

Research on the liability regime for damage to the space environment by commercial satellites

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Abstract: The commercialization of outer space is an inevitable choice for the development of science and technology and the law of the market. At the same time, the protection of the outer space environment should be taken into account. After sorting out the international treaties related to commercial satellite activities and the environmental protection of outer space, it is found that the existing regulations lack the commercial activities of outer space and the environmental protection of outer space. According to the analysis of the collision case of "Iridium 33" and "Space 2251" and the fall case of "cosmic 954", it is found that the existing regulations are difficult to keep up with the commercial development of outer space and provide environmental damage relief, and the international responsibility of environmental damage of commercial satellites should be built on the basis of the existing outer space regulation. Through analysis, it is found that the environmental damage liability of commercial satellite space should be a transboundary damage liability. In principle, fault should not be taken as the constituent element, etc. The private subject needs to be included in the category of liability subject and international institutions should be established as the compensation subject to better protect the outer space environment.

1. Introduction

As the 21st century moves into a new space era, the global situation that the space industry is completely dominated by the national government has become a thing of the past, and the proportion of commercial space in the whole industry is gradually expanding. In 2022, the global near-earth orbit satellite market is about \$5162.6 million and is expected to grow to \$16.74 billion by 2028 at a compound annual growth rate of 21.7% during 2022-2028. Since 2015, the Chinese government will gradually open many behavior in the field of outer space to private capital, which prompted the surge in the number of commercial space companies in China, as of September 2021, China's domestic registered commercial space companies as many as hundreds, including private enterprises accounted for more than eighty percent, and more concentrated in satellite launch and applied satellite field.

Commercial space rapid development, outer space environment is inevitably affected by human activities, but in the legal regulation level, the United Nations office for outer space affairs in 2017 by the international space law documents, clearly summarizes the existing applicable to the outer

space activities of five international conventions, five sets of principles, five resolutions and two other documents [], which for the outer space environment protection and commercial satellite applicable specification is minimal. The current outer space law has many uncertainties in the protection of the outer space environment and the lack of specialized international treaties. Moreover, due to the early formation of the outer space law, people have not considered private entities as the main body of the space industry, but mainly take the state as the subject of responsibility and the object of regulation. On the one hand, the rise of commercial space has used the profitability of private enterprises to expand the exploration and utilization of space efficiency, bringing new opportunities to various countries, but on the other hand, it also brings new challenges to the outer space environment. Outer space belongs to the important international public domain, the development of commercial satellite need to consider the protection of outer space environment, and outer space activities as highly dangerous activities, for space environment has great risk and uncertainty, in the commercial satellite industry development at the same time the need to pay attention to the sustainable development, need to consider from the international environmental law level for environmental damage prevention and relief.

2. Current status of legal provisions on international liability for environmental damage to the outer space from commercial satellites

In view of the particularity of outer space and the international concerns about the future of space development, the United Nations General Assembly established the Committee on the Peaceful Uses of Outer Space in 1959, which manages the exploration and utilization of space for the benefit of all mankind. to this day, Under the auspices of the United Nations, the promotion of the important international treaty on the exploration and utilization of the moon and other celestial objects in outer space activities of principle treaty (the outer space treaty), the rescue space crew, back to space crew and the return of objects launched into outer space agreement (rescue agreement), the convention on damage caused by space objects (the responsibility convention), the convention on the registration of objects launched into outer space (the registration convention), the agreement on countries on the moon and other celestial bodies (the moon agreement). Although these five conventions have different degrees of ratification and recognition, they together constitute the outer space legal system under the existing framework of international law and establish the basic norms for outer space activities of countries at the level of international law.

The Outer Space Treaty is the basis of international space law, known as the "space constitution", and stipulates nine principles that states should follow when exploring outer space.^[1] The Treaty of Outer Space stipulates the principles of international liability and compensation of damages, and Article VI provides for international responsibility for all outer space activities undertaken by their governmental or non-governmental sectors,^[2] Article 7 provides for the responsibility of the Contracting State to supervise the commercial activities undertaken by its private entity in the outer space and to assume international responsibility for such commercial activities.^[3]

Although environmental damage is not included in the Liability Convention,^[4] However, as an outer space treaty that stipulates the principle of attribution, it still has reference significance for the attribution of environmental damage. The Liability Convention has established a relatively complete liability compensation system from seven aspects, but there are also many practical problems to be improved. The Convention makes it clear that the international responsibility for space environment damage is the "launching country". However, with the increasingly obvious trend of space commercialization and privatization, the international responsible subject of space environment damage is bound to face new challenges. For example, where a commercial enterprise in state A obtains a launch license in country B and then launches from the site and equipment of

State B, which country should be liable for compensation? To sum up, the existing international outer space legal framework lacks provisions on environmental responsibility, and there is no separate regulation on the environmental protection of outer space. Moreover, limited to the limitations of The Times and the lag of international law, the environmental responsibility system for commercial satellite launch still needs to be further improved.

3. Case analysis of environmental damage to the outer space from commercial satellites

Theoretically, there are two negative effects of human activities on space environment, one is possible environmental effects, including chemical pollution, biological pollution and electromagnetic interference; the other is actual harm, mainly refers to the use of space nuclear power and space debris. In reality, there are few cases of environmental damage caused by commercial satellites, mainly space debris caused by commercial satellite collisions and pollution caused by nuclear power use. In this paper, the environmental damage of commercial satellites to outer space will also focus on these two practical damages.

3.1 Iridium 33 and Cosmos 2251 collision case

On February 10, 2009, the U. S. commercial satellite Iridium-33 (Iridium 33) collided with the Russian military satellite Space-2251 (Cosmos-2251) over the Temer Peninsula on the Arctic coast of Siberia, Russia. Space-2251 is a Russian military communications satellite launched on June 16, 1993, but the satellite failed as early as 1995 and became an uncontrolled space junk. Iridium-33, owned by Iridium Corporation, is one of its commercial communications networks, which was launched in 1997 and was socially operational.

3.1.1 Accountability problem

In this case, the liability for compensation caused by the collision of the two satellites in the outer space mainly points to article 3 of the Liability Convention, and the principle of fault liability is applied. The issue in this case is whether, on the one hand, it is a fault for Russia to leave an abandoned satellite in orbit and, as for Iridium, the possibility of a collision, but the failure or failure to act to avoid a collision is a fault.

Russia noted that cosmic-2251 is an abandoned satellite that, under international law, has no obligation to dispose of cosmic-2251 after abandonment, and blamed the incident on Iridium's failure to manipulate its satellite to avoid collisions. Although the launching country can routinely give up dead satellites, Russia's inaction still violates the appropriate obligations of all countries under the Outer Space Treaty.

For Iridium-33, Iridium-33 was a fully equipped satellite whose orbit could be adjusted to avoid collisions with other space objects. The US Government Space Surveillance Network (SSN) is able to carry out spatial situational awareness activities and rendezvous forecasting. However, SSN failed to: 1) predict that it may collide with Cosmos 2251; 2) alert or instruct Iridium management to take appropriate action to change the orbit to avoid a collision. According to the International Court's decision in the Corfu Strait case, the omission or even inability of the United States cannot exempt it from international liability for not causing harm. The United States has omitted, ignored, failed, or failed to attempt to prevent the collision of Cosmos 2251 by Iridium 33, and remains internationally responsible for the consequences of the accident.

To sum up, if either party wants to make compensation for the destruction of the satellite, it needs to prove the fault of the other party, as well as the amount and nature of the damage it has suffered. In this regard, the view that Russia has suffered damage by the destruction of its

abandoned satellite may be untenable.

3.1.2 Responsible subject

Russia is clearly the launching country of the Cosmos 2251 satellite because it was launched from the Plesetsk Cosmodrome on June 16, 1993. The United States is the host of the Iridium 33 commercial communications spacecraft because the satellite is owned by private company Iridium Satellite, which could be considered as facilitating the launch. The problem is that Iridium 33 was launched on September 14, 1997, using the Kazakhstan (Baikonur Space Launch Site) facility leased from Russia by a Russian Proton K rocket. According to the definition of "launching country" in the relevant legal framework, Russia and Kazakhstan are also the launching countries.[] In other words, Russia may be liable for both Iridium 33 and Universe 2251 in this case, which may also be an important reason for the final claim in this case.

The problem of the subject of responsibility in this case reveals that in the responsibility of commercial satellite launch, due to the universal international cooperation and the commercialization of outer space, the confusion of the subject faced by the state as the main body of responsibility, resulting in the complex situation of a country becoming the subject of compensation and responsibility at the same time.

3.2 Unimos 954

A typical case of environmental damage caused by the use of nuclear power sources in outer space is that the Soviet satellite "cosmic 954" fell into Canada. Although this case does not involve private business entities, it still has reference significance in the relief of environmental pollution damage.

On January 24, 1978, the cosmic satellite 954 entered the Earth's atmosphere and invaded Canadian airspace. Satellite debris was deposited on Canadian territory upon reentry and disintegration. At the time of the incident, the Canadian government sought help from the United States, and they eventually found 12 large pieces, 10 of which had an average radioactivity of 1.1 sivets per hour, which accounted for only 1% of the fuel. The operation cost C \$14 million in Canada and \$2.5 million in the United States.^[5]

3.2.1 Basis of and claim for compensation made by Canada

Although the liability convention first identified damage only personal and property damage, but the Canadian side and the Soviet satellite deposited harmful radioactive debris throughout the large territory of Canada, the debris in the environment also makes part of the Canadian territory can not be used, constitute the convention in the sense of "damage to property". According to Article 2 of the Liability Convention, the Soviet satellite shall be absolutely liable for the damage caused to the Canadian territory. In the end, Canada believed the invasion of Soviet satellite debris on its territorial sovereignty and held the Soviet Union for radioactive contamination from the debris, totaling \$6,041,174.70.^[6]

3.2.2 Dispute focus issues

The dispute in this case is whether the large amount of debris formed by the satellite caused the damage to environmental pollution and the scope of compensation for the damage.^[7] The Soviet Union did not want to bear the \$6 million compensation, and showed that the crash caused only minor local pollution, requiring only simple inactivation measures. The Canadian side believes that the fall of the Soviet satellite debris caused no casualties, but spent a lot of human and economic

costs in the process of clearing the debris, and should be compensated by the Soviet Union. In the end, the Soviet Union was willing to pay for C \$3 million in compensation.

3.2.3 Difficulty in blaming the use of a nuclear power source in outer space

In the issue of regulating nuclear power sources, the "cosmic 954" case is a relatively rare case with clear rules. If there is no satellite fall, the use of nuclear power sources in outer space will not only make it difficult to determine the environmental damage to the space, but also determine the attribution of the damage behavior. And it is difficult to achieve the objective components of the international liability for space damage caused by nuclear power facilities. As long as the space environment damage violates international obligations, the international responsibility will arise. From the current international space rules, the use of nuclear power sources to produce space environment damage in space activities does not necessarily violate international obligations, because the space law does not stipulate whether to allow the use of nuclear energy in outer space. In 1992, the United Nations general assembly resolution 47 / 68 (1992) in the use of nuclear power source principle, as long as the use of nuclear power source for the purpose of generating electricity rather than propulsion, and limited to non-nuclear power source cannot reasonably perform space mission, when dangerous timely notify the relevant countries, so this situation of nuclear power source pollution seems to produce international responsibility.

4. Realization of international responsibility for environmental damage to the outer space of commercial satellites

4.1 Nature of international liability for environmental damage to the outer space of commercial satellites

"International liability for the damaging consequences of acts not prohibited by international law" is an international liability different from traditional international wrongful liability. According to the International Law Commission's draft International Liability clause for damaging consequences arising from acts not prohibited by international law and the draft text on the distribution of losses in transboundary damage (CP) adopted by the International Law Commission in 2004, the elements include two elements: dangerous activities not prohibited by international law that have or do not cause transboundary damage; second, tangible consequences cause damage.^[8]

In the nature of legal liability, the liability for environmental damage caused by the outer space activities of commercial satellites shall be the international liability for the damage consequences caused by acts not prohibited by international law, that is, the transboundary damage liability.^[6] First, commercial satellite outer space activity is not prohibited by international law; second, private commercial activity in outer space is a risk of major transboundary damage. In the comments of the Principles of Loss Distribution,^[7] the activity in outer space itself, whether private participation or state dominance, must have the risk of significant trans-boundary damage. Finally, most of the environmental damage caused by private commercial activities in outer space has transboundary nature, and the areas where the damage can be divided into outer space and air space, and the final geographical location of the damage is highly likely to occur transboundary.

4.2 Principles of liability for environmental damage to the outer space of commercial satellites

Article 2 and 3 of the Liability Convention respectively stipulate the principles of strict liability and negligence liability: strict liability applies to the damage caused to the earth's surface and the spacecraft in flight, and the theory of negligence liability is applied to the personal and property

damage caused to other transmitting countries other than the earth's surface. However, transboundary damage liability is different from the traditional sense of international liability, which no longer requires negligence as the principle of national liability. There are different opinions in the academic circle about the liability of environmental damage liability. The author believes that the environmental damage liability of commercial satellites should be based on the principle of cross-boundary liability and the principle of strict liability.

First of all, the principle of fault liability is adopted in the international legal liability for environmental pollution in the outer space, and the protection of the outer space environment is lower than the principle of absolute liability. The injured party should not only prove the fact that environmental pollution caused by outer space activities, but also prove that the subject of liability is subjective fault. Due to the particularity of the outer space and the limitation of the scientific level, human's understanding of the outer space environment is not deep enough, and the collection of evidence also needs the support of advanced science and technology, which makes the burden of proof of the outer space environment pollution more difficult, which is extremely unfavorable to the protection of the outer space environment.

Secondly, the application of the principle of absolute responsibility can limit outer space activities and exploration to some extent. Countries that can do business in outer space have strong economic strength and scientific and technological strength, and can enjoy more outer space resources than other countries. The application of the principle of absolute responsibility is to weigh the interests of countries in the world in fairness, so that countries with space activities can not only enjoy the economic benefits brought by space activities, but also be responsible for the pollution of the outer space environment, caused by their space activities.

Finally, even if the principle of negligence liability is applied in form, the "negligence" should be inclined to reverse the presumption of negligence and the burden of proof.^[7]For the damage caused by outer space activities, it is very difficult to require the injured party to prove the negligence of the offending country. In accordance with the principle of strict responsibility, the state shall be required to bear the responsibility for transboundary damage to outer space activities and transfer the burden of proof to the offending state. Even if a country is liable under the Liability Convention for damage to launching countries other than the surface, the offending country is required to prove that it can be exempted from liability, otherwise it is presumed to be liable for negligence.

4.2.1 Integrate the private subjects into the environmental responsibility subjects

In the field of outer space law, the State is the subject of liability, partly because of the lag of the international law as the subject of outer space activities. However, more and more private entities are beginning to participate in space launch activities, and it is possible to integrate private entities into international responsibility. First, private entities join the space activities, which leads to the gradually increasing difficulty in determining the subjects responsible for environmental pollution in outer space. Moreover, as the above collision between Iridium 33 and cosmic 2251, Russia may also become the subject of responsibility and compensation in the case, but cannot effectively hold it accountable. Secondly, private space companies usually focus only on the economic interests of commercial satellite launch, not on the outer space environment pollution, which will lead to excessive utilization of the outer space environment. Finally, the inclusion of private subjects in the environmental responsibility subjects does not exempt the responsibility of the launching country. The launching country still has the internal supervision obligation. In addition to the responsibility of the private transmitters, the launching country should also be in the same compensation position as the private transmitter, and the launching country shall bear unlimited joint and several liability to the private transmitter.^[8]

4.2.2 Establish international institutions with the qualification of compensation subject

The two cases discussed in this paper are both cases where one country has caused practical damage to the subject of another country. However, when the space activities only cause space environment pollution without practical damage to other countries, who is qualified to be the compensation subject of such space environment damage is an important issue. There may not be a specific victim of environmental pollution in the outer space. When the public domain of the outer space is polluted, an organization should be able to make compensation claims to the responsible subject on behalf of the interests of all mankind. An agency similar to the International Seabed Authority can be established under the framework of the United Nations as the subject of a claim for the damage to the external space environment representing the interests of all mankind.^[9]

5. Conclusion

The launch activities of commercial satellites are gradually frequent, and the damage to the outer space environment needs to be paid attention to. As an important global public domain, outer space should be fully protected and follow the principle of sustainable development and the principle of common heritage of mankind, which is necessary and critical for the construction of environmental damage liability in the outer space of commercial satellites. The environmental damage liability of commercial satellites should be a kind of transboundary damage liability. In principle, fault should not be taken as the constituent element, but the principle of strict liability principle. Private subjects need to be included in the category of liability subjects and international institutions should be established as the compensation subject to better protect the outer space environment.

For China, actively promoting the promulgation of the Space Law of the People's Republic of China, encouraging the development of China's private space enterprises, and creating a favorable business environment for private space enterprises is one of the important ways to help the continuous development of China's space industry. In the construction of external space environmental damage liability of commercial satellites, how to balance the launching enthusiasm of private subjects and the protection of outer space environment is the link that should be focused on. Paying attention to environmental protection, promoting the development of a new model of outer space governance with the concept of a community of shared future for outer space, better protecting the outer space environment, and forming a sound outer space order are also the key to the sustainable development of all mankind in outer space.

References

- [1] *Nine principles: The exploration and use of outer space should be for the welfare of all countries, explore freedom, not for oneself, use peace for the purpose of weapons of mass destruction in outer space, state responsibility, state damage liability, avoidance of pollution, and treat astronauts as the principle of human envoys.*
- [2] *Article 6 of the Outer Space Treaty.*
- [3] *Article 7 of the Outer Space Treaty.*
- [4] *Article 1 of the Liability Convention.*
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