

# Reflections on the International Legal Framework Governing the Re-entry of Space Objects

Xiaodan Wu\*

## Abstract

China's first space station, Tiangong-1, returned to earth on 1 April 2018 after more than six years in outer space. This was not isolated and some of the previous return of space objects are Cosmos 854 in 1978, Skylab in 1979, Delta II second stage in 1997, MIR Space Station in 2001, Italian BeppoSax in 2003, US-193 in 2008 and ESA's GOCE in 2013. In light of these events and its inevitably increasing frequencies, it is necessary to reflect on the international law governing the re-entry of space objects.

In the current international legal framework, the state obligations cover the whole process of re-entry without obvious loopholes, preventative *ex ante* and responsible *ex post*. But the state practice is largely uneven and there are controversies and ambiguities over obligations to forewarn hazardous events and disclose information for facilitating damage control and cleanup operation; under what conditions can re-entry objects be actively removed; and how to return the objects and compensate the damages. This requires adjustment and fine-tuning of some critical notions in the space treaties and other legal documents, particularly, how to apply victim-oriented and environment-friendly principles in space sector, the balance between launching states' jurisdiction and control of space objects and the interest of other states, the definition and determination of damages and state responsibility for hazardous activities.

## 1. Background Introduction of Re-reentering Objects

Space objects have been reentering the atmosphere ever since the beginning of space era and there has been hundreds of recovered debris from space hardware reentered.<sup>1</sup> Almost every spacefaring nation has the record of

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\* Law School, China Central University of Finance and Economics  
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1 Senate Committee on Aeronautical and Space Sciences, Convention on International

objects re-entries. Satellites, rocket stages or fragments reenter the denser layer of the atmosphere almost on a daily basis and large space structures reenters every few years. Most of them burned up and only the large ones or the ones containing toxic materials are deemed significant threats. During the last decades, thousands of satellites and more than 10,000 associated pieces of debris, i.e., thousands tons of materials are believed to have survived reentry with only one reported casualties.<sup>2</sup> Nonetheless, considering the ever-growing size and range of space activities and the diversity of space actors (more countries and private entities), the legal issues of random reentry and de-orbiting mission may not be negligible.

### An Incomplete List of Well-Known Reentries

Space Objects	Launching State	Mass (kg)	Reentry Date	Re-entry Model
Apollo SA-5 Nose Cone	USA	17,100	Apr. 30, 1966	Uncontrolled
Cosmos 954	USSR	3,800	Jan. 24, 1978	Uncontrolled
Skylab	USA	69,000	July 11, 1979	Uncontrolled
Cosmos 1443	USSR	15,000	Sep. 19, 1983	Controlled
Salyut 7	USSR	40,000	Feb. 7, 1991	Uncontrolled
Compton GRO	USA	14,910	Jun. 4, 2000	Controlled
Mir	Russia	120,000	Mar. 23, 2001	Controlled
BeppoSax	Italy	480	Apr. 29, 2003	Uncontrolled
USA-193	USA	2,300	Feb. 21, 2008	Destroyed
Phobos-Grunt	Russia	13,505	Jan. 15, 2012	Uncontrolled
GOCE	ESA	1,077	11 Nov. 2013	Destroyed
Tiangong-1	China	8,500	Apr. 1, 2018	Controlled/Uncontrolled

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Liability for Damaged Caused by Space Objects: Analysis and Background Data, U.S. Government Printing Office, May 1972. R. Perry, A History of Satellite Reconnaissance Volume IIIA – Gambit, January 1974. Reentry Statistics, The Aerospace Corporation, <https://aerospace.org/reentries>, December 2018.

- 2 In January 1997, a lightweight fragment from a reentering satellite struck a woman in Oklahoma, U.S., and fortunately, she was not injured, <https://aerospace.org/cords/research/reentry-data>, December 2018.

## 2. The International Legal Obligations and State Practice during the Re-entry Process

### 2.1 The Victim-Oriented and Environment-Friendly Principles

In the current international legal framework, the state obligations cover the whole process of re-entry without obvious loopholes, preventative *ex ante* and responsible *ex post*, guiding by the victim-oriented and environment-friendly principles.

Outer Space Treaty (OST) affirmed that States are responsible for national activities in outer space and liable for damages to another state, or its national or juridical persons, caused by a space object that it has launched or procured the launching. To implement this principle, the Liability Convention (LC) was drafted as a victim-oriented instrument to balance the advancement of space exploration against the necessity of protecting innocent victims.<sup>3</sup> It stipulated some innovative provisions departing from general international legal rules to provide more effective protection to non-state victims, such as state assuming international responsibility for non-governmental activities, granting states the competence to bring claims on behalf of individual victims, the waiving of exhaustion of local remedies and procedures to facilitate the prompt payment of compensation.

In accordance with 1972 Stockholm Declaration and 1992 Rio Declaration, states have the responsibility to ensure that activities within their jurisdiction and control do not cause damage to the environment of other states or of areas *beyond the limits of national jurisdiction*. This principle is now part of corpus of international law relating to the environment and has acquired the nature of a norm of customary law.<sup>4</sup> Outer space is an area beyond national jurisdiction and is thus regulated by this principle. Article IX of Outer Space Treaty refers to the obligation to conduct all space activities with due regard to the corresponding interest of other states. The notion of “due regard” is

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3 The Convention was intended to be victim-oriented, designed not as a reciprocal agreement between the two prevailing space powers, the United States and the U.S.S.R, but as a safeguard for each state, perhaps in particular non-space powers. Verbatim Record of the 72 Meeting, UN Doc. A/AC.105/PV.72, 1969, Statement of Canada, cited from J. A. Burke, Convention on International Liability for Damage Caused by Space Objects: Definition and Determination of Damaged after the COSMOS 954 Incident, 8(2) Fordham International Law Journal, 1984, p. 297. Cocca, The Principles of “Full Compensation” in the Convention on Liability for Damage Caused by Space Objects Launched into Outer Space, Proceedings on the 15th Colloquium on the Law of Outer Space, 1972, p. 92. N. Matte, Aerospace Law: from Scientific Exploration to Commercial Utilization, 1977, p. 169. C. Q. Christol, Space Law – Past, Present and Future, Kluwer, 1991, p. 211. B. Cheng, Studies in International Space Law, Oxford University Press, 1997, p. 303.

4 The Legality of the Threat or Use of Nuclear Weapons, Advisory Opinion, ICJ Report, 1996, pp. 809, 821. The Gabcikovo-Nagymaros Project case, ICJ Report, 1997, pp. 6, 67.

the standard expression in international documents.<sup>5</sup> But its meaning is ambiguous, some generic concepts with an element of flexibility. In earth environment protection context, it entails taking all necessary precautionary steps including environment impact assessment, consultation and notification.<sup>6</sup> The absence of further elaboration “due regard” in space treaties and complex nature of space activities render its application in space sector more uncertain and there is only the basic common understanding, i.e., the performance of an act with a certain standard of care, attention or observance.<sup>7</sup>

## **2.2 The Transparency of Re-entry Process**

A state that becomes aware that its space object will crash has the duty to forewarn a state in danger, as required by Article IX of Outer Space Treaty. But the legal uncertainty, nonlinear dynamics of reentry and the complexity of technologies involved complicate the transparency of re-entry.

### **2.2.1 To whom the information shall be disclosed?**

When Cosmos 954’s orbit became erratic, the U.S. initiated a series of secret meetings with the USSR in January 1978, during which the USSR provided information about Cosmos 954’s reactor. Then the U.S. warned its NATO and OECD partners about the fall of Cosmos 954 and offered to help clean up the radioactive contamination afterwards.<sup>8</sup> After Cosmos 954 was disintegrated and the debris was deposited on Canadian territory, the U.S. then President Carter notified the Canadian Prime Minister within 15 minutes of the accident. The USSR responded to the inquires of the U.S., the leading state in the alliance in secret, diplomatic communications, though Canada claimed that the USSR was obligated to forewarn all potentially endangered states of the hazards posed by its falling satellite, no matter how remote the possibility is.<sup>9</sup>

The information disclosure of some recent reentry event is widely public instead of selective, but barely constitutes solid state practice or

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5 For instance, article 87 of UN Convention on the Law of the Sea established that the high seas are open to all states and the freedom shall be exercised by all states with due regard for the interest of other states in their exercise of the freedom of the high seas, and sole with due regard for the rights under the Convention with respect to activities in the seabed area.

6 Case concerning the Gabcikovi-Nagymaros Project (Hungary v. Slovakia), Judgment, ICJ Report, 1997, p. 7. M. N. Shaw, *International Law*, 6th Edition, Cambridge University Press, 2008, pp. 855-856.

7 S. Marchisio, Article IX, in S. Hobe, B. Schmidt-Tedd and K. Schrogl, *Cologne Commentary on Space Law*, Vol. I. Carl Heymanns Verlag, 2009, p. 175.

8 *New York Times*, 25 January 1978, at A1, 29 January 1978, at A1. *Washington Post*, 27 January 1978.

9 A. F. Cohen, *Cosmos 954 and the International Law of Satellite Accidents*, 10 *Yale Journal of International Law*, 1984, p. 79.

interpretation of Outer Space Treaty. The Italian Space Agency set up a temporary mission with a website to supply information, more than 20 reports during the whole process of BeppoSAX's re-entry from December 2002 to April 2003.<sup>10</sup> After Tiangong-1 ceased to function on 16 March 2016, China's Manned Space Agency posted on its website with updated information both in Chinese and English on a weekly basis from 21 March 2017 to 11 March 2018 and on a daily basis from 14 March 2018 to 1 April 2018 as well as three times a day on 2 April 2018, twice before and once after the re-entry.<sup>11</sup> China, Italy and Russian Federation have submitted to the UN notification on the reentry of Tiangong-1, BeppoSAX, Mir and Mars 96.<sup>12</sup>

### **2.2.2 What information shall be disclosed?**

Canada requested the Soviet authorities to furnish information about the nature and characteristics of the nuclear core contained in Cosmos 954. Under the Soviet interpretation, the duty to provide information is limited to the minimum for conducting a cleanup.<sup>13</sup> The USSR charged that Canada was using requests for information as a pretext for intelligence gathering.<sup>14</sup> Based on the American Space Surveillance Network assessment, the Italian space agency provided the status of BeppoSAX and analysis of the countries that might be affected by the re-entry. China's Manned Space Agency published the orbital status regarding the re-entry of Tiangong-1.

The specifications of the re-entry object determine the accuracy in applying tracking techniques and are helpful in enabling the endangered state to assess the dangers, act to counter them and clean up the remains. But there is no specific normative framework for what information shall be disclosed before

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10 <https://www.asdc.asi.it/bepposax/reentry>, December 2018.

11 Notice and Announcement of China's Manned Space Agency on Tiangong I Orbital Status, <http://en.cmse.gov.cn/col/col1763/index.html>. Last accessed August 2018.

12 Note Verbale from the Permanent Mission of China to the United Nations Secretary-General on the Re-entry of Tiangong-1, 4 May 2017, 8 December 2017, and 26 March 2018, A/AC.105/1150, A/AC.105/1150/Add.1, A/AC.105/1150/Add.2. Note Verbal from the Permanent Mission of Italy to the United Nations Secretary-General on the Re-entry of BeppoSAX, 12 December 2002, A/AC.105/803. Note Verbal from the Permanent Mission of the Russian Federation to the United Nations Secretary-General on the Re-entry of Mir, 23 January 2001 and 28 February 2001, A/AC.105/759, A/AC.105/759/Add.1. Note Verbal from the Permanent Mission of the Russian Federation to the United Nations Secretary-General on the Re-entry of Mars 96, 18 November 1996, A/AC.105/648.

13 A. F. Cohen, *Cosmos 954 and the International Law of Satellite Accidents*, 10 *Yale Journal of International Law*, 1984, p. 83.

14 The Soviet side finds it necessary to note that some of the questions put by the Canadian side obviously relate to information which is outside the scope of the amount necessary to secure the health and safety of person and environment. A. F. Cohen, *Cosmos 954 and the International Law of Satellite Accidents*, 10 *Yale Journal of International Law*, 1984, p. 83.

and after the re-entry and the launching states are reluctant to provide information of the space objects and cooperate in tracking unless there is data sharing agreement.

### **2.3 The Jurisdiction and Control of Launching States and Active Removal of Re-entering Space Objects**

There are available disposal options for space objects surviving atmospheric re-entry: previously design of controlled system or afterwards intentional destructive interference to prevent entry into the Earth or deorbiting to a known location. Some of the re-entries are controlled. The satellite of USA-193 malfunctioned shortly after its deployment in 2006 and was intentionally destroyed 14 months later by a missile fired from an American warship. The scientific objectives of the mission required GOCE to be operated in an extremely low orbit at altitudes down to 224 km and the mission was ended by a planned destructive reentry. ESA's five Automated Transport Vehicle missions all performed controlled and safe reentries into an uninhabited area in the South Pacific Ocean.

Launching states shall retain jurisdiction and control over their space objects and shall register such space objects under Outer Space Treaty and Registration Convention. Jurisdiction shall induce control and control should be based on jurisdiction.<sup>15</sup> The term "jurisdiction" describes the power of the state under international law to regulate or otherwise impact upon people, property and circumstances and reflects the basic principles of state sovereignty, equality of states and non-interference in domestic affairs.<sup>16</sup> In space law context, jurisdiction and control defines the power of launching states.<sup>17</sup> In practice, "control" refers to the right to direct, stop, modify and correct the elements of the space objects and its mission.<sup>18</sup> The launching states' jurisdiction and control over the space objects is exclusive, excluding interference by another state. Thus, the removal of re-entering space objects by any state other than the launching state would constitute an international wrongful act. Nonetheless, the wrongfulness of this removal operation can be precluded under the circumstances of valid consent, countermeasures and necessity on an exceptional basis as the only way to safeguard an essential interest against a grave and imminent peril, distress.<sup>19</sup> International law

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15 G. Lafferranderie, *Jurisdiction and Control of Space Objects and the Case of an International Intergovernmental Organization (ESA)*, 54(2) *Zeitschrift für Luft und Weltraumrecht*, 2005, pp. 231-232.

16 M. N. Shaw, *International Law*, Cambridge University Press, 7th ed., 2014, p. 469.

17 B. Schmidt-Tedd, S. Mick, *Article VIII*, in S. Hobe, B. Schmidt-Tedd and K. Schrogl, *Cologne Commentary on Space Law*, Vol. I. Carl Heymanns Verlag, 2009, p. 156.

18 G. Lafferranderie, *Jurisdiction and Control of Space Objects and the Case of an International Intergovernmental Organization (ESA)*, 54(2) *Zeitschrift für Luft und Weltraumrecht*, 2005, pp. 230.

19 *Draft Articles on Responsibility of States for International Wrongful Acts*, International

allows for a balance between the interest of the launching states and the interest of the states or the whole international community being adversely affected by the reentry of space objects.<sup>20</sup> Nonetheless, destroying or deorbiting a re-entering space object of another State could be deemed as hostile. There is no specific rule or precedent and it is unclear as to what constitutes valid consent, legitimate countermeasures and necessity on an exceptional basis.

#### **2.4 The Return of Space Objects and the Post-Entry Clean up Operation**

The USSR offered to help clean up the remains of Cosmos 954 but was declined by Canada, and America was permitted in the operation. In the Soviet view, the cleanup should be undertaken jointly by the launching state and the injured state.<sup>21</sup> According to Canada, the injured State is entitled to choose who carries out the cleanup. The German-Japanese experiment re-entry space system, EXPRESS capsule, unintentionally landed in Ghana in 1996, instead of the originally planned location in Australia, and the recovery and return from Ghana to Germany was executed in consensus of the two governments. The provisions in Outer Space Treaty and Rescue Agreement has not provided answers to whether the launching state's participation in the post-entry clean up is mandatory; whether the return and receiving of space objects is mandatory; and whether a state can retain the space object before the payment of compensation.

#### **2.5 The Compensation Issues**

There is no unanimous view among academics about which types of harms caused by the re-entry space objects are recoverable. Article I of the Liability Convention defines the term "damage" as physical, psychological or property damage and loss of life. As for environmental damages or indirect damages, such as preventive and cleanup measures, some argue for yes,<sup>22</sup> while others made a clear no statement.<sup>23</sup> It is possible in theory that damage should not be narrowly defined as in Article I. Under article XII, the compensation is

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Law Commission, article 20, 24, and 25.

20 C. Steinkogler, *Legal and Political Challenges of Active Space Debris Removal: Towards an International Normative Framework*, IAC-16, E3.4, 34008.

21 If a satellite or any spacecraft, when it goes out of control should cause damage to another State, then the launching State is duty-bound to participate in the search and recovery of the debris of the satellite. Statement of the Academician Federov, Scientific and Technical Sub-Committee of the UN Committee on the Peaceful Uses of Outer Space, 14 February 1978.

22 C. Christol, *International Liability for Damage Caused by Space Objects*, 74 *American Journal of International Law*, 1980, p. 346. p. 362. L. Kovudhikulrungsri, D. Nakseeharach, *Liability Regime of International Space Law: Some Lessons from International Nuclear Law*, 4 *Journal of East Asia and International Law*, 2011, p. 306.

23 S. Gorove, *Cosmos 954: Issues of Law and Policy*, 6 *Journal of Space Law*, 1978, p. 141. I.H. Ph. Diederiks-Vershoor, *An Introduction to Space Law*, 1999, p. 41.

calculated in accordance with international law and the principles of justice and equity, while the notion of *restituto in integrum* provides an adequate system for the compensation of damages.<sup>24</sup>

The relevant practice failed to provide guidance regarding what damages is compensable. They were settled through diplomatic channel and the Liability Convention and the mechanism established for claims under this Convention has never been formally implemented. Canada took precautionary measures to avoid a public hazard caused by radioactive emissions from COSMOS 954 and argued that the presence of hazardous radioactive debris in the environment rendered part of Canada's territory unfit for use and constituted "damage to property". But Canada demanded 6 million Canadian dollars in damages out of an expenditure of 14 million Canadian dollars,<sup>25</sup> unsure whether and to what extent this sum includes environmental damages. The other examples of damages are the fall of the second stage of a Thor Able Star rocket into Cuba in 1960 leading to the payment from the US government of US\$2 million and the failure of a Proton rocket in 1999 with the reported claim paid by Russia to Kazakhstan about the US\$400,000. It is not clear whether they were defined as space objects and what damages are compensated.

### **3. The Need and Approach to Improve the Current International Legal Framework**

The current legal framework for the re-entry of space objects is fragmented, not specific and targeted. These rules are drafted for other reasons than regulating the coming back manned-made objected launched into outer space, which, however, will happen increasingly frequently with the expansion of manned space flights and space mining operation. This requires adjustment and fine-tuning of some critical notions in the space treaties and other legal documents, particularly, the concrete meaning of victim-oriented and environment-friendly principles in space sector, the balance between launching states' jurisdiction and control of space objects and the interest of

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24 The Permanent Court of International Justice stated that reparation must, as far as possible, wipe out all the consequences of the illegal act and reestablish the situation which would, in all probability, have existed if that act had not been committed. The Case concerning the Factory at Chorzow, Judgment of 13 September 1928. Szilagyi, Protection of Outer Space Environment – Questions of Liability, Proceedings of the 25th Colloquium on the Law of Outer Space, 1982, p. 53. J. A. Burke, Convention on International Liability for Damage Caused by Space Objects: Definition and Determination of Damaged after the COSMOS 954 Incident, 8(2) Fordham International Law Journal, 1984, pp. 267-285.

25 A. F. Cohen, Cosmos 954 and the International Law of Satellite Accidents, 10 Yale Journal of International Law, 1984, p. 85.



other states, definition and determination of damages and state responsibility for hazardous activities.

The technology has matured to a point to make controlled reentry practical, by choosing low-melting-point materials to reduce survivability of satellite components, constructing the satellites in a manner of assuring a particular breakup scenario and lifetime reduction, and disposal by controlled deorbit providing certainty in the impact location by targeting the spacecraft to a safe area, generally a broad ocean area, to minimize the hazard to people and property. Though the previous reentries demonstrate the chances are slim to cause casualty, it is inhumane to assume the legal requirements for controlled reentry depending on casualty expectation. Given the reluctance of states to adopt new multilateral treaties, non-binding standards and guidelines on traffic management, long-term sustainability, debris removal or best practice for re-entry could be developed with the aim to impose more specific requirements of the reentry of space objects and apply the notion of due regard and environment impact assessment in outer space activities.