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Legal and Political Challenges of Active Space Debris Removal
– Towards an International Normative Framework

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1. Introduction

Space activities and applications are of growing importance for our society not only in terms of technological progress but also for economic and social development more generally. At the same time, the safe and sustainable conduct of space activities is increasingly threatened by the rising amount of debris in outer space. While in 2005 the total mass of catalogued objects in Earth orbit was an estimated 5,000 tons, this number had risen to approximately 6,000 tons by 2010 and amounts to over 7,400 tons today.¹ At present, approximately 18,347 space objects with sizes ranging from a few centimetres to several meters are officially catalogued.² Of these, however, only 1,200 are operational satellites.³ The large majority of objects in Earth orbit is therefore space debris. This includes non-functional spacecraft and orbital stages, fragments from accidental collisions, break-ups or intentional destruction of spacecraft as well as operational debris, such as instrument covers or pieces of paint and isolation.⁴

With the growing number of functional and non-functional objects in Earth orbit, the probability of in-orbit collisions is rising. Once a critical density of objects is reached, the rate of fragment creation by collisions will exceed the rate of removal of objects from Earth orbit by natural decay. Therefore, the debris population will increase, even if no further objects are launched into outer space. This collision cascading effect, described as “Kessler Syndrome”, could render the use of outer space for human activities impossible in the future.⁵ Against the background of so called “megaconstellations”, which are currently under development and envisage the placement of several hundreds or thousands of satellites in Earth orbit, this concern becomes increasingly relevant.⁶

¹ National Aeronautics and Space Administration, “Monthly Mass of Objects in Earth Orbit by Object Type”, *Orbital Debris Quarterly News*, Volume 21, Issue 1, February 2017, p. 13.

² National Aeronautics and Space Administration, “Satellite Box Score”, *Orbital Debris Quarterly News*, Volume 21, Issue 2, May 2017, p. 14. Note that this number excludes data of military spacecraft, debris that cannot be attributed to a specific source as well as very small objects that cannot be tracked with current technologies. According to statistical models, the current number of space objects larger than 10 cm is approximately 29,000 and the number of objects of a size between 1 and 10 cm is in the order of 750,000. See: European Space Agency, “Space Debris by the Numbers”, January 2017, http://www.esa.int/Our_Activities/Operations/Space_Debris/Space_debris_by_the_numbers (accessed 1.5.2017).

³ European Space Agency, “Space Debris by the Numbers”, January 2017, http://www.esa.int/Our_Activities/Operations/Space_Debris/Space_debris_by_the_numbers (accessed 1.5.2017).

⁴ Heiner Klinkrad, “Space Debris: Models and Risk Analysis”, Springer, 2006, pp. 18-27; Inter-Agency Space Debris Coordination Committee, Support to the IADC Space Debris Mitigation Guidelines, IADC-04-06, Rev 5.5, 2014, pp. 7-8.

⁵ Donald J. Kessler and Burton G. Cour-Palais, “Collision Frequency of Artificial Satellites: The Creation of a Debris Belt”, *Journal of Geophysical Research*, Vol. 83, June 1978, pp. 2637-2646; Donald J. Kessler, “Collisional cascading: The limits of population growth in low earth orbit”, *Advances in Space Research*, Vol. 11, Issue 12, 1991, pp. 63-66.

⁶ See e.g. the planned constellations by OneWeb which consist of between 720 and 1,280 satellites, the constellation developed by Boeing which includes between 1,396 and 2,956 satellites, and the constellations

In order to limit the future growth of the space object population, non-binding guidelines and standards on space debris mitigation have been developed at the international level.⁷ While a widespread implementation of these instruments has been shown to be effective in reducing the generation of new space debris, it is regarded as insufficient to stabilise the space debris environment in the long term due to the large number of objects already in Earth orbit.⁸ Therefore, the active removal of space debris has been suggested as a necessary and effective step to enhance the sustainability and safety of space activities.⁹ While space debris mitigation refers to the prevention of the creation of future debris, active space debris removal addresses the elimination of existing debris from Earth orbit. Initiatives to develop and demonstrate technologies and procedures for the active removal of space debris are currently undertaken by governments, space agencies as well as private actors.¹⁰ Suggested technologies for debris capturing and removal range from robotic arms, nets and harpoons to laser systems and drag augmentation devices.¹¹

However, the use of these technologies raises several legal and political questions and concerns. These include the question whether an obligation to remove space debris exists under international law, the possible infringement of states' jurisdiction and control over space objects they have registered, the international responsibility of states regarding space debris removal activities, the dual-use characteristics of removal technologies as well as liability for potential damage caused as a result of debris removal operations. Security aspects are of particular relevance in this context, as debris

planned by SpaceX which consist of between 4,425 and 7,518 satellites. Caleb Henry, "FCC gets five new applications for non-geostationary satellite constellations", Spacenews, 2 March 2017, <http://spacenews.com/fcc-gets-five-new-applications-for-non-geostationary-satellite-constellations/#sthash.eFN9uU45.dpuf> (accessed 1.5.2017).

⁷ See e.g.: United Nations Committee on the Peaceful Uses of Outer Space, Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space, Report of the Committee on the Peaceful Uses of Outer Space, Fiftieth Session, 6-15 June 2007, General Assembly, Official Records, Sixty-second Session, Supplement No. 20 (A/62/20), Annex, 2007; Inter-Agency Space Debris Coordination Committee, IADC Space Debris Mitigation Guidelines, IADC-02-01, Revision 1, 2007; ASI, BNSC, CNES, DLR and ESA, European Code of Conduct for Space Debris Mitigation, Issue 1.0, 2004; International Organization for Standardization, Space systems - Space Debris Mitigation Requirements, ISO 24113, 2011.

⁸ Luciano Anselmo et al., "Effect of mitigation measures on the long-term evolution of the debris population", *Advances in Space Research*, Vol. 28, 2001, pp. 1427-1436; Inter-Agency Space Debris Co-ordination Committee, Stability of the Future LEO Environment, IADC-12-08, Rev. 1 January 2013.

⁹ Jer Chyi Liou and Nicholas L. Johnson, "A sensitivity study of the effectiveness of active debris removal in LEO", *Acta Astronautica*, Vol. 64, January-February 2009, pp. 236-243; Jer Chyi Liou et al., "Controlling the growth of future LEO debris populations with active debris removal", *Acta Astronautica*, Vol. 66, March-April 2010, pp. 648-653.

¹⁰ See e.g. ESA's Clean Space Initiative (http://www.esa.int/Our_Activities/Space_Engineering_Technology/Clean_Space/e.Deorbit), the Swiss CleanSpace One project (http://espace.epfl.ch/CleanSpaceOne_1), or the Chinese "Roaming Dragon" satellite (D. Axe, "Is China's Mysterious New Satellite Really a Junk Collector - or a Weapon?", *The Daily Beast*, 5.7.2016, <http://www.thedailybeast.com/articles/2016/07/05/is-china-s-mysterious-new-satellite-really-a-junk-collector-or-a-weapon.html>) (all accessed 1.5.2017).

¹¹ Minghe Shan, Jian Guo and Eberhard Gill, "Review and comparison of active space debris capturing and removal methods", *Progress in Aerospace Sciences*, Vol. 80, January 2016, pp. 18-32.

removal technologies can be used not only for the removal of hazardous space debris but also for the destruction or damage of active, intact spacecraft. Consequently, the development of debris removal technologies may be interpreted as deployment of anti-satellite weapon capabilities. Since a growing number of states use space activities and applications for security purposes, interference with space assets can be perceived as threat to national security. This could generate misperceptions and mistrust among states and lead to instability at the international level.

The active removal of space debris is thus of importance for different dimensions of space security.¹² It is regarded as necessary measure to ensure the security of space assets by protecting them from damage or destruction caused by space debris to guarantee their sustainable use. At the same time, it poses a challenge for space security from a military perspective due to the dual-use nature of debris removal technologies. The thesis therefore aims at analysing the legal and political challenges posed by active space debris removal with a particular focus on security related aspects. Since especially in the area of international security legal and political issues are highly intertwined an interdisciplinary approach appears suitable to address the topic in a comprehensive manner.

2. Current State of Research and Contribution of the Thesis

The active removal of space debris is a novel topic that has only recently become an issue of interest at the international level. This is on the one hand due to the growing realisation over the past few years that space debris is increasingly posing a serious threat for the safety of space activities and on the other hand due to the recent development of the technology necessary for the conduct of removal operations by several state and non-state actors. Therefore, an increasing number of scientific works exists that analyse the technical aspects of active space debris removal.¹³ However, there is only very limited literature concerning the legal and political aspects. Furthermore, the existing works are generally limited to pointing out some of the challenges related to active debris removal rather than undertaking an in-depth analysis or developing concrete and feasible solutions. In addition, the topic is mostly addressed either from a political perspective or from a legal perspective, the interrelated challenges posed by active space debris removal are therefore not tackled in a comprehensive

¹² For a description of the different dimensions of space security see: Michael Sheehan, "Defining Space Security" in Kai-Uwe Schrogl, Peter L. Hays, Jana Robinson and Denis Moura (eds.), *Handbook of Space Security: Policies, Applications and Programs*, Springer, 2014, pp. 7-21.

¹³ See e.g.: Jer Chyi Liou, "An active debris removal parametric study for LEO environment remediation", *Advances in Space Research*, Volume 47, Issue 11, June 2011, pp. 1865-1876; Christophe Bonnal, Jean-Marc Ruault, Marie-Christine Desjean, "Active Debris Removal: recent progress and current trends", *Acta Astronautica*, Vol. 85, April-May 2013, pp. 51-60; International Academy of Astronautics, "Space Debris Environment Remediation", August 2013.

manner.¹⁴ Moreover, discussions at the international level involving the issue of active space debris removal have only started recently and have so far not led to a concrete outcome.¹⁵ Consequently, neither binding nor non-binding international legal instruments exist that specifically address active space debris removal. The thesis therefore hopes to contribute to the ongoing discussions through a profound and interdisciplinary analysis of the legal and political aspects of active space debris removal which aims at proposing concrete ways to effectively tackle the issue of space debris removal at the international level.

With regard to the analysis of the legal challenges posed by active space debris removal, the thesis can build upon existing literature on legal questions related to space activities in general which focuses on the analysis and interpretation of international space law. Of particular relevance for this thesis are works that address the issues of liability for damage caused by space objects, the responsibility of states for national governmental and non-governmental space activities, the use of force in outer space and jurisdiction and control over space objects.¹⁶ Moreover, the issue of space debris has been discussed at the UN level as well as in academic works since the 1980s.¹⁷ Extensive literature therefore exists on the problem of space debris from a technical as well as from a legal perspective. The thesis will in particular examine works that focus on the analysis of international space debris mitigation instruments as well as on legal issues concerning space debris, such as the liability for damage caused by space debris.¹⁸ With respect to the security aspects of space debris removal, the thesis can draw on

¹⁴ See e.g.: Brian Weeden, "Overview of the legal and policy challenges of orbital debris removal", *Space Policy*, Vol. 27, February 2011, pp. 38-43; Melissa K. Force, "When the Nature and Duration of Space Becomes Appropriation: Use as a Legal Predicate for a State's Objection to Active Debris Removal" in *56th Colloquium on the Law of Outer Space, Proceedings of the International Institute of Space Law 2013*, Eleven International Publishing, 2014, pp. 405-420.

¹⁵ See e.g. the International Code of Conduct for Outer Space Activities (http://eeas.europa.eu/non-proliferation-and-disarmament/outer-space-activities/index_en.htm) and the UNCOPUOS Guidelines on the Long-term Sustainability of Outer Space Activities (United Nations Committee on the Peaceful Uses of Outer Space, Report of the Committee on the Peaceful Uses of Outer Space, Fifty-ninth Session, 8-17 June 2016, General Assembly, Official Records, Seventy-first Session, Supplement No. 20, (A/71/20), paras 125-138 and Annex, 2016).

¹⁶ See e.g.: Armel Kerrest, "Liability for Damage Caused by Space Activities" in Marietta Benkö and Kai-Uwe Schrogl (eds.), *Space Law: Current Problems and Perspectives for Future Regulation*, Eleven International Publishing, 2005, pp. 91-112; Bernhard Schmidt-Tedd and Stephan Mick, "Article VIII" in Stephan Hobe, Bernhard Schmidt-Tedd and Kai-Uwe Schrogl (eds.), *Cologne Commentary on Space Law*, Volume I, Carl Heymanns Verlag, 2009, pp. 146-168; Francis Lyall and Paul B. Larsen "Space Objects: Control, Registration, Return and Liability - The Treaties and the Practice" in Francis Lyall and Paul B. Larsen, *Space Law: A Treatise*, Ashgate, 2009, pp. 81-127; Fabio Tronchetti, "Legal Aspects of the Military Uses of Outer Space" in Frans von der Dunk with Fabio Tronchetti (eds.), *Handbook of Space Law*, Edward Elgar Publishing, 2015, pp. 331-381.

¹⁷ See e.g.: United Nations Committee on the Peaceful Uses of Outer Space, Impact of Space Activities on the Earth and Space Environment, (A/CONF. 101/BP/4), 1981; Howard A. Baker, "Space Debris: Legal and Policy Implications", Martinus Nijhoff Publishers, 1989; United Nations Committee on the Peaceful Uses of Outer Space, Technical Report on Space Debris, (A/AC.105/720), 1999.

¹⁸ See e.g.: Detlef Alwes, Marietta Benkö and Kai-Uwe Schrogl, "Space debris: an item for the future", in Marietta Benkö and Kai-Uwe Schrogl (eds.), *International space law in the making: current issues in the UN Committee on the Peaceful Uses of Outer Space*, Editions Frontière, 1993, pp. 233-273; George T. Hackett, "Space debris and the

existing analyses in the area of space security and space strategy. Over the past years, the topic of space security has received increasing attention, as new actors, such as China, Iran and North Korea, are seeking to enter the military space realm and are thus posing a growing challenge to the dominant position of the United States with regard to the military uses of outer space. The debate is focused on the question whether robust space defence is needed to protect critical space assets or whether the deployment of weapons in outer space should be avoided to prevent military conflict. Works that put this debate into historical context and explain the main trends, underlying causes and influencing factors of military space developments are particularly relevant for the analysis of the security related aspects of active space debris removal.¹⁹

3. Research Question

The main question to be answered in the framework of the thesis can be summarised as follows:

How can the legal and political challenges related to the active removal of space debris best be addressed at the international level in order to foster a safe, sustainable and peaceful conduct of debris removal activities in accordance with international law?

To answer this question comprehensively, the following sub-questions will be addressed:

- To what extent is existing international law, in particular international space law, applicable to debris removal activities and what kind of problems arise in this regard?
- Is the existing international legal framework sufficient to tackle the challenges posed by active space debris removal or is the development of additional regulation necessary?
- Which international forum or body could be most suitable for discussions on the issue of active space debris removal as well as for the negotiation of possible future international regulations regarding this issue?
- What could be the legal nature and the main characteristics and provisions of a possible international normative framework on active space debris removal?

To answer these questions the thesis will analyse the existing international legal framework applicable to active debris removal activities in order to identify legal concerns that have not been envisaged previously due to the novelty of such activities and to assess whether additional regulation is needed.

corpus iuris spatialis”, Éditions Frontières, 1994; Stephan Hobe and Jan Mey, “UN Space Debris Mitigation Guidelines”, *Zeitschrift für Luft- und Weltraumrecht* Vol. 61, 2012, pp. 388-403; Marcus Schladebach, “Space Debris as a Legal Challenge”, *Max Planck Yearbook of United Nations Law*, Vol. 17, 2013, pp. 61-85.

¹⁹ See e.g.: James C. Moltz, “The Politics of Space Security: Strategic Restraint and the Pursuit of National Interests”, Stanford University Press, 2nd ed., 2011; Edythe Weeks, “Outer Space Development, International Relations and Space Law”, Cambridge Scholars Publishing, 2012; Kai-Uwe Schrogl, Peter Hays, Jana Robinson and Denis Moura, “Handbook of Space Security: Policies, Applications and Programs”, Springer, 2014.

It will furthermore examine the political context in which international discussions on the active removal of space debris take place with a view to analyse how to best address the topic at the international level to allow for the development of effective and feasible international regulations that can give practical guidance to space actors.

4. Theoretical Framework and Methodology

The methodology used in the thesis will primarily consist of a profound examination of primary and secondary legal sources as well as of a review and critical analysis of academic literature. In addition, reports and studies by space related international, regional and national organisations and institutions, such as UN bodies, space agencies and think tanks, will be examined. Moreover, current discussions and recent initiatives at the international level involving the topics of space debris and active space debris removal will be analysed. For this purpose, a textual analysis of the proposed instruments as well as of statements and documents submitted by states and space related institutions during international negotiations will be undertaken. This will be complemented by interviews with delegates and staff of international organisations as well as with government officials involved in the international discussions and initiatives. The analysis of literature, documents and interviews will be based on the analytical method proposed by Heiner Legewie.²⁰ This method is particularly suitable for the purpose of this thesis as it allows for an analysis of documents in their social and political context. It furthermore permits the interpretation of different types of documents ranging from academic literature and policy studies to statements and interviews.²¹

In order to analyse recent international discussions and negotiations involving the issue of active space debris removal as well as to evaluate states' positions on this issue, International Relations theories will be applied. International Relations theories present a suitable theoretical framework for the analysis of multilateral negotiations as they allow to better understand strategic international actions. In the context of negotiations regarding the active removal of space debris, they can for instance be used to explain why states have opposing views on the topic of active space debris removal, which aspects of debris removal are most controversial and why negotiations on active debris removal have failed in the past.

The thesis will primarily apply the theories of realism and liberalism to analyse states' positions with regard to active space debris removal. According to the realist theory, in an environment of anarchy

²⁰ Heiner Legewie, "Globalauswertung von Dokumenten" in Andreas Boehm, Andreas Mengel and Thomas Muhr (eds.), *Texte verstehen: Konzepte, Methoden, Werkzeuge*, Universitätsverlag Konstanz, 1994, pp. 177-182.

²¹ Ibid, p. 177.

and distrust, the main objective of states to survive is best pursued by an increase in power which maximises their security.²² Thus, an unequal distribution of gains is seen as a central obstacle to international cooperation and can explain the failure of negotiations with regard to security related issues, such as active space debris removal. States with advanced space technology would not be willing to give up their advantages over other states by concluding international agreements that limit their capabilities. In the liberal theory security is also of importance. However, according to this theory, security can be achieved by mutually beneficial international cooperation. The liberal view highlights the importance of international institutions, which can contribute to international cooperation and confidence building by providing a platform for information exchange as well as opportunities for negotiations. While in the realist theory military security dominates the agenda, in the liberal view other issues such as welfare are also of importance. Moreover, according to the liberal theory decision-makers are able to “learn” and to change their positions based on new insights and advanced knowledge.²³ The liberal theory can therefore be applied to explain the reasons why states would be willing to negotiate international regulations on space debris removal, including that they realise the importance of space activities for social and economic progress, that they become aware of the increasing threat space debris is posing to the conduct of space activities and that they recognize the mutual benefit for all states, if space debris removal operations are conducted in a safe, secure and peaceful manner under a common international framework. The use of International Relations theories to analyse international negotiations involving active space debris removal can help to determine states’ positions in future negotiations and thus to identify practically feasible ways to address the topic at the international level and to propose concrete normative solutions.

5. Preliminary Structure

The first part of the thesis will give an overview of the increasing problem space debris is posing for the safety and sustainability of space activities and will analyse why there is a need for active space debris removal. It will first focus on definitional and technical issues related to space debris, which include inter alia the definition of space debris, the main types and sources of debris as well as the

²² Kenneth N. Waltz, “Theory of International Politics”, Random House, 1979. See also Robert Jackson and Georg Sorensen, “Introduction to International Relations: Theories and Approaches”, Oxford University Press, 6th ed., 2015, pp. 61-92; Tim Dunne, Milja Kurki and Steve Smith, “International Relations Theories: Discipline and Diversity”, Oxford University Press, 4th ed., 2016, pp. 34-66.

²³ Robert O. Keohane (ed.), “International Institutions and State Power - Essays in International Relations Theory”, Westview Press, 1989; Robert O. Keohane and Joseph S. Nye (eds.), “Power and Interdependence”, Longman, 3rd ed., 2001. See also Robert Jackson and Georg Sorensen, “Introduction to International Relations: Theories and Approaches”, Oxford University Press, 6th ed., 2015, pp. 96-126; Tim Dunne, Milja Kurki and Steve Smith, “International Relations Theories: Discipline and Diversity”, Oxford University Press, 4th ed., 2016, pp. 68-106.

qualification of space debris as space object, which is of further relevance for the legal questions related to active space debris removal.²⁴ It will moreover discuss the most important space debris mitigation guidelines and standards that have been developed at the international level²⁵ and highlight some of the main legal concerns regarding space debris, such as the issue of liability for damage caused by debris objects.²⁶ It will furthermore give an overview of the current space debris environment and examine recent scientific studies which demonstrate that a tipping point has been reached where the amount of space debris will augment even without further launches, due to collisions between objects that are already in Earth orbit.²⁷ Finally, some of the most recent initiatives to develop and test debris removal technologies will be presented.²⁸

In the second part of the thesis, the existing legal framework applicable to active space debris removal activities will be analysed. For this purpose, treaty obligations, provisions of customary international law as well as non-binding international standards and guidelines in the areas of international space law, international environmental law and general public international law that could be applied to space debris removal activities will be examined. This will on the one hand allow to identify lacunae in the existing legal framework and to assess where additional regulation is needed to ensure a sustainable, safe and peaceful use of debris removal technologies. It will on the other hand permit to identify existing applicable regulations that should be taken into account when elaborating new normative instruments.

As a first issue, the question whether an obligation to remove space debris objects from Earth orbit or to cooperate in the removal operation exists under international law will be analysed. The analysis will be undertaken from an international space law perspective based on a discussion of Articles I and IX

²⁴ See e.g.: Carsten Wiedemann, "Space Debris Mitigation" in Irmgard Marboe (ed.), *Soft Law in Outer Space*, Böhlau, 2012, pp. 315-324; Peter Stubbe, Vladimir Kopal and Kai-Uwe Schrogl, "The 2007 Space Debris Mitigation Guidelines of the UN Committee on the Peaceful Uses of Outer Space" in Stephan Hobe, Bernhard Schmidt-Tedd and Kai-Uwe Schrogl (eds.), *Cologne Commentary on Space Law*, Volume III, Carl Heymanns Verlag, 2015, pp. 605-657.

²⁵ See footnote 7 above.

²⁶ See e.g.: Luboš Perek, "Ex Factor Sequitur Lex: Facts Which Merit Reflection in Space Law in Particular with Regard to Registration and Space Debris Mitigation" in Marietta Benkő and Kai-Uwe Schrogl (eds.), *Space Law: Current Problems and Perspectives for Future Regulation*, Eleven International Publishing, 2005, pp. 29-46. Lesley Jane Smith, Armel Kerrest and Fabio Tronchetti, "The 1972 Convention on International Liability for Damage Caused by Space Objects" in Stephan Hobe, Bernhard Schmidt-Tedd and Kai-Uwe Schrogl (eds.), *Cologne Commentary on Space Law*, Volume II, Carl Heymanns Verlag, 2013, pp. 83-226.

²⁷ See e.g.: Jer Chyi Liou, "An active debris removal parametric study for LEO environment remediation", *Advances in Space Research*, Volume 47, Issue 11, June 2011, pp. 1865-1876; Technische Universität Braunschweig - Institute of Aerospace Systems, "Maintenance of the ESA MASTER Model - Final Report", European Space Agency, 2011; National Aeronautics and Space Administration, "Monthly Number of Objects in Earth Orbit by Object Type", *Orbital Debris Quarterly News*, Volume 20, Issues 1 & 2, April 2016.

²⁸ See footnote 10 above.

of the Outer Space Treaty²⁹, as well as from an environmental law perspective including an analysis of ICJ decisions such as the case concerning the Gabčíkovo-Nagymaros project³⁰, of the Draft Articles on Prevention of Transboundary Harm from Hazardous Activities adopted by the International Law Commission (ILC) in 2001³¹ as well as of UN instruments such as the Stockholm and Rio Declarations.³²

A main focus of the analysis will be on security aspects related to the development and use of debris removal technologies. In this context, space law and general public international law norms on the use of force and self-defence will be examined in connection with active space debris removal. This includes inter alia analyses of Articles IV and IX of the Outer Space Treaty and of Articles 2(4) and 51 as well as Chapter VII of the UN Charter.³³ The concepts of militarisation and weaponisation of outer space as well as the term “space weapon” will also be discussed.

Another area of focus will be the question of jurisdiction over space debris objects. Under international space law the state of registry of a space object retains jurisdiction and control over the object while it is in outer space. A removal of the object by another state than the state of registry would therefore constitute an internationally wrongful act. In this connection, the questions of jurisdiction and state responsibility, in particular the circumstances precluding wrongfulness, will be analysed from a space law perspective as well as from a general public international law perspective. The discussion will focus on Article VIII Outer Space Treaty and the ILC Draft Articles on Responsibility of States for Internationally Wrongful Acts.³⁴

The issue of responsibility will also be discussed more generally with regard to the conduct of removal operations, together with the question of liability for damages caused during such operations. The question of liability is of general importance since the active removal of space debris is a highly complex

²⁹ Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, done 27 January 1967, entered into force 10 October 1967, 610 UNTS 205, 6 ILM 386 (1967).

³⁰ Case concerning the Gabčíkovo-Nagymaros Project (Hungary/Slovakia), Judgment, I.C.J. Reports 1997, p. 7.

³¹ International Law Commission, Draft articles on Prevention of Transboundary Harm from Hazardous Activities, with commentaries, Report of the International Law Commission on the work of its Fifty-third Session, 23 April-1 June and 2 July-10 August 2001, General Assembly, Official Records, Fifty-sixth Session, Supplement No.10 (A/56/10), para 98, 2001.

³² Declaration of the United Nations Conference on the Human Environment, Stockholm, 16 June 1972; Rio Declaration on Environment and Development, Rio de Janeiro, 14 June 1992.

³³ Charter of the United Nations, done 26 June 1945, entered into force 24 October 1945, USTS 993.

³⁴ International Law Commission, Draft articles on Responsibility of States for Internationally Wrongful Acts, with commentaries, Report of the International Law Commission on the work of its Fifty-third Session, 23 April-1 June and 2 July-10 August 2001, General Assembly, Official Records, Fifty-sixth Session, Supplement No.10 (A/56/10), para 77, 2001. On state responsibility and jurisdiction in general see e.g.: James Crawford and Simon Ollesen, “The Character and Forms of International Responsibility” in Malcolm D. Evans (ed.) *International Law*, Oxford University Press, 4th ed., 2014, pp. 443-464; Malcolm N. Shaw, “International Law”, Cambridge University Press, 7th ed., 2014, pp. 469-505 and 566-577.

undertaking that bears the risk of damaging intact spacecraft. The responsibility of states is particularly relevant with regard to the conduct of removal activities by private entities. The discussion will include a general discussion of state responsibility and liability under public international law as well as a detailed analysis of Articles VI and VII Outer Space Treaty, Articles II, III and IV Liability Convention³⁵ and of international instruments on space debris mitigation.³⁶

The third part of the thesis will analyse the international political context in which discussions on the active removal of space debris take place. It aims at exploring ways of addressing this issue at the international level that allow for the successful elaboration of an international regulation on active space debris removal. First the legal nature of a possible normative framework will be discussed. Advantages and disadvantages of both, binding and non-binding instruments will be analysed and the practical feasibility of each option will be examined.³⁷ Furthermore, possible fora for the elaboration of international regulations on active space debris removal, such as the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS), the Conference on Disarmament or an independent expert body, will be discussed. In order to assess the feasibility of the development of an international normative framework on active space debris removal, current international discussions and recent multilateral initiatives involving this issue, such as the International Code of Conduct for Outer Space Activities and the Guidelines on the Long-term Sustainability of Outer Space Activities, will be examined.³⁸ In this context, International Relations theories will be applied to analyse the positions of states regarding active debris removal activities and to make recommendations for future negotiations on a normative framework at the international level.

Based on the principal findings of the previous chapters, the conclusion will seek to propose an achievable legal form for an international normative framework on active space debris removal as well as a suitable forum for the elaboration of such a framework. It will furthermore recommend provisions that should be included in the framework in order to ensure that debris removal activities are carried out in a safe and sustainable manner and do not pose a threat to international security.³⁹ These include inter alia internationally agreed criteria and procedures for the selection of objects for removal,

³⁵ Convention on International Liability for Damage Caused by Space Objects, done 29 March 1972, entered into force 1 September 1972, 961 UNTS 187, 10 ILM 965 (1971).

³⁶ See footnote 7 above.

³⁷ See e.g. P. J. Blount, "Renovating Space: The Future of International Space Law", *Denver Journal of International Law and Policy*, Vol. 40, Issue 1-3, 2011-2012, pp. 515-532; Marco Ferrazzani, "Soft Law in Space Activities - An Updated View" in Irmgard Marboe (ed.), *Soft Law in Outer Space*, Böhlau, 2012, pp. 99-117.

³⁸ See footnote 15 above.

³⁹ For this purpose, reference will be made to existing international treaties that regulate similar issues such as the Nairobi International Convention on the Removal of Wrecks, done 18 May 2007, entered into force 14 April 2015, 46 ILM 694 (2007).

conditions and standards for the conduct of removal operations and mechanisms for an enhanced exchange of data on space objects as well as for the broad and efficient sharing of information on planned removal missions among states in order to ensure transparency and safety of space debris removal activities.

6. Preliminary Structure - Overview

1. Introduction
2. Research Question and Methodology

Part I: The Problem of Space Debris and the Need for Active Space Debris Removal

3. Technical Aspects of Space Debris
 - 3.1. Definition of Space Debris
 - 3.2. Types and Sources of Space Debris
 - 3.3. Major Debris Creating Events
4. Legal Aspects of Space Debris
 - 4.1. Legal Status of Space Debris – Space Debris as Space Object?
 - 4.2. International Instruments on Space Debris Mitigation
 - 4.3. Legal Concerns
5. Active Space Debris Removal
 - 5.1. The Space Debris Environment
 - 5.2. Recent Scientific Studies – The “Kessler Syndrome”
 - 5.3. Initiatives for the Development of Debris Removal Technologies
6. Chapter Conclusion: The Need to Address Legal and Political Aspects of Active Space Debris Removal

Part II: Legal Aspects of Active Space Debris Removal

7. Obligation to Remove Space Debris
8. Security Aspects
9. Jurisdiction and Control
10. Responsibility and Liability
11. Chapter Conclusion: The Need for a Normative Framework on Active Space Debris Removal

Part III: Political Challenges of Active Space Debris Removal

12. Legal Nature of a Normative Framework on Active Space Debris Removal
 - 12.1. A Binding International Treaty
 - 12.2. A Non-Binding Instrument

13. Forum for the Negotiation of a Normative Framework on Active Space Debris Removal
 - 13.1. The United Nations Committee on the Peaceful Uses of Outer Space
 - 13.2. The Conference on Disarmament
 - 13.3. An Independent Expert Group

14. Recent Initiatives Involving Active Space Debris Removal
 - 14.1. The International Code of Conduct for Outer Space Activities
 - 14.2. The UNCOPUOS Guidelines on the Long-term Sustainability of Outer Space Activities

15. Chapter Conclusion: Forum for Negotiation, Legal Nature and Characteristics of a Normative Framework on Active Space Debris Removal

Part IV: Conclusion: A Normative Framework on Active Space Debris Removal

7. Research Plan

July 2016-June 2017:

- Preliminary research and drafting of the Exposé
- Research stay at McGill University, Institute of Air & Space Law (July-September 2016)
- Publication: “Small Satellites and Space Debris Mitigation”, in Irmgard Marboe (ed.), *Small Satellites – Regulatory Challenges and Chances*, Brill Nijhoff, Studies in Space Law Vol 11, 2016
- Completion of the following course:
 - VO zur rechtswissenschaftlichen Methodenlehre
 - Seminar zur Vorstellung und Diskussion des Dissertationsvorhabens
 - Seminar aus dem Dissertationsfach
 - Lehrveranstaltungen aus dem Dissertationsfach:
 - KU International and European Environmental Law
 - KU Collective Security and the Use of Force

July 2017-June 2018:

- Further research on the thesis topic
- Participation in the Centre for Studies and Research of The Hague Academy of International Law on the topic “50 Years of Space Law – Space Law in 50 Years” (August-September 2017)
- Work on the publication: “Space Traffic Management – A New Perspective for Space Law?” in *The Hague Academy of International Law Centre for Studies and Research “50 Years of Space Law – Space Law in 50 Years”*, Brill Nijhoff
- Completion of the following courses:
 - Seminar aus dem Dissertationsfach
 - Lehrveranstaltung aus dem Dissertationsfach:
 - KU General Legal Framework of the Use of Outer Space Technologies

July 2018-June 2019:

- Further research and drafting of the thesis
- Work on the publication: “Austrian National Space Law”, in *Oxford Encyclopedia of Planetary Science*, Oxford University Press

July 2019-December 2020:

- Further drafting and finalisation of the thesis
- Research stay at George Washington University, Space Policy Institute (planned for summer 2019)

8. Preliminary Bibliography (Extract)

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