

Proposal for a Legal Definition of Space Debris

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Abstract

Wherever humans go, pollution follows. Outer space is no exception.

After 60 years of space missions, the orbits around Earth are filled with “space debris”, which threatens satellites as they pass by. The international community has been working on means to remove them through so-called ‘Active Debris Removal’ (ADR) operations. However, the latter pose unresolved challenges in terms of jurisdiction, control and ownership over space debris, as well as in terms of international liability during and after operations.

The present paper tackles them with a focus on the legal notion of “space debris”. In particular, it explores the possibility of defining “space debris” like “waste” is defined on Earth. Building upon the EU waste regulation, it proposes a definition which revolves around the position of the owner of a space object and its intention to discard it. The conclusion demonstrates how this solution fits in the system of international space law without any modification of it, providing an effective solution to the legal hurdles of ADR operations.

Keywords: *debris, waste, definition, IADC, law, STM*

Acronyms/Abbreviations

<i>Acronym:</i>	<i>Meaning:</i>
COPUOS	Committee on the Peaceful Uses of Outer Space
ESA	European Space Agency
STS	Scientific and Technical Subcommittee
UNOOSA	United Nations Office for Outer Space Affairs

1. Introduction

Wherever humans go, pollution follows. Outer space is no exception.

After 60 years of space missions, the orbits around Earth are filled with residual materials of satellites, rockets and other space objects launched

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beyond the atmosphere. Today's technology allows us to have a clear idea of the phenomenon.

There are different entities, private and public, around the world that keep track of all the objects orbiting around Earth. If we take a look at the data collected by ESA in its Space Debris User Portal, for instance, it is possible to see that the vast majority of manmade assets in the cis-terrestrial space is represented by pieces and component parts of space objects¹.

As of 11 August 2022, there are 6300 functioning satellites in orbit. At the same time, the estimated number of space debris, based on statistical models (MASTER-8, future population 2021), is of:

- 36500 space debris objects greater than 10 cm;
- 1000000 space debris objects from greater than 1 cm to 10 cm;
- 130 million space debris objects from greater than 1 mm to 1 cm.²

Due to their number and their orbital speed, space debris pose various problems to satellite operators, such as frequent avoiding manoeuvres, risk of catastrophic collisions, potential liability claims and interference with ordinary operations.

In view of this situation, it is no surprise that the international community of spacefaring actors is actively addressing the issue of pollution in outer space. The United Nations and other international entities have been working for several years now on the creation of instruments that – if implemented – can help reduce the amount of junk that space missions will leave in orbit in the future (e.g. guidelines, best practices and industrial standards). These instruments are generally called mitigation measures. Next to them, private and public actors are working also on methods to remove the component parts of space objects that space missions left in orbit in the past. Such methods are called 'Active Debris Removal' (ADR) operations.

As the name suggests, the latter consist in the active dislocation of a targeted non-functional object from its orbit using several possible technologies: laser-based, tether-based, magnetic-based, or satellite-based (e.g. capturing them with nets and harpoons).³ The final goal, in simple terms, is to deorbit them, eliminating the threat they pose to the stability of the cis-terrestrial environment.

It is easy to imagine how ADR operations represent a significant challenge for engineers, who have to interact with objects moving at high velocity and with uncontrolled trajectories.

1 The Space Debris User Portal can be consulted at the following link: <https://sdup.esoc.esa.int/discosweb/statistics/> (last accessed on September 1st, 2022).

2 *Ibid.* under "Space Environment Statistics".

3 See the comprehensive work of C. Priyant Mark et al., *Review of Active Space Debris Removal Methods*, in *Space Policy*, 47, 2019, p. 194 et seq.

However, dealing with space debris is more than just a technical issue. A closer look at the reasons why ADR operations are not yet a reality unveils that the main problems are legal. They can be summarized as follows:

- 1) the potential military use of ADR technology requires an international intervention ensuring its peaceful use;
- 2) the liability regime for damages caused by space activities requires a mechanism to ensure a proper apportionment of compensation costs among the launching states of the debris and the launching states of the ADR operator.

The main impairment to all measures trying to solve the problem of outer space pollution is actually legal: there is not a legal definition of “space debris”.

For this reason, the present paper intends to tackle the issue of defining space debris, putting into question the generally used notion that describes it as a non-functional space object.

In the following sections, the author addresses the definitions of space debris in use among the main space actors. The discourse then brings the attention on the notion of “waste” on Earth, and specifically in the EU. Finally, it looks at the international legal framework of space objects with the purpose of integrating the notion of waste into the system of space law. The findings of the study are presented at the end together with a proposal on how to implement the solution offered therein.

2. What Is a Space Debris?

In 1989, the UN addressed for the first time the matter of space debris defining it as a concern to all Nations.⁴ Soon after, in 1993, twelve of the major national space agency of the world together with ESA created a specific Inter-Agency Space Debris Coordination Committee (IADC), which in nine years elaborated a set of voluntary technical guidelines for space debris mitigation.⁵

The starting point of their work was understanding what constitutes a space debris.

They first looked at the UN Registration Convention of 1974, one of the five international treaties on space matters.⁶ Its Article IV lists all the information that a State of registry (i.e. a launching State on whose registry a space object

4 See UN General Assembly, *International co-operation in the peaceful uses of outer space*, A/RES/44/46, 12 August 1989.

5 IADC, *Space Debris Mitigation Guidelines*, vers. 02-01, 2020.

6 *Convention on the Registration of Objects Launched into Outer Space*, 1023 UNTS 15, adopted on 12 November 1974, entered into force on 15 September 1976.

is carried⁷⁾ must furnish to the Secretary General of the United Nations (in practice, through UNOOSA) in connection with any space object carried on its registry. This includes, inter alia, information concerning *the general function* of the space object.⁸

Building upon this provision, the definition of space debris offered by the IADC was centred on the aspect of “functionality”:⁹

*“Space debris are all man-made objects including fragments and elements thereof, in Earth orbit or re-entering the atmosphere, that are non-functional.”*¹⁰

This direct connection to a technical aspect of a space object’s operations found the general approval of the international space community and the IADC definition became the most influential reference for any further discourse on space debris.

According to some authors,¹¹ two advantages can be found in using the functionality criterion. First, given that space debris can be considered waste in a variety of types and sizes, the non-functionality is just one qualification which can encompass and be applicable to all technical classes of space debris. Second, when it comes to whole inactive satellites, their status of being functional can, usually, be easily determined by the operator and/or the launching State.

Undoubtedly, it must be recognized that the functionality test was widely used also in the definitions adopted by other international entities in the following years¹² (e.g. the International Academy of Astronautics, the UN General Assembly).

7 *Ibid.*, article I, lett. (c).

8 UN COPUOS, *Active Debris Removal An Essential Mechanism for Ensuring the Safety and Sustainability of Outer Space (A Report of the International Interdisciplinary Congress on Space Debris Remediation and On-Orbit Satellite Servicing)*, A/AC.105/C.1/2012/CRP.16, 2012, p. 30.

9 *Ibid.*

10 See IADC, above at 5, Article 3.1.

11 Y. Kim et al., *Proposal for improved mitigation procedures and guidelines*, in European Commission’s RedSHIFT, Document Ares (2019)2154321, 2019, p. 6.

12 In reality, already in 1995 the UN COPUOS STS offered a first definition of space debris similar to the one endorsed by IADC. At its thirty-second session, the following notion was suggested:

“Space debris are all manmade objects, including their fragments and parts, whether their owners can be identified or not, in Earth orbit or re-entering the dense layers of the atmosphere that are non-functional with no reasonable expectation of their being able to assume or resume their intended functions or any other functions for which they are or can be authorized”. COPUOS, *Report of the Scientific and Technical Subcommittee on the Work of its Thirty-Second Session*, A/AC.105/605, 1995, p. 18.

Notably, also the European Union in its Space Programme Regulation of 2021 has defined space debris as:

*“Any space object including spacecraft or fragments and elements thereof in Earth’s orbit or re-entering Earth’s atmosphere, that are non-functional or no longer serve any specific purpose, including parts of rockets or artificial satellites, or inactive artificial satellites.”*¹³

However, even if the scientific soundness of this definition is undeniable, its appropriateness from a legal perspective appears questionable.

The main problem with the functionality criterion is that it is unreliable.¹⁴

A satellite that – because of a software malfunction, a shortage of fuel or because of damage suffered in orbit – has become non-functional, may return to be functional if duly restored. The technology of the time is moving in that direction and as consequence there will be space objects that change their legal status depending on their reparation or restoration.

Moreover, a space object that is irreparably non-functional may still hold value to the owner, who may not want to see it dislocated from outer space. A notable example is that of the first Ecuadorian satellite, which was launched in 2013 and fatally damaged in orbit shortly after. Despite its inoperability, official statements of the Ecuadorian government have referred to it as a precious symbol of Ecuador’s technological capability and therefore a valuable historical asset.¹⁵

Finally, the functionality criterion does not solve the most problematic issue of space debris: the fact that any intervention on a space debris requires an act of the State of registry which allows it or denies it.

In other words, the centrality of the State of registry is completely discarded by the IADC definition, which limits its assessment to a technical element.

In the definitions that followed the IADC one, sometimes, next to lack of functions, other features of a space object have been used to qualify a space debris, such as being non-maneuvrable, inactive, or not being under control. However, these additional elements have not been beyond reproach. See for all Y. Kim, above at 11, p. 7.

13 Regulation (Eu) 2021/696 of the European Parliament and of the Council of 28 April 2021 establishing the Union Space Programme and the European Union Agency for the Space Programme and repealing Regulations (EU) No 912/2010, (EU) No 1285/2013 and (EU) No 377/2014 and Decision No 541/2014/EU, OJ L 170, 12.5.2021, Article 2(1).

14 For a critical analysis of the functionality criterion see UN COPUOS, above at 8, p. 31 et seq.

15 See the report of the Ecuadorian Space Agency on the accident of its satellite “*The Pegasus Incident: the Loss of the First Ecuadorian Satellite and Its Recovery*”, presented by R. Nader and Dr. T.S. Kelso at the 65th International Astronautical Congress 2014. See also the press release of the Ecuadorian Space Agency on 5 September 2013 available at the following link: <http://exa.ec/bp54/index.html>.

But legal definitions should not be made dependent on a set of criteria that can be neutralized due to their origins in a technical area in full development.¹⁶

For that reason, the following section explores a definition that comes from a different type of residuals resulting from human activities: waste on Earth. More specifically, it looks at the context of EU law where the definition of waste revolves around a completely subjective and legal element.

3. What Is Waste in the EU?

The European Union has created a compound system of legislation on the matter of waste.

For the purpose of the present paper, the pivotal instrument that needs to be analysed is the so-called “EU Waste Framework Directive”¹⁷ of 2008. Its Article 3 defines “waste” as follows: “*waste*” means any substance or object which the holder discards or intends or is required to discard.

Before delving into the analysis of the terms used, it is already possible to highlight how such definition – by emphasizing the role of the holder – captures the essence of pollution. As the former president of the European Council for Environmental Law, Prof. Alexandre Kiss, has put it: “*In the widest sense, a major proportion of pollution consists of introduction into the environment of substances of which one wishes to rid oneself.*”¹⁸

Going back to Article 3 of the EU Waste Framework Directive, each word used by the legislator here holds particular significance.

First, the definition applies to “*any substance or object*”. Therefore, its scope of application is quite vast and, in fact, the European Court of Justice (ECJ) has dismissed any attempt to interpret this definition restrictively.¹⁹ In particular, according to the ECJ settled case law, “*the term “waste” must be interpreted in the light of the aim of Directive 2008/98, which, in the words of recital 6 thereof, is to minimise the negative effects of the generation and management of waste on human health and the environment.*”²⁰

Moving to the next term of the definition – “*holder*” – it is possible to formulate the following consideration.

16 A. Capurso, *The Non-Appropriation Principle: A Roman Interpretation*, in Proceedings of the International Institute of Space Law 2018, Eleven International Publishing, 2019, p. 123.

17 Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives, OJ L 312, 22.11.2008.

18 A. Kiss, *La réparation de dommages catastrophique*, Oxford, 1995, p. 301.

19 See, to that effect, ECJ judgment of 4 July 2019, *Openbaar Ministerie v Tronex BV*, Case C-624/17, EU:C:2019:564, paragraph 18. See also ECJ judgment of 12 December 2013, *Shell Nederland*, C-241/12 and C-242/12, EU:C:2013:821, paragraph 38 and the case-law cited.

20 *Ibid.*

The EU legislator decided to put at the centre of its regulation of waste not the owner, nor the possessor, but the person who has a direct connection with the actual use of the substance or object: the holder.

In the following words of Article 3, we find the actions that trigger the application of EU waste law: “discards or intends ... to discard.”

The pivotal element of the definition is in the intention of the holder. In the words of the ECJ: “*the classification of a substance or object as waste is to be inferred primarily from the holder’s actions.*”²¹

The ECJ has made this point very clear in the *Arco v. Elpon* judgment (Case C-418/97), where paragraphs 64-67 and 94 suggest that the critical factors in deciding whether a certain material is “waste” are not whether it has economic value, nor whether processing it will be undertaken without endangering human health or the environment, nor whether such material has undergone a complete recovery operation.²² All these aspects are irrelevant. Similarly, it is not important what the biological, chemical or industrial condition of the material is. In other words, to know whether a substance or an object is “waste”, the question should not be posed to a scientist, an engineer or an economist, but to a lawyer. It is only the legal investigation on the conduct of the holder that can define whether something is waste or not.

All this, however, does not clarify what the verb “discard” means.

Undoubtedly, “discard” implies a specific *mens rea* or psychological attitude towards the object or substance on the part of its holder.²³ But what is its concrete meaning?

Once again, the ECJ provides us with guidance:

*“Particular attention must be paid to the fact that the object or substance in question is not or is no longer of any use to its holder, such that that object or substance constitutes a burden which he will seek to discard. If that is indeed the case, there is a risk that the holder will dispose of the object or substance in his possession in a way likely to cause harm to the environment, particularly by dumping it or disposing of it in an uncontrolled manner.”*²⁴

An interesting interpretation has been proposed by Dr. Jurgen Fluck, who suggested that ‘discard’ should be defined not just as getting rid of something, but as relating to a decision to change the purpose of a substance

21 See ECJ judgment of 4 July 2019 above at 19, paragraph 17.

22 Joined Cases C-418/97 ARCO Chemie and C-419/97 Hees/ EPON. See the commentary made by A. Waite, *The Definition of Waste: The Riddle of the Sands*, in *Frieden in Freiheit - Peace in liberty - Paix en liberté*, 2008, p. 800.

23 See D. Wilkinson, *Time to Discard the Concept of Waste?*, in *Environmental Law Review*, 1.3, 1999, p. 179.

24 See ECJ judgment of 4 July 2019 above at 19, paragraph 22.

or object, or to release it from its original purpose without immediately reallocating it to any new purpose, or rededicating it to recovery or disposal.²⁵

The ‘purpose’ given by the holder to a certain thing becomes then the main element of inquisition in determining the meaning of “waste” under the Waste Directive.²⁶

In this sense, following Dr. Andrew Waite’s intuition, it is possible to delineate the following test:

1. If the true purpose of the holder is to re-utilise the material or have it re-utilised by a third party, it is not waste.
2. If, however, his purpose is to get rid of the material, it is waste.
3. Where n. 2 applies, the material is waste even though the waste management route may lead to its subsequent re-utilisation.²⁷

This interpretation of the EU’s definition of waste captures the essence of the terms used by the legislator. It is only the person who has a direct use of any substance or object who can – through his conduct and through his manifest intention to get rid of it – determine whether it is waste or not.

In view of this brief description of the main elements of “waste” in EU law, what can be said about the notion of “space debris”?

4. Space Debris in Space Law Treaties

Before looking at how the system of EU law can offer solutions to the space debris problem, it is necessary to make a preliminary consideration on the importance of properly defining space debris under the international legal framework of space law.

There are five treaties on space activities adopted by the UN. For the purpose of the present study, the most relevant are: 1) the Outer Space Treaty of 1967;²⁸ 2) the Liability Convention of 1972;²⁹ and 3) the Registration Convention of 1974.³⁰

None of them contains a reference to space debris.

25 J. Fluck, *The Term Waste in EU Law*, in *European Environmental Law Review*, 79, 1994, p. 81.

26 A. Waite, *Crucial Need to Understand the Meaning of Waste*, in *Institute of Wastes Management, Law and the Waste Industry*, 1994. Cited by D. Wilkinson, above at 23.

27 *Ibid.*

28 *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space Including the Moon and Other Celestial Bodies*, 610 UNTS 205, adopted on 27 January 1967, entered into force on 10 October 1967.

29 *Convention on International Liability for Damage Caused by Space Objects*, 961 UNTS 187, adopted on 29 March 1972, entered into force on 1 September 1972.

30 See *Convention*, above at 6.

They are centered on the more general concept of “space object”. The latter is defined in both the Liability Convention and the Registration Convention as follows:

“The term “space object” includes component parts of a space object as well as its launch vehicle and parts thereof.”³¹

The Outer Space Treaty of 1967, although it does not contain a definitional provision, uses a similar expression: “space object or its component parts.”³² This inclusive notion constitutes the scope of application of all the norms of international space law which regard satellites, rockets, and other manmade objects used for space activities. In particular, the rules on jurisdiction, control, ownership, registration and liability apply to “space objects”, irrespective of whether such objects are considered debris or not.

When does the notion of space debris become relevant?

At the present time, it matters only for the purpose of categorizing what should not be placed in orbit and what may be removed by ADR operations. In both cases, from a legal perspective, we are still under the umbrella of “space objects”,

As ESA explains it in its webpage on ADR: “legal constraints dealing with the ownership of space debris objects, and the validation thereof, cannot be neglected. Firm agreements with the owners of the object is required.”³³

On this point, the findings of the Report of the International Interdisciplinary Congress on Space Debris Remediation and On-Orbit Satellite Servicing of 2012 are still relevant:

“The State that holds jurisdiction and control over a space object is the State on whose registry an object launched into outer space is carried. If a State, or a State-licensed actor, remediates a space object, it can only legally do so if it has legal jurisdiction and control over that space object or permission from the State of registry.

The rules establishing State jurisdiction and control over space objects provide certainty in a situation where States may not exercise sovereignty in outer space.

There is no legal recognition of a temporal termination of a State of registry’s jurisdiction and control over a space object.

[...] It is important to note that the space security nexus to jurisdiction and control over space objects continues ad infinitum. As such, circumventing the provisions of the existing regime that establish

31 *Ibid.*, Article I, lett. b).

32 See *Treaty*, above at 24, Articles VII and VIII.

33 See ESA, *Active Debris Removal*, webpage available here: https://www.esa.int/Space_Safety/Space_Debris/Active_debris_removal.

jurisdiction and control in the State of registry may have negative consequences for space security.

The legal regime was not constructed to deal with this issue and discourse is only just beginning. The international community needs to think about what mechanisms will facilitate the seeking and granting of permission and establish rules respecting both the jurisdiction and control issue and consent.”³⁴

All the issues related with the removal of residual material from space activities in orbit are connected to the role that the State of registry has in the system of space law.

The literature on the matter is consistent in affirming that the State of registry is the only actor competent to judge whether its space object retains a particular function, interest or value.³⁵ In any case, an object should not be presumed abandoned without an express declaration on the part of its State, nor should such relinquishment be deduced from the failure of said State to demand restitution.

In view of all this, the question is: can the State of registry discard its space object or component parts thereof?

5. The Possibility to Discard Space Objects

There has been a long-standing debate on whether the jurisdictional power granted by Article VIII, Outer Space Treaty attaches permanently to a space object, regardless of the absence of continued, effective, physical control and despite its technical *status*, or whether the jurisdictional power may lapse with the end of any possibility to dispose of such object.

It is argued here that, considering the relevance put by the treaties of space law on the role of the launching State and in particular of the State of registry, it is possible to envisage a power to discard a space object under one's own jurisdiction and control.

In practical terms, this power can be concretized in the insertion of a new entry in the national registry as well as in the registry kept at the UN level.

This entry shall contain a simple information stating that the concerned space object is discarded by its State of registry.

What are the implication of such insertion?

In terms of jurisdiction and control it is clear that if a space object is non-functional it cannot be controlled and the power of jurisdiction becomes

³⁴ See UN COPUOS, above at 8, p. 32.

³⁵ See for all P. De Mann, *Exclusive Use in an Inclusive Environment*, Springer, 2016, p. 372.

void. Hence, maintaining that the State of registry must keep jurisdiction and control is a formal statement, with little substantial value.

In terms of ownership, it is accepted that ownership entails the power to discard the thing owned. Then, the matter poses only a procedural question, which regards how the owner can obtain the insertion of the “discard entry” in the State’s and UN’s registries. If the owner of the space object is the State of registry *nulla quaestio*. If the owner is a third party (e.g. a private entity), the process of discarding a space object requires an additional step consisting in a request to the State of registry. In both scenarios, it is the intention of the entity who actually owns the object that determines its legal status as a discarded object or not.

As for liability, the preliminary consideration is that the system of the Liability Convention is based on a two-folded *rationale*, which is reflected in the standards of liability envisaged in its Articles II and III: respectively, absolute liability for damages on Earth or to aircraft in flight; fault-based liability for damages in orbit. The first standard is based on the idea that subjects on Earth which are completely extraneous to the activity that caused the damage should always be compensated because they are innocently exposed to the dangers of ultra-hazardous space activities. The second standard, on the other hand, is based on the idea that those who take part in space operations are bearing the risks of their actions, since all spacefaring actors are doing something dangerous they can be asked to compensate eventual damages only if they were negligent.

The Liability Convention (just like the Outer Space Treaty) does not envisage the possibility to renounce to the status of launching State. The general principle is: once a launching State, always a launching State.

This means that even if the State of registry discards its space object, by law it would still be liable in case its object caused damage on Earth.

However, this assumption may not be applicable in practical terms to damage caused in orbit.

As a matter of fact, if a discarded space object collided with another space object it would raise the issue of proving the fault of its former State of registry.

It would be very hard to sustain that a subject who had no control on its object was at fault in any terms.

Thus, liability for discarded objects is more a theoretical issue than a practical one.

In addition, if an ADR operator wanted to remove a discarded space object, but its mission did not succeed and as a result the target asset were to hit another space object, it would be almost impossible to attribute any type of fault on the part of the former State of registry. The reason is that the intervention of the ADR operator on the discarded space object would create a new relationship of cause and effect, which would interrupt any chain of

causation between the acts or omissions of the former State of registry and the event (*i.e. the failed ADR mission*) that caused the damage.

In view of these considerations, it appears that introducing the element of “discard” in the registration of space objects may solve the main issues surrounding space debris. From this, an incentive to the creation of a system of space waste disposal from Earth’s orbits will be created.

6. Implementation Proposal and Concluding Remarks

Implementing the concept of discard in international space law does not require any convolute intervention on the current legal framework.

The legal definition of space debris as “*all man-made objects including fragments and elements thereof, in Earth orbit or re-entering the atmosphere, that the State of registry discards*” can be suggested for the consideration of and consensus agreement by the UN COPUOS, followed by possible adoption by the UN General Assembly as a dedicated resolution or other action.

In order to facilitate its embracement at the international level, the practice of spacefaring Nations can play a significant role. In fact, the solution proposed here entails only two elements: 1) a notion of space debris that contains the possibility for the State of registry to discard its space objects; 2) a specific entry in space registries, at the national and international level, containing the information on the legal status of the space object: “discarded” or not. Both aspects can be put in place by domestic instruments, waiting for their diffusion and general acceptance at the UN level.

In conclusion, the proposal suggested in the present paper builds upon the existing international legal framework of space law, without any necessity of modifying it. Using the tools already available, it highlights the role of the State of registry as the center of decisions for the categorization of its space objects as waste or not. In the absence of any concrete repercussions in terms of jurisdiction, control, ownership and liability, it is suggested here that the introduction of a “discard entry” in the space registries can provide a decisive thrust for ADR operations and, therefore, for the safety and stability of the space environment.