who is a rational consumer will try to maximise its utility which will lead to increased exploitation of resources.

A tragedy of the commons may arise when a good is both rivalrous in consumption and non-excludable, i.e., consumed by a single user at a

time but has no restricted access. Ponds, coal, timber, and other such goods fall into this category.

Connected to the tragedy of the commons is the concept of the prisoner's dilemma. A tragedy of the commons illustrates failed cooperation situations that can be analysed using various game theory models. Just like the prisoner's dilemma in the absence of cooperative movement, the outcome of tragedy of the commons is also sub-optimal. Whereas with collective action and cooperation, the individuals can enjoy the Pareto optimal outcome for both.

With reference to this model, this research article discusses a lesser-known issue of Space Debris and how the junk in outer space is the new tragedy of the commons.

### **SPACE DEBRIS: A CAUSE OF CONCERN**

Space exploration has been a long-standing activity for humans. A number of satellites and rockets have been put into the earth's orbit by the human civilization. However, with these milestones, there has been an unprecedented problem of an increase in space junk. Space junk or space debris are pieces of machinery that are left in space. They can be dead or failed satellites or parts that fall off from the rocket. We frequently hear in the news about how humans' callous behaviour is damaging the environment, yet space debris is a problem that goes unaddressed. As a source of pollution, orbiting debris adversely affects the space

environment and further leads to abruptions in space operations. According to Space Environment Statistics (2022)<sup>[2]</sup> as on 22 December 2022, more than 640 breakups, explosions, collisions, or anomalous events result in fragmentation in the space. It was also revealed that about 32,490 debris objects or trackable junk is still present up there.

Outer space is like international waters which is an unclaimed territory and is common to all nations and organisations. Past literature suggests that outer space is a common resource of all mankind. As stated by Peng Wang in his paper titled "Tragedy of Commons in Outer Space – The Case of Space Debris" (2013)<sup>[3]</sup>, the logic of the tragedy of the commons equally applies in outer space which means the resource of outer space will inevitably be over-used, for example, space debris. Also, according to the Outer Space Treaty, all countries are entitled to freely explore and access outer space and all areas of celestial bodies. Therefore, with continued space exploration the debris is getting accumulated in low Earth orbit (LEO). Furthermore, this accumulation poses a big collision threat with other satellites in orbit.

Heavy space traffic presents two significant risks to space users - collisions and interference to the space endeavours undertaken.

Colliding space debris can cause damage, but the effects depend on various factors. These factors include the mass, size and velocity of the debris; the design of the space vehicle; and the

orbital region and angle at which the debris collides with that vehicle. Reports produced by interested space bodies arrived at a similar finding that there are three types of orbital debris which are of concern for the space community. The first type is referred to as 'small debris' which are less than 1 millimetre in size and cause surface degradation to a space vehicle if it has inadequate levels of protective shielding. The second class of space debris refers to particles that are between 1 millimetre and 10 centimetres in size. An impact from one of these pieces of debris can cause significant damage like surface erosion, damage to components, or loss of manoeuvring ability. Pieces of debris that are greater than 1 centimetre in size are called 'large debris', and their collision can be catastrophic, resulting in the complete break-up of a spacecraft.

The increased presence of space debris and congestion in Earth's orbit poses the risk of interference to current and planned commercial space endeavours. Such interference ranges from a minor disturbance to the complete frustration of the undertaken space-related activity. Orbital debris crowding in certain regions can also cause minor interruptions in the services provided by the private satellite industry and other enabled markets to their customers. Radio frequencies relied on by commercial space service providers, are particularly vulnerable to interference which might occur in different ways. There are a few instances where space debris reflecting off of nearby fragments can interfere with a satellite's

control sensors, which then causes disruptions in the data transmission and service. Another potential issue is when a space vehicle changes its orbital location and approaches an active telecommunications satellite - this can cause the frequency signal to deteriorate and the antenna of the telecommunications satellite to be blocked.

There are a number of risks associated with space debris, not just for those operating in civil and commercial space, but also for the environment. Five such risks which are identified as causing damage to the space are enumerated below:

- [1] increasing the orbital lifetime of space objects,
- [2] provoking the 'cascading effect',
- [3] accumulating the number of uncatalogued orbital debris,
- [4] releasing contamination,
- [5] changing the space weather.

This resulted in a theory termed as 'Kessler Syndrome' which is the catastrophic cascade of collisions which would arise from the excessive amount of space debris resulting in widespread destruction of space machinery.

## DEALING WITH THE TRAGEDY OF THE COMMONS

Over a period of time, there have been many theories to deal with the problem of the tragedy of the commons. Different researchers

proposed different ways of building up different models according to different conditions or situations but the core idea of all the researchers revolves around three concepts. These are Privatisation or Private Property Rights, Regulations by external forces and the Governance of the Commons.

Under the regulations by external forces, it was suggested to regulate the private interest of the public by introducing the intervention of external forces like Government and International Authorities as they control most of the natural resource system and also hold the power with them to exercise law and order. This would limit each person's access to common resources.

Another suggestion was Private Property Rights, which involves dividing up the common resources into private packets of property in such a way that there are no externalities or free rider problems amongst the people. Here, as the owner is individually responsible for his/her costs and benefits of his decision, the tragedy is solved.

The idea of Governance of the Commons was given by Elinor Ostrom in her book "Governing the Commons: The Evolution of Institutions for Collective Action" (1990)<sup>[4]</sup> who criticised the very idea of Garrett Hardin and proposed that within a community, rational decision-making and collective decision lead to the end of the problem.

## OVERCOMING THE PROBLEM OF SPACE

## COMMONS: THE SOLUTIONS

The solution to the problem can have two approaches to begin with: Debris Mitigation and Active Removal.

Debris Mitigation is a preventive measure which aims to reduce the creation of further debris objects essentially through regulations and setting up guidelines to provide a framework (how space missions and payloads must be designed) to avoid space debris. There is an Inter-Agency Space Debris Coordination Committee and various other international organisations to deal with such authority and regulating work.

Another approach is Active Debris Removal which intuitively describes itself as actions to remove existing space debris. Under this strategy, many researchers proposed a solution of Privatising which implies imposing a private property right. This can be perceived as International Organisations or respective governments of different countries implementing monetary punishments for inaction such as enforcing taxation or charging up a fee for the usage of orbit.

The concept of taxation can be understood as suggested by a group of researchers as considering the cooperation needed from each entity (according to their choice) and the immediate and long-term threat posed by debris to their assets and then suggesting the options to remove the debris as proportional amount to their number of satellites in space or a piece of debris a year. The monetary

punishment as an outcome of non-fulfilment of requirements could act as an incentive to remove debris by the entities.

Another way under Privatisation is similar to monetary punishment but with a difference. Through this, the entities would be charged Orbital fees. It could be a straight-up fee or tradeable permits or orbit-specific. The fee will be reflecting the cost to put another satellite into orbit and the current expected and future expected collision risk that may cause. These solutions can help in preventing the Kessler Syndrome resulting in the benefit of the common welfare.

## CONCLUSION

Space debris is the result of exploration and exploitation of outer space which can be awfully dangerous. Being a non-classical example of the tragedy of commons, space pollution has received less attention than overgrazing, deforestation or overpopulation. Space is a great commons, and it's time to treat it as such.

The international organisations have been working on their space ventures without realising the cost it generated to other users and to the space environment itself. With increased crowding up in space, orbits might eventually be unusable and disrupt human life.

There are many policies prescribed by researchers to deal with The Tragedy of the Commons such as Common Pool Resources, Privatising and others but in this case specific

problem, the ultimate solution suggested by most of the researchers is Privatising and regulating the space agencies by international committees and respective governments of different countries in order to achieve common welfare.

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