Space Debris
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A. Introduction

1 One of the direct consequences of human activities in outer space is the creation of space debris. In the most general terms, these pieces of debris are uncontrollable man-made objects in the Earth’s orbit, including satellites that are no longer functional; mission related objects, such as tools lost by astronauts during extravehicular activities; and the result of satellite fragmentation events, which can be either accidental—such as in the case of non-deliberate in-orbit collisions—or intentional—such as in the case of anti-satellite weapons tests or deliberate collisions. Fragmentation events are the largest source of space debris.

2 As a result of the intensification of outer space exploration and utilization, the amount of space debris has been constantly growing. Some long-running projections estimate that an exponential increase in space debris will occur owing to a chain of uncontrolled collisions between particles of functional objects and debris already in orbit—the so-called ‘Kessler effect’.

3 The proliferation of space debris represents a hazard for human activities in outer space. Pieces of debris, which move at speeds up to 17,500 miles per hour, pose, in fact, navigational threats to functional satellites and other space assets (Spacecraft, Satellites and Space Objects), including human space flight and robotic missions. The International Space Station is frequently at risk of damage, which places in danger the lives of astronauts on board and in transit. Moreover, space debris could disable a host of satellites critical to global commerce, national defence, navigation, and agriculture, and even undermine access to outer space. Material that re-enters the Earth’s atmosphere also threatens infrastructure and people because of the potential of damage on the Earth’s surface. Finally, space debris pollutes outer space, contributing to environmental degradation.

B. Definition

4 The current regime of international space law, consisting of five United Nations (UN) treaties—Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and other Celestial Bodies [1967] ‘Outer Space Treaty’ or ‘OST’; Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space [1968]; Convention on International Liability for Damage Caused by Space Objects [1972] ‘Liability Convention’ or ‘LC’; Convention on Registration of Objects Launched into Outer Space [1975] ‘Registration Convention’ or ‘RC’; Agreement Governing the Activities of the States on the Moon and Other Celestial Bodies [1979]—does not provide for a definition of ‘space debris’. In fact, at the time these instruments were drafted no one could foresee the hazard that pieces of man-made material could have caused in the future. The operative terminology used in those instruments is ‘space object’, which is also rather obliquely defined.

5 The International Law Association’s Draft International Instrument on the Protection of the Environment from Damage Caused by Space Debris—ILA Conference Buenos Aires 1994—was the first international attempt to provide a legal definition of ‘space debris’—see Williams ‘The ILA Finalizes its International Instrument on Space Debris in Buenos Aires, August 1994’. In the first article on definitions, space debris was defined as manmade objects in outer space, other than active or otherwise useful satellites, when no change can reasonably be expected in these conditions in the foreseeable future.
The Technical Report on Space Debris was published in 1999 as a product of the multi-year work plan 1996-1998 of the Scientific and Technical (‘S&T’) Subcommittee of the UN Committee on the Peaceful Uses of Outer Space (‘COPUOS’). It was one of the earliest UN documents on space debris, which served as a basis for further deliberations on the topic of congestion in the space environment. It reports the following definition of the term ‘space debris’:

Space debris are all man-made 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 (para. 6).

In 2002, the Inter-Agency Space Debris Coordination Committee (‘IADC’) developed the IADC Space Debris Mitigation Guidelines on the basis of the fundamental principles present in the national policies of the member agencies, which were agreed to by consensus. The definition of space debris contained therein was an abbreviated form of the definition contained in the Technical Report on Space Debris:

‘Space debris’ refers to all man-made objects, including fragments and elements thereof, in Earth orbit or re-entering the atmosphere, that are non-functional.

The publication of the IADC Guidelines prompted the S&T Subcommittee of UN COPUOS to create a Space Debris Working Group, which eventually produced a draft set of high-level qualitative guidelines based on the work of the IADC (‘Space Debris Mitigation Guidelines’). This draft was adopted by UN COPUOS in 2007—Report of the Scientific and Technical Subcommittee on Its Forty-Fourth Session—and endorsed by the United Nations General Assembly (‘UNGA’; → United Nations, General Assembly) later that year through Resolution 62/217 (2007). The definition of space debris provided in the UN COPUOS Space Debris Mitigation Guidelines is identical to the one provided for in the IADC Space Debris Mitigation Guidelines.

Notably, all definitions of space debris are contained in soft law instruments, which do not create any legally binding obligations for States. The absence of a legal definition of space debris introduces ambiguity and calls into question the relevance of existing international law instruments in regulating the problems arising from the proliferation of space debris.

C. Liability for Damage Caused by Space Debris

Art. VII OST provides that the launching State is internationally liable for damage caused by an object launched into outer space, or its component parts (→ Outer Space, Liability for Damage). Art. II LC echoes the same principle by providing that

A launching State shall be absolutely liable to pay compensation for damage caused by its space object on the surface of the Earth or to aircraft in flight.

Art. III LC emphasizes this criterion again to determine liability for damage caused elsewhere than on the surface of the Earth. This provision provides for a fault-based liability; that is, that the launching State should be held liable for any damage caused in outer space provided that the damage ‘is due to its fault or to the fault of persons’ under its responsibility.
This liability regime refers expressly to damage caused by ‘space objects’. Whether a space debris can be considered to be a space object or a component part of it is, however, debatable. The OST alludes to a ‘space object’ in Arts VII and VIII as ‘an object launched into outer space’, including ‘objects landed or constructed on a celestial body’. The LC was the first international agreement that attempted to define a ‘space object’ as the ‘component parts of a space object as well as its launch vehicle and parts thereof’. The RC adopted this definition in its Art. I (b). This description, however, fails to define the term exhaustively while merely providing a vague inclusive boundary. As far as space debris is concerned, two opposite interpretations are possible. On the one hand, if one takes into account the literal meaning of the text, space debris would intuitively fall outside the scope of the expression ‘space object’ as defined in the LC and RC. On the other hand, however, if one endorses a functional reading of the provisions at stake, a reasonable conclusion is that space debris is indeed included in the definition of space object, as the debris originates from a component part of a space object or from its launch vehicle. Opposing views apply also to the definition of space object contained in the OST: space debris is not directly launched into outer space and therefore, according to the text’s literal meaning, would lack one of the requirements to classify as a space object to which the OST applies. Conversely, a functional approach would allow a more extensive interpretation in the sense that a space debris is indirectly launched into outer space and can accordingly be considered a space object.

In addition, in the absence of clear international obligations related to the production of space debris, establishing fault in case of damage caused by space debris in outer space might be difficult. Arguably, fault could be rooted in the lack of compliance with space debris mitigation guidelines and best practices, which have been introduced at the international level (see sec D below).

The definition of damage contained in Art. I (c) LC as ‘loss of life, personal injury...or loss or damage to property of States or of persons’ also potentially limits the applicability of the liability regime with respect to damage caused by space debris. It excludes the possibility of holding the launching State liable for the ‘environmental damage’ caused by the proliferation of space debris.

D. Space Debris Mitigation

Art. IX OST provides that States parties to the treaty should consult with the other States parties before engaging in activities that might cause ‘harmful interference’ with the activities of the other States, and that any State that is party to the treaty has the right to request consultations if it believes other States’ activities have or will cause harmful interference. The OST creates obligations upon States parties to take reasonable measures to ensure that their activities do not interfere with the interests of other States or cause harmful contamination. Thus, a State that creates space debris in the space environment could in principle be considered as acting without due regard for the interests of other States by causing harmful contamination, and to be under a duty to consult. In this respect, Art. IX OST would give rise to an obligation of result—ie not to contaminate the outer space through the creation of space debris—and an obligation of conduct—ie to implement mitigation measures in order to prevent the production of debris.

However, there are a few problems with this assumption. First, from a practical perspective, it is impossible to operate in outer space without creating some amount of debris, which makes the discharge of the absolute prohibition of production of debris unfeasible to fulfil. Art. IX OST at best encourages States parties to limit the generation of new orbital space debris in a nonspecific manner, but there is little chance for a State to ever be held internationally responsible for a violation of Art. IX OST based upon creating...
ordinary space debris. Second, a critical aspect is how to enforce and apply such ill-defined obligations. Without specific guidelines, a State would have difficulty proving that another State, by allowing space debris to be created, had violated the due regard or harmful contamination clause contained in Art. IX OST. Accordingly, space debris mitigation guidelines and best practices might offer a tool for filling in such a normative lacuna.

17 Art. III OST provides that State activities in the use and exploration of outer space should be undertaken in accordance with international law, which includes international environmental law (→ Environment, International Protection). As space debris might have harmful effects on the outer space environment, international environmental law might be seen as part of the applicable legal framework. The customary rule prohibiting transboundary environmental harm, for instance, provides that States should not cause harm to the environment of other States or of areas beyond any State’s jurisdiction and, therefore, might be relevant with respect to the issue of space debris. It can be argued that, in light of this no harm rule, States have a → due diligence obligation to adopt measures aimed at reducing the generation of space debris and to preventively assess the potential environmental harm caused by space activities. Moreover, they should satisfy procedural requirements, which include a duty to inform, cooperate and consult other States concerning any expected significant environmental harm to outer space. Yet, regardless of recent clarifications (see, in particular, the judgment of the → International Court of Justice (ICJ) in → Certain Activities Carried out by Nicaragua in the Border Area and Construction of a Road in Costa Rica along the San Juan River Cases [2015]), this rule retains a certain degree of vagueness as far as procedural and substantive obligations concerning transboundary harm are concerned, especially if seen from the perspective of a potential harm to the outer space environment.

18 Other general principles of international environmental law may also be of pertinence. For instance, the → sustainable development principle, which merges environmental and economic concerns, might have a bearing on the way in which States conduct space activities. Furthermore, the → precautionary approach/principle—that is, that cost-effective measures should be taken to prevent environmental degradation where there is a threat of serious or irreversible damage, even notwithstanding a lack of full scientific certainty that damage, or a certain scale of damage, will occur—might also function as an additional ground requiring States to take measures in order to avoid the proliferation of space debris. The exact content of these principles and their legal status remain, however, contentious.

19 The fact that a handful of specially affected States—such as Canada, China, France, Germany, India, and the United States—have taken steps aimed at mitigating the production of new debris might also support the idea that an obligation ‘to mitigate’ has come into existence under the guise of custom (→ Customary International Law). Yet, these developments are quite recent and have concerned only a small number of States. More generally, the difficulty which characterizes any attempt to establish that a custom has actually been established and, in particular, whether → State practice is accompanied by States’ conviction of being legally bound to undertake certain conduct, inevitably affects this assumption.

E. Space Debris Remediation

20 An exponential increase in space debris is expected even if no more launches take place, due to the increase in the rate of collisions among space debris. For this reason, remediation, mainly in the form of active removal, is commonly seen as a necessary step.
While so far there is no technology capable of removing debris from outer space, several legal issues can already be identified that could hinder its practical application.

21 A first aspect is whether States are under an obligation to actively remove space debris that they have created through their national space activities. The corpus iuris spatialis does not explicitly provide for such an obligation. The duty to avoid harmful interference, contained in Art. IX OST, and the aforementioned environmental law principles, do not seem, in fact, to provide a ground to infer such an obligation. Neither is the practical application of other environmental law principles, such as the polluter pays principle—pursuant to which the polluter should in principle bear the cost of remediating pollution—useful in deducing an obligation for the State of registry to remove space debris. Moreover, it would be difficult to apply such a rule in practice, given that linking a specific space debris to a State of registry may prove particularly hard.

22 Another major legal issue is whether a State can actively remove space debris that other States have created. Art. VIII OST establishes an obligation to register space objects and provides that the State of registration retains jurisdiction and control over them. Hence, if one accepts the argument that space debris should constitute a space object, any removal operation carried out by other States would inevitably require the prior consent of the State of registration. But even leaving aside instances where consent is denied, it may prove extremely problematic to retrace the State of registry when the removal concerns small particles of space objects registered and launched many years earlier.

23 Whether the hazard posed by space debris might instead satisfy the requirements of necessity (Necessity, State of), and thus preclude the wrongfulness of an active removal operation in breach of the control and jurisdiction rule—in lack of authorization by the State of registry—is questionable. This would in fact require that removal of a specific object is the only means at the disposal of the State to safeguard one of its essential interests from a grave and imminent peril. The character of imminence and gravity of the peril posed by a specific object to a State’s essential interest can, however, be difficult to prove in such a case.

24 In practice, active removal might also be discouraged by the hazard inherent to such operations, which could potentially lead to complex liability—which State is to be held liable in case of damage caused during an active removal operation? Are there standards of care which might help in assessing fault in this scenario?—and by the unwillingness of States to share technical information in case of dual-use space objects—which could make it difficult to obtain consent to undertake the removal.

25 The above considerations apply also in case of on-orbit satellite servicing, meant, for instance, to extend mission life by refuelling or to facilitate post-mission disposal. Whereas on-orbit servicing could have a positive impact on the issue of space debris, by reducing the amount of non-functional objects on the most congested orbits, and thus the risk of collision, its implementation by States different from the State of registration would feature the same problems that have been underlined with respect to active debris removal.

F. Prospects and Assessment

26 Several initiatives have been undertaken at the international level, which seek to identify best practices and standards to be endorsed and implemented for tackling the issue of space debris. The UN COPUOS Space Debris Mitigation Guidelines, which—as previously discussed—owe much to the IADC Guidelines, are generally seen as the main instrument addressing the issue of space debris to date. They set measures aimed at limiting the creation of space debris both in the near future and over the long term, by reducing the production of debris during normal space operations and by avoiding intentional and
unintentional break-up. The measures envisaged include, for instance, the design of space systems in a manner that will not produce space debris or, at least, to avoid failures; the avoidance of any intentional destruction of a spacecraft in orbit or other harmful activities capable of generating space debris; and the removal from orbit of non-operational spacecraft in a controlled fashion.

27 The Long Term Sustainability of Space Activities (‘LTSSA’) is another initiative that has flourished within the S&T Sub-Committee of UN COPUOS since 2010, when an ad hoc Working Group was established and tasked with producing a consensus report outlining voluntary best practice guidelines for all space actors to ensure the long-term sustainable use of outer space. As of February 2018, the SubCommittee had adopted a set of twenty-one guidelines, addressing policy, regulatory, operational, safety, scientific, technical, international cooperation, and capacity-building aspects of space activities, including, for instance, the registration and design of space objects and the sharing of information (Guidelines for the Long-term Sustainability of Outer Space Activities).

28 In the Legal Sub-Committee of UN COPUOS an item titled ‘General exchange of information on national mechanisms relating to space debris mitigation measures’ has been on the agenda since 2009. This item focuses on the implementation of mitigation mechanisms at the domestic level, but does not deal with substantive legal aspects related to debris mitigation measures. Any attempt to introduce a discussion on the review of the substantive legal aspects of the UN COPUOS Space Debris Mitigation Guidelines has in fact failed to reach the necessary consensus to give rise to a new agenda item.

29 The Group of Governmental Experts on Transparency and Confidence-Building Measures (‘TCBMs’) in Outer Space Activities, convened by the UN Secretary General in 2011 on the basis of UNGA Res 65/68 (2010), has also dealt with the issue of space sustainability and safety. In its 2013 Report (UN Doc A/68/189), the GGE envisaged, inter alia, measures related to the promotion of spaceflight safety aimed to avoid harmful interference, limit the creation of space debris and minimize the risk of collision.

30 The → International Organization for Standardization (ISO) has also developed space debris mitigation standards. Its top-level standard (ISO 24113:2011) sets basic measures relating to the design, operation and disposal of spacecraft and launch vehicles, with a view toward reducing the generation of space debris.

31 Efforts to propose measures aimed at decongesting outer space orbits have also taken place at the regional level. In 2004, for instance, the → European Space Agency (ESA) and the Space Agencies of France, Germany, Italy and the United Kingdom adopted a European Code of Conduct for Space Debris Mitigation. In 2012, the European Union has also launched international consultations on a Draft International Code of Conduct for Outer Space Activities—first drafted in 2008, and later amended in 2010 and in 2014—as a means to achieve enhanced safety and security in outer space through the development and implementation of transparency and confidence-building measures. It provides for the establishment and implementation of policies geared towards minimizing the risk of on-orbit collisions and avoiding intentional destruction of spacecraft or launch vehicles unless this is required to reduce the creation of space debris itself. The Draft Code, however, has not met the support of the main spacefaring States.

32 All these initiatives constitute important tools for the purpose of tackling the problem of space debris. Yet, each one has failed to create legally binding obligations on States. By contrast, they merely set out recommendations to which States can voluntarily adhere. The involvement of spacefaring States in some of these initiatives might facilitate the implementation of the measures envisaged at the national level—eg by adopting specific
regulations or by using such guidelines in domestic licensing procedures, as has already occurred in some States.

Additional concerns relate to the content of these initiatives. For instance, the problem of space debris falling on the Earth’s surface is generally overlooked by such initiatives. Moreover, even if the measures envisaged are fully implemented on a voluntarily basis, they fall short of effectively curtailing the amount of existing space debris and, thus, the potential risks of a Kessler effect event, as they mainly focus on avoiding the creation of new debris.

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