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LEGAL AND MARKET-BASED APPROACH TO SPACE DEBRIS

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Currently, no international law clearly prohibits states from creating space debris. In the current operation, the existing Outer Space Treaty is interpreted as applicable to space debris: the Outer Space Treaty (1967), the Liability Convention (1972), and the Registration Convention (1976). Article IX of the Outer Space Treaty demands that states "avoid harmful contamination" in outer space. The Liability Convention states that "a launching State shall be absolutely liable to pay compensation for damage caused by its space objects on the surface of the Earth or to aircraft, and liable for damage due to its faults in space." In Cosmos 954 case, the fragments of the Soviet Union's satellite fell in Canada's territory and the Canadian government claimed damages under Article II of the Liability Convention. The Registration Convention demands that states and international organizations register their space objects with the Secretary-General to identify which states bear responsibility and liability for those space objects.

However, these treaties do not penalize the act of leaving space debris itself. The launching state is liable under the Liability Convention only if "the damage is due to its fault or the fault of persons for whom it is responsible." Therefore, it is difficult to claim damages against a launching state when their space object transforms into space debris and causes damage.

In the above paragraph, we show that the application of existing Outer Space Treaties is not effective at reducing space debris. Here, we will discuss the need for international law that directly regulates space debris.

The Inter-agency Space Debris Coordination Committee (IADC) issued Space Debris Mitigation Guidelines in 2007, which some countries transferred into their national regulations. Although these guidelines have no legal consequences for non-compliance, they will establish a minimum standard of care. The states that do not follow the guidelines and cause damage can be "at fault" and liable under the Liability Convention.

However, there are some difficulties controlling the occurrence of space debris by legislation. First, it is almost impossible to avoid the creation of space debris in space activities. Space debris results from "unavoidable incidents like the malfunctioning of spacecraft and launchers and fragmentation events." Moreover, it is difficult to identify which states' activities created the smaller pieces of space debris. Even with NASA's special ground-based sensors, objects <10 cm are not consistently trackable.There are around 500,000 1–10 cm objects in orbit and likely thousands of millions of objects <1 cm.

Besides, it is unlikely that each state will always provide sufficient information about its satellites. For example, military-purpose satellites are generally top-secret projects. Therefore, establishing a penalty in international law is impractical.

Second, it is very difficult to establish a new legally binding treaty. No treaties about space activities "have been agreed since the 1960s and 70s when COPUOS created legally-binding instruments related to space like the Outer Space Treaty." Moreover, only 110 states are part of the Outer Space Treaties, and countries that are not parties have no duty to follow these guidelines. These countries may not sign a new treaty on space debris in an attempt to escape legal liability.

As mentioned above, it is unlikely that new international legislation will rapidly reduce space debris emissions; a new treaty will not solve the problem of the vast amount of space debris that already exists in orbit. Hence, Active Debris Removal (ADR) is necessary. According to ESA

and NASA, the environment could be stabilized if approximately 5–10 objects per year can be removed from Low Earth Orbit (the area of space below an altitude of 2,000 km).

Proposed ADR methods include:

Capturing space debris and affixing augmentation devices to reduce their orbital life; targeting space debris objects with laser beams to reduce their altitude and accelerate their atmospheric re-entry; capturing large space debris objects and removing them from protected regions.

However, these methods have huge costs and require advanced technologies. If states that launched space objects do not have sufficient ADR technology, what should they do? Are only countries with those technologies obliged to perform removal operations?

One possible approach is to introduce a market-based mechanism to handle the emission of space debris. Market-based mechanisms are already used for carbon emissions, which provides flexible solution and keep the costs of climate action low. Emissions trading schemes and carbon taxes are the two main market-based instruments for pricing greenhouse gases. Kitazawa (2011) recommended a similar approach for space debris emissions in the International Interdisciplinary Congress on Space Debris Remediation. He proposed the establishment of the World Space Debris Remediation Organization (WSO). Like carbon taxes, the WSO collects funds from all space-active countries. The amount of funds required from each country is based on their level of debris hazardousness index and ISO24113 (Space Debris Mitigation Requirement). The fund has an exemption for satellites from developing countries and satellites for academic purposes. WSO uses those funds to order space agencies or companies to perform debris removal; it imports emissions trading schemes from CO_2 frameworks.

Such a schema is effective because it provides both financial incentives and moral responsibility for the removal of space debris. In addition, legal penalties require the identification of launching states but the fund can remove ownerless debris. In addition, in recent years, private space development has become more active than that of national governments.

Furthermore, such a schema would establish a new market for debris removal services. Recently, both states and private companies have taken important roles in debris removal. For instance, SpaceLogistics, a subsidiary of Northrop Grumman in the United States, has initiated commercial ADR. In Europa, the ESA contracted ClearSpace in Switzerland for its first space project to remove an item of debris from orbit in 2025. Astroscale UK, Amazon Web Service, Fujitsu UK, and the University of Glasgow collaboratively designed a solution to optimize ADR so that Astroscale UK can pick up more debris, more quickly than ever before. It is important that nations, space agencies, research institutes, and private companies share this information exchange and work together for sustainable development in outer space.

This paper provided two potential solutions to the space debris problem: the establishment of a new treaty and active debris removal.

Regarding the legal solution, we have seen that the application of existing Outer Space Treaties is not effective at reducing space debris. The IADC issued the Space Debris Mitigation Guideline but they included no legal consequences for noncompliance. It is unlikely that new international legislation will rapidly reduce space debris emissions.

An alternative, non-legal approach is to introduce a market-based mechanism for space debris. Like carbon emissions frameworks, market-based mechanisms can provide flexible solutions and keep costs low. In addition, states can gain financial benefits from debris removal.

Advanced science and technology are required to remove debris. Nowadays, both nations and private companies take important roles in active debris removal. It is important that nations, space agencies, research institutes, and private companies share this information exchange and work together to enable sustainable development in outer space.